İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

ELASTİK ZEMİNE OTURAN TIMOSHENKO KİRİŞİNİN SONLU ELEMANLAR YÖNTEMİYLE ELASTOPLASTİK ANALİZİ

YÜKSEK LİSANS TEZİ

Elif YAZICI

Anabilim Dalı : İnşaat Mühendisliği

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Tez Danışmanı: Prof. Dr. Metin AYDOĞAN

HAZİRAN 2009

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HAZİRAN 2009

ÖNSÖZ

İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü'ne bağlı Yapı Mühendisliği programında gerçekleştirilen bu yüksek lisans tez çalışmasında Timoshenko kirişleri detaylı olarak incelenmiş, çeşitli şartlar altındaki problemlerin çözümü gerçekleştirilmiştir.

Çalışma boyunca her konuda benden yardımını esirgemeyen saygı değer hocam Prof.Dr. Metin Aydoğan başta olmak üzere bugüne kadar eğitimimde emeği geçmiş herkese teşekkürü bir borç bilirim.

Haziran 2009

Elif YAZICI

İnşaat Mühendisi

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ELASTİK ZEMİNE OTURAN TIMOSHENKO KİRİŞİNİN SONLU ELEMANLAR YÖNTEMİYLE ELASTOPLASTİK ANALİZİ

ÖZET

Günümüzde teknolojinin ilerlemesine paralel olarak gelişen bilgisayar programları, değişik bilim dallarına ait problemlerin çözümünde kolayca uygulanmakta, bu sayede muhtelif koşullar altında çeşitli sistemlerin davranışları önceden belirlenebilmektedir.

Bu çalışmada pek çok mühendislik probleminin çözümünde oldukça iyi bir yaklaşım sağlayan sonlu eleman yöntemi kullanılarak FORTRAN dilinde yazılan bir bilgisayar programı yardımıyla Timoshenko kirişi için muhtelif tip problemlere ait elastoplastik çözümler elde edilmiştir. Bu program yüksek lisans tezine konu olan Timoshenko kirişlerinin tabakalı ve tabakasız halleri için, farklı zemin koşulları, yüklemeler ve değişik malzeme durumlarında davranışlarının incelenmesinde kullanılmıştır.Timoshenko kirişleri genel kiriş teorisine ilaveten enine kayma şekil değiştirmelerini de dikkate alır ve L/h (genişliğinin yüksekliğine oranı) değeri küçük olan problemlerde çok daha doğru sonuçlar verdiğinden "Kalın Kiriş" teorisi olarak da bilinir.

Çalışmanın girişten sonraki bölümünde bir boyutlu elastoplastik problemler ve çözüm yöntemlerinden bahsedilmiştir. Üçüncü bölümde Timoshenko kirişi ayrıntılı olarak irdelenerek sonlu eleman yaklaşımının bu kirişlere uygulanmasına ait esaslar verilmiştir. Dördüncü bölümde kullanılan bilgisayar programlarına ait akış diyagramları verilmiş, ana ve alt programlar ve bu programlarda kullanılan komutların işlevleri ayrıntılı olarak sunulmuştur. Beşinci bölümde Timoshenko kirişlerinin elastik zemine yataklanma durumu da dahil olmak üzere tekil ve yayılı yük etkileri altında uygulamalar yapılmıştır. Aynı bölümde tabakalı hal için de çözümler bulumaktadır. Altıncı ve son bölümde önceki bölümde yapılan çözümler irdelenerek sonuçlar verilmiştir.

ELASTOPLASTIC FINITE ELEMENT ANALYSIS OF TIMOSHENKO BEAM ON ELASTIC FOUNDATION

SUMMARY

Nowadays computer programs has developed in parallel with technological advancement. Most of these programs could be easily applied to solution process of various problems relating to various branches of science. Thanks to these applications attitudes of different systems can be determined easily.

In this study elastoplastic solution of Timoshenko beam is achieved by using the finite element method which provides fairly well approximate solutions for many engineering problems. Mathematical calculations were carried on a computer program which taken from the literature and improved by the author of this thesis in Fortran programming language. This program is used to obtain the behaviour of the nonlayered Timoshenko beams at different foundation conditions, loading types and material properties. The layered beam case is also analyzed.

This thesis consist of six chapters. The first chapter is introduction. The second chapter is devoted to one dimensional elastoplastic problems and the summary of the general four solution methods. In the third chapter the essentials of Timoshenko beam theory is explained in detail and the principals of finite element method for Timoshenko beam is introduced. In the fourth chapter computer programs is given with flow charts. Master and subroutine programs are examined with all of their commands. In the fifth chapter Timoshenko beam applications were presented under the concentrated and uniform loading conditions including the embedment in the elastic foundation. In the same chapter some solutions for the layered case also introduced. In the last chapter the results of the numerical solutions assessed and conclusion is presented.

1. GİRİŞ

1.1 Konu

Kirişler yapılarda döşeme ve duvarlardan gelen yüklerle yapının kullanım amacına göre değişen yük etkilerini düşey taşıyıcı elemanlara aktaran ve düşey taşıyıcıların bağlanarak çerçeve sisteminin oluşturulmasını sağlayan yapı elemanlarıdır.

Uygulamada en çok kullanılan kiriş teorisi Euler-Bernoulli kiriş teorisidir. Bunun nedeni basitliğidir. Bu teoride şekil değiştirmeden önce ortalama düzleme dik olan kesitin şekil değişiminden sonra da dik kaldığı varsayılır. Timoshenko kiriş teorisinde ise enine kayma şekil değiştirmeleri de dikkate alınır. Yani şekil değiştirmeden önce ortalama düzleme dik olan kesit şekil değişiminden sonra bu düzlemle bir açı yapar, ancak düzlem kesit yine düzlem kalır (Bernoulli-Navier hipotezi). Timoshenko kiriş teorisi Euler-Bernoulli kiriş teorisinden daha gelişmiş ve bir anlamda onun iyileştirilmiş halidir. Özellikle kısa ve yüksek kirişler, yani açıklık/yükseklik oranı düşük olan kirişler, için Euler-Bernoulli teorisine nazaran daha doğru sonuçlar verir.

1.2 Çalışmanın Amacı ve Kapsamı

Günümüzde bilgisayar teknolojisi ve yazılımlardaki gelişmelere paralel olarak birçok bilim dalında olduğu gibi yapı mühendisliği alanında da çeşitli yapı elemanlarının farklı koşullar altındaki davranışlarını değişik yaklaşımlarla incelemek ve daha hassas sonuçlar elde etmek oldukça kolaylaşmıştır.

Bu çalışmanın amacı bir parametreli elastik zemine (Winkler zemini) oturan Timoshenko Kirişinin elastoplastik davranışının sonlu eleman yaklaşımıyla incelenmesidir. Çalışmanın kapsamı içinde bir boyutlu doğrusal olmayan problemler ve çözüm yöntemleri özetlenmiş, bir boyutlu elastoplastik problemler açıklanmıştır.

Timoshenko Kirişinin sonlu elemanlar yöntemi ile elastoplastik analizi açıklanarak çözüm amacıyla kullanılan ve literatürde daha önce geliştirilmiş olan bir bilgisayar programı hakkında bilgi verilmiştir. Tez kapsamında söz konusu programda bazı iyileştirmeler yapılarak ilgili rutinler tadil edilmiştir. Keza programda elastik zemine oturma haline ait eklenti ve değişikliklikler de yapılmıştır.

Önce tabakasız hale ait bilgisayar programı açıklanmış, daha sonra tabakalı hal için yapılan değişiklikler gösterilmiştir. Program FORTRAN dilinde kodlanmıştır.

Tabakasız hal için kullanılan programdaki rijitlikler yerine kayma şekil değiştirmelerini dikkate alan rijitlik matrisi konularak bulunan çözümler öncekiler ile karşılaştırılmıştır. Bu hal için ayrıca elastik zemine yataklanma durumu da incelenmiştir.

Yukarıda açıklanan problemlerle ilgili programlara ait giriş bilgileri ve çıkış düzenleri anlatılmış, sayısal uygulamalara ait sonuçlar grafikler ve çıktılar halinde verilmiştir.

2. BİR BOYUTLU DOĞRUSAL OLMAYAN PROBLEMLER

Bilim ve mühendisliğin birçok dalıyla ilgili olan doğrusal olmayan pek çok problem, katsayıları ana değişkenlere bağlı fonksiyonlardan oluşan denklemlere indirgenerek çözüm yapılabilir. Bu başlık altında tez konusuna esas olan problemin çözümünde kullanılacak olan yöntemler açıklanacaktır.

2.1 Doğrusal Olmayan Problemler İçin Basit Sayısal Çözüm Yöntemleri

Sonlu eleman yönteminin doğrusal olmayan problemlerin çoğunun çözümünde kullanılan denklem formu;

$$\mathbf{H}\boldsymbol{\varphi}+\boldsymbol{f}=0 \qquad \textbf{(2.1)}$$

şeklindedir. Bu denklemde "**φ**" temel bilinmeyenler vektörünü, "***f*** " yük vektörünü, " **H** " rijitlik matrisini temsil etmektedir. Yapısal problemlerde "yük" ve "rijitlik" terimleri doğrudan kullanılabilirken, diğer mühendislik ve fizik problemlerinde bu terimlerin anlamları göz önüne alınan fiziksel probleme göre değişebilmektedir.

Bu denklemdeki **H** matrisi, eğer **φ** bilinmeyenleri veya türevlerine bağlı ise problem doğrusal olmaz. Bu durumda **(2.1)** denkleminin doğrudan çözümü genellikle mümkün olmaz ve iteratif çözüm yolları kullanılır. İteratif çözüm yöntemlerinin en çok uygulananları aşağıda sıralanmıştır:

2.1.1 Doğrudan iterasyon (veya ardışık yaklaşım) yöntemi

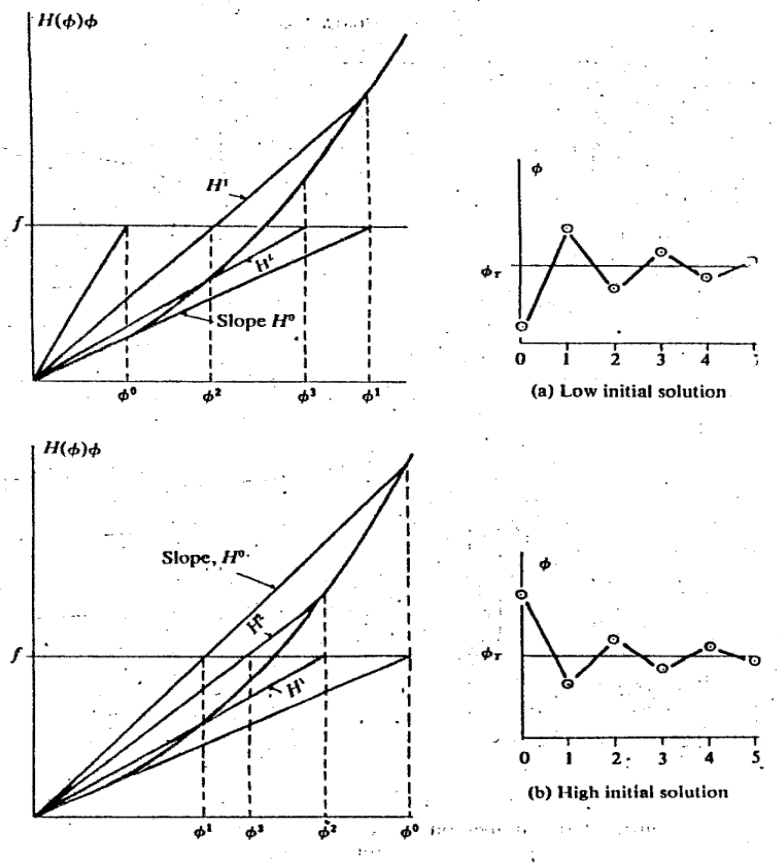
Bu yöntemde ardışık çözümler kullanılır. Her bir çözüm bir önceki çözümdeki φ bilinmeyenlerinin H(φ) matrisindeki değerini tahmin etmek için kullanılır.

(2.1) denklemi yeniden yazılır ve (r+1). İterasyon için düzenlenirse

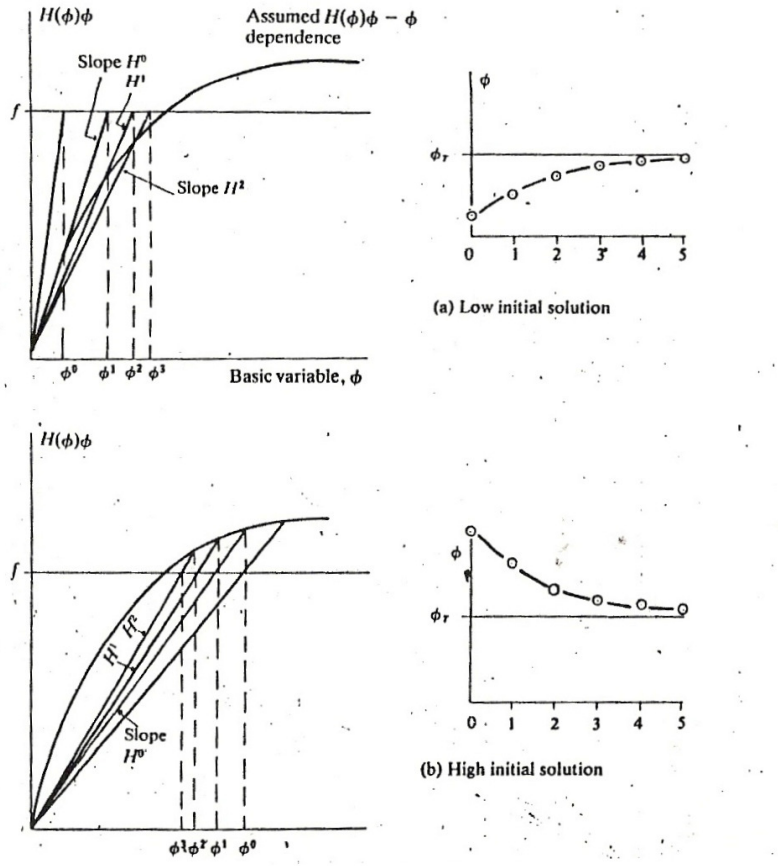
$$\varphi = -\left[H(\varphi)\right]^{-1} \cdot f \qquad \textbf{(2.2)}$$

$$\varphi^{r+1} = -\left[H(\varphi^{r})\right]^{-1} \cdot f \qquad \textbf{(2.3)}$$

olur. Eğer çözüm yakınsıyorsa, yani r sonsuza giderken, φ doğru sonuca yaklaşır. **(2.3)** denkleminden görüldüğü gibi her iterasyon adımı için rijitlik matrisi H yeniden hesaplanmalıdır. Çözüme başlarken φ bilinmeyeninin tahmini başlangıç rijitlik matrisinin hesaplanabilmesi için gereklidir.



Şekil 2.1: Tek değişkenli problem için direkt iterasyon yöntemi-içbükey H-ø ilişkisi



Şekil 2.2: Tek değişkenli problem için direkt iterasyon yöntemi-dışbükey H-ø ilişkisi

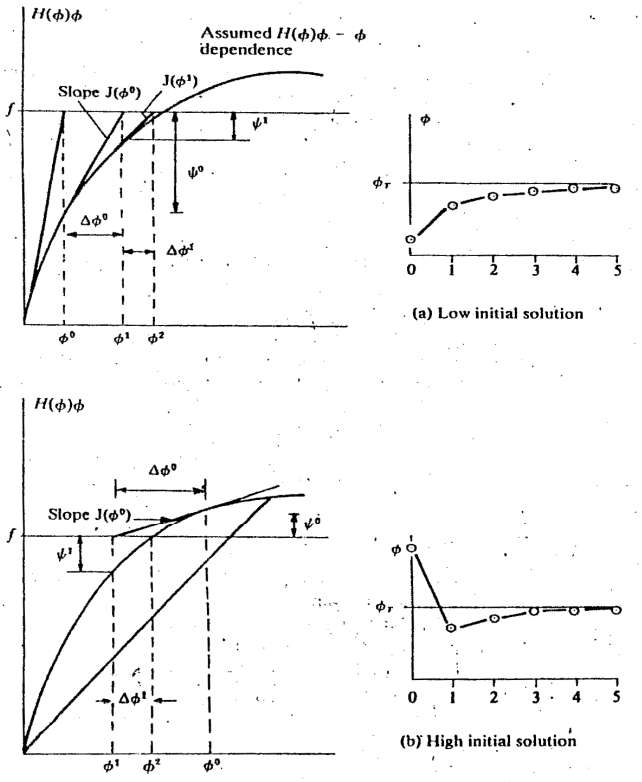
2.1.2 Newton- Raphson yöntemi

Doğrudan iterasyon yöntemindeki iteratif çözüm yönteminin herhangi bir aşamasında sonuca yakınsama olmadan **(2.1)** denklemi sağlanamaz. Newton-Raphson yönteminde artık kuvvetlerin olduğu varsayılır ve bu kuvvetlerin sistem çözümündeki varlığı aşağıdaki gibi gösterilir.

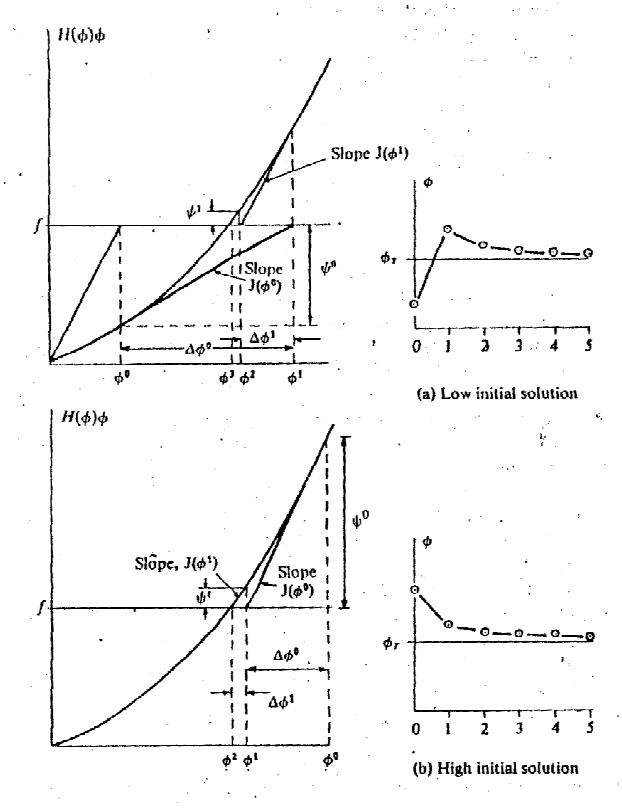
$$\psi = H\varphi + f \neq 0 \qquad \textbf{(2.4)}$$

Bu yöntemde bir $ø^0$ başlangıç değeri ile yaklaşıma başlanır. Şekil (2.4)'te görüldüğü gibi $J(ø^1)$ eğrisi ile $ø^0$ noktasının kesiştiği yerden $J(ø^1)$'e çizilen teğetin yatay ekseni kestiği yer yani $ø^1$ bir sonraki yaklaşımın başlangıç noktasıdır. Bu şekilde $ø^1$, $ø^2$, … , $ø^n$ ile eğrinin teğetinin yatay ekseni kesim noktaları bulunarak köke yaklaşılır.

Newton-Raphson yönteminde eğrinin kendisi yerine teğeti kullanılarak lineerleştirme yapılır. Ardışık yaklaşım, kök değeri izin verilen en büyük hata değerinden küçük olunca sona erer.



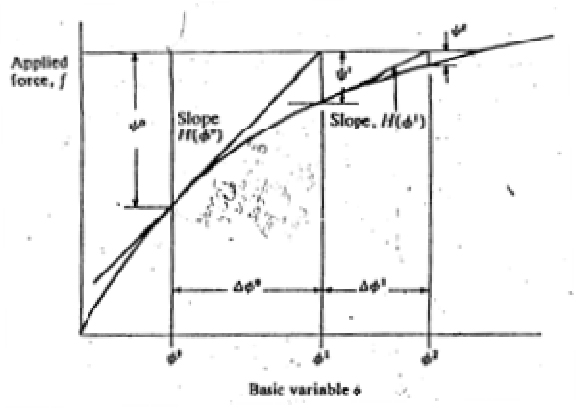
Şekil 2.3: Tek değişkenli problem için Newton-Raphson Metodu-dışbükey H-ø ilişkisi



Şekil 2.4: Tek değişkenli problem için Newton-Raphson Metodu-içbükey H-ø ilişkisi

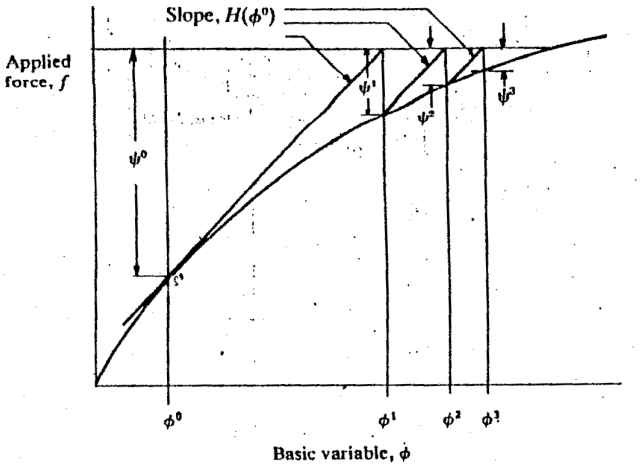
2.1.3 Teğetsel rijitlik yöntemi

Yapı mühendisliğinde H, yapının rijitlik matrisi olarak yorumlanabilir. Rijitliğin yer değiştirmenin derecesine bağlı olduğu doğrusal olmayan durumlarda H, yapının herhangi bir noktasındaki kuvvet-yer değiştirme ilişkisinin yerel değişimine eşittir ve bu teğetsel rijitlik olarak tanımlanır. Artımlar halinde çözüme gidilen problemlerin analizinde çözüm yapının sadece o andaki yer değiştirmelerine değil önceki yükleme geçmişine de bağlıdır. Herhangi bir yük adımında problem doğrusallaştırılabilir.



Şekil 2.5: Tek değişkenli problem için teğetsel rijitlik çözüm algoritması

2.1.4 Başlangıç rijitliği yöntemi



Şekil 2.6: Tek değişkenli problem için başlangıç rijitliği çözüm algoritması

Yukarıda bahsedilen diğer 3 yöntemde her iterasyonda denklem takımının tekrar çözümü gereklidir. Deneme değerlerinin hesabında başlangıçtaki denemeye karşı gelen rijitlikler kullanılırsa her adımda denklem takımının tekrar çözümü gerekmez. Bu halde tüm denklem takımının çözümü yalnızca ilk iterasyonda yapılır ve bunu takip eden yaklaşımlarda rijitlik için bu değer kullanılır. Her adımda, aynı rijitlik matrisi kullanıldığından, sadece adımın sağ tarafındaki terimler indirgenir. Bu,

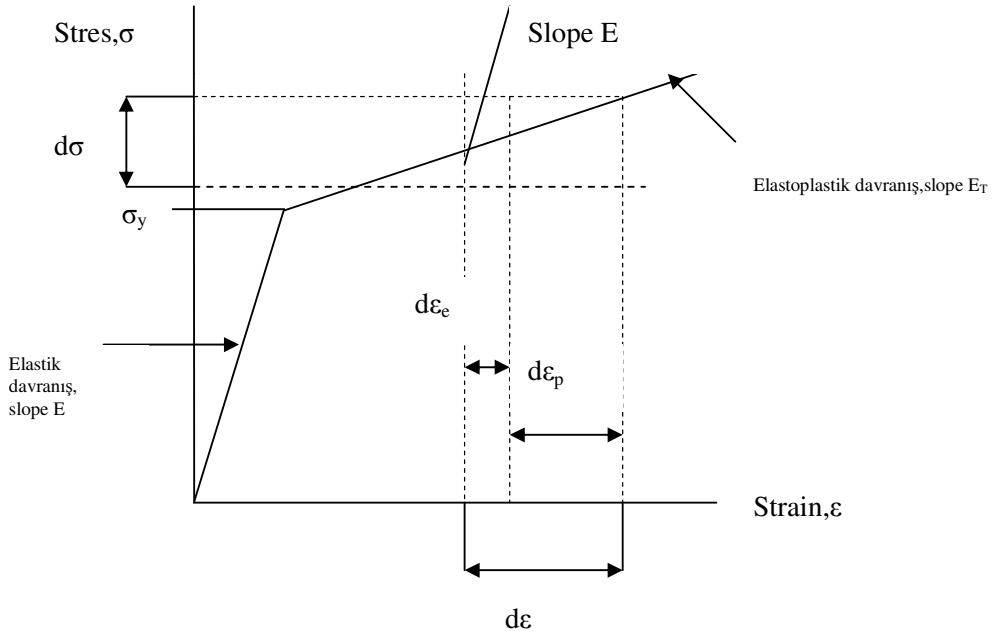
Şekil(2.6) da görüldüğü üzere çözüm süresini önemli bir oranda azaltır, ancak yakınsaklık oranını da düşürür. İterasyon algoritması teğetsel rijitlik yöntemindeki ile idantikdir. Bu yöntem koşulsuz olarak yakınsaktır ve malzemeden oluşan negatif rijitlikli hallerde de kullanılabilir. Başlangıç rijitliği ya da teğetsel rijitlik yöntemlerinden hangisinin daha ekonomik olduğu ilgilenilen probleme ait nonlineerlik derecesinin büyüklüğü ile alakalıdır. Optimum algoritma her iki yöntemin karışımı ile bulunabilir, yani seçilen iterasyon aralıkları için rijitlikler değiştirilebilir.

2.2 Bir Boyutlu Elastoplastik Problemler

Elastoplastik davranış, başlangıçtan belirli bir gerilme değerine kadar elastik olan malzeme davranışının bu seviyeden sonra plastik davranışa dönüşmesi olarak tanımlanabilir.

Plastik şekil değiştirme yüklemenin kaldırılmasıyla geri çevrilemez. Plastik şekil değiştirmenin başlangıcı (veya akma) akma kriteri ile tanımlanır ve genellikle akma sonrasında pekleşme bölgesi adı verilen şekil değiştirme diliminde malzeme rijitliği önemli ölçüde azalır.

Bir boyutlu problemlerde elastoplastik davranışın tam anlamıyla tanımlanabilmesi için gerekli olan malzeme parametreleri malzemeye tek eksenli çekme testi uygulanarak elde edilir.



Şekil 2.7: Elastoplastik davranış

Şekil(2.3) de bir malzeme için idealleştirilmiş gerilme-şekil değiştirme eğrisi görülmektedir. Çekme ve basınç etkileri altında malzemenin benzer davranış gösterdiği varsayılmıştır.

Malzeme, başlangıçta gerilme tek eksenli akma gerilmesi σ_y değerine ulaşıncaya kadar eğimi elastisite modülüne (E) eşit olacak şekilde doğrusal elastik şekil değiştirme yapar. Yükün gerilme akma sınırını aşacak şekilde artırılmasıyla malzemenin doğrusal olarak pekleştiği varsayılır. Pekleşen kısımdaki doğrunun eğimi teğetsel elastisite modülü (E_T) ile gösterilir ve E değerine göre oldukça yatık olduğu görülmektedir.

Yükün akmadan sonra artmaya devam etmesi sonucu akmadan sonra bir $d\varepsilon$ artımından dolayı $d\sigma$ gerilme artımı meydana gelsin. Şekil değiştirmenin iki ayrı bölgeye ayrılabildiği varsayılırsa

$$d\varepsilon = d\varepsilon_e + d\varepsilon_p \qquad \textbf{(2.5)}$$

yazılabilir.

Burada H' ile gösterilen bir pekleşme parametresi tanımlansın:

$$H' = \frac{d\sigma}{d\varepsilon_P} \tag{2.6}$$

Bu parametre gerilme-şekil değiştirme eğrisinin plastik kısmının elastik şekil değiştirme bileşenin kaldırılmasından sonraki eğimi olarak açıklanabilir.

$$H' = \frac{d\sigma}{d\varepsilon - d\varepsilon_e} = \frac{E_T}{1 - E_T / E} \tag{2.7}$$

Doğrusal yer değiştirme yapan tek eksenli çubuk elemanı dikkate alalım. Enkesit alanı A olan ve artan bir eksenel F kuvveti etkisinde olan bu elemanda $\sigma = F / A$ değerinin σ_y'ye eşit ya da küçük olduğu durumlarda malzeme elastiktir. Bu aralıkta çubuktaki eksenel yer değiştirme δ ve malzeme davranışının elastik olduğu düşünülerek K_e rijitliği

$$K_e = \frac{F}{\delta} = \frac{E \cdot A}{L} \tag{2.8}$$

olur. Eleman rijitlik matrisi ise:

$$K_e^{(e)} = \frac{EA}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \tag{2.9}$$

dir. F kuvveti malzeme akana kadar arttırılsın. Bu noktadan sonra elemanda ilave bir uzamaya (dδ) neden olan bir yük artımı (dF) olacaktır. Eleman uzunluğu L ise bu durumda aşağıdaki ifadeler yazılabilir:

$$d\delta = (d\varepsilon_e + d\varepsilon_p)L \tag{2.10}$$

$$dF = d\sigma A = AH' d\varepsilon_p \tag{2.11}$$

Bu durumda malzemenin teğetsel rijitliği ise

$$K_{ep} = \frac{dF}{d\delta} = \frac{AH' d\varepsilon_P}{L(d\sigma / E + d\varepsilon_p)} \qquad \textbf{(2.12)}$$

veya **(2.6)** denklemini kullanarak

$$K_{ep} = \frac{EA}{L}\left(1 - \frac{E}{E + H'}\right) \qquad \textbf{(2.13)}$$

şekillerinde yazılabilir.

Sonuç olarak elastoplastik malzeme davranışı için eleman rijitlik matrisi

$$K_{ep}^{(e)} = \frac{EA}{L} \cdot \left(1 - \frac{E}{E + H'}\right)\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \qquad \textbf{(2.14)}$$

ile verilir. **(2.14)** denkleminde matristen önceki ilk terim **(2.9)** denkleminde de görülebileceği gibi elastik rijitliği, ikinci terim ise akmadan dolayı malzeme elastikliğinde meydana gelen azalmanın rijitlikteki etkisini göstermektedir.

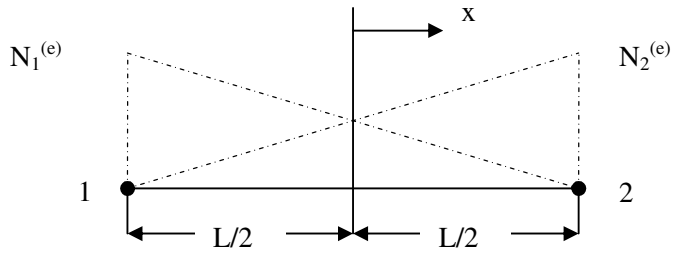
Sonlu elemanlar yönteminde eleman rijitlik matrisinin standart ifadesi aşağıdaki gibidir:

$$K_e^{(e)} = \int_V B^T DBdV = A\int_0^L B^T DBdx \qquad \textbf{(2.15)}$$

Tek boyutlu elemanlarda D=E olmak üzere

$$B = \begin{bmatrix} \frac{dN_1^{(e)}}{dx} & \frac{dN_2^{(e)}}{dx} \end{bmatrix} = \begin{bmatrix} \frac{-1}{L} & \frac{1}{L} \end{bmatrix} \qquad \textbf{(2.16)}$$

yazılabilir. Burada $N_1^{(e)}$ ve $N_2^{(e)}$ doğrusal yer değiştirmeye karşı gelen şekil fonksiyonlarıdır.



Şekil 2.8: Şekil fonksiyonları

$$N_1^{(e)} = \frac{1}{2} - \frac{x}{L} \qquad \textbf{(2.17)}$$

$$N_2^{(e)} = \frac{1}{2} + \frac{x}{L}$$

Netice olarak elastoplastik malzeme davranışı için teğetsel rijitlik matrisi D yerine D_{ep} konularak elde edilebilir:

$$D_{ep} = E \cdot \left(1 - \frac{E}{E + H'} \right) \qquad \textbf{(2.18)}$$

Tam (perfekt) plastik malzeme halinde akmadan hemen sonra $H' = 0$ ve **(2.14)** bağıntısından $K_{ep}^{(e)} = 0$ olur. Bu durumda elastoplastik teğetsel rijitlik matrisi tekil olur ve çözüm için teğetsel rijitlik yöntemi kullanılamaz. Bu güçlük başlangıç rijitliği yöntemi ile yenilebilir, bu halde her hesap adımında elastik eleman rijitlikleri kullanılır.

3. ELASTOPLASTİK TIMOSHENKO KİRİŞ ANALİZİ

Elastoplastik kiriş analizinin yapılacağı bu bölümde öncelikle kiriş analizi ile ilgili iki ana teori, Euler-Bernoulli ve Timoshenko kiriş teorileri, tanımlanacaktır:

- **Euler-Bernoulli Kiriş Teorisi:** Kübik yer değiştirmeleri esas alan deplasman yöntemi olan ve basitliği nedeniyle mühendisler tarafından en çok kullanılan teoridir. Burada kayma şekil değiştirmeleri dikkate alınmaz. Hermitian elemanla temsil edilebilen bu halde eğilme momentleri eleman boyunca lineer bir şekilde değişebilir.

- **Timoshenko Kiriş Teoremi:** Bu teori kayma gerilmelerinin etkilerini göz önüne alır.En basit Timoshenko kiriş eleman doğrusal yer değiştirmeleri esas alan Hughes elemanıdır. Bu elemanda eğilme momentleri eleman boyunca sabittir.

Euler-Bernoulli kiriş teoremi daha sık kullanılsa da, bu çalışmada elastoplastik kiriş analizinde kullanmak üzere Timoshenko kiriş teoremi ve sabit momentli sonlu elemanlar seçilmiştir.
Öncelikle Timoshenko kiriş teorisi ile ilgili temel varsayımlar özetlenmiş ve elastik hal için Hughes elemanına ait formülasyon verilmiştir.

Timoshenko kirişlerinin elastoplastik analizi için iki yaklaşım mevcuttur;

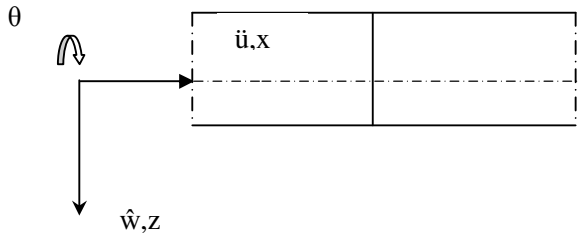
- **Tabakasız Yaklaşım:** Bu yöntemde eğilme momenti akma değerine ulaştığında tüm kiriş enkesitinin ani bir şekilde plastikleştiği varsayılır. Başlangıçta kirişin dış lifleri plastikleşirken hızla kesitin tamamında aşamalı bir şekilde plastikleşme meydana gelir ve tüm kesit plastikleşene kadar sürer.

- **Tabakalı Yaklaşım:** Bu yaklaşımda kiriş yüksekliği boyunca her biri farklı plastikleşen tabakalara ayrılır. Tabaka sayısı arttıkça kiriş yüksekliği boyunca plastiklikleşme kademeleri daha gerçekçi bir şekilde temsil edilir.

3.1 Timoshenko Kiriş Teorisinin Temel Varsayımları

Tipik bir Timoshenko kirişinde şekil değiştirmeden önce tarafsız eksene normal olan doğrular şekil değiştirmeden sonra da doğru olarak kalır, ancak tarafsız eksene normal kalmaları gerekmez.

Herhangi bir (x,z) noktasındaki eksenel yer değiştirme $\bar{u}$, normalin $\vartheta(x)$ dönmesi cinsinden doğrudan ifade edilebilir;



Şekil 3.1

$$\bar{u}(x,z) = -z\vartheta(x) \qquad \textbf{(3.1)}$$

Burada normal dönme $\vartheta(x)$, tarafsız eksenin eğimi ($\frac{d\bar{w}}{dx}$) ile enine kayma şekil değiştirmelerinden oluşan dönmenin (β) farkına eşittir. Yani

$$\vartheta(x) = \frac{d\bar{w}}{dx} - \beta \tag{3.2}$$

Herhangi bir (x,z) noktasındaki yanal yer değiştirme ($\bar{w}$) tarafsız eksene ait yanal yer değiştirmeye eşittir.

$$\bar{w}(x,z) = w(x) \tag{3.3}$$

3.1.1 Gerilme-şekil değiştirme bağıntıları:

Timoshenko kiriş teoresinde düzlem gerilme analizi için kullanılan elastik gerilme-şekil değiştirme bağıntıları biraz değiştirilerek kullanılır.
Kirişin x-z düzlemi boyunca yüklenmiş olduğu kabul edilerek izotrop elastik malzemeye ait gerilme-şekil değiştirme bağıntıları:

$$\begin{bmatrix} \sigma_x \\ \sigma_z \\ \tau_{xz} \end{bmatrix} = \frac{E}{1-\nu^2} \begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{(1-\nu)}{2} \end{bmatrix} \cdot \begin{bmatrix} \varepsilon_x \\ \varepsilon_z \\ \gamma_{xz} \end{bmatrix} \tag{3.4}$$

dır. Burada E elastisite modülü, ν ise Poisson oranıdır. σ_z'nin sıfıra eşit olduğu kabul edilir.

$$\varepsilon_z = -\nu \cdot \varepsilon_x \tag{3.5}$$

ve **(3.4)** denkleminde ε_z yerine konulursa;

$$\sigma_x = E \cdot \varepsilon_x \quad , \quad \tau_{xz} = G \cdot \gamma_{xz} \tag{3.6}$$

bağıntıları elde edilir. Burada (G) kayma modülü izotrop malzeme için $G = \frac{E}{2(1+\nu)}$ formülüyle bulunur.

3.1.2 Şekil değiştirme-yer değiştirme bağıntıları:

Genellikle küçük yer değiştirme teorisi kabul edilir ve eksenel şekil değiştirme ε_x;

$$\varepsilon_x = \frac{\partial \overline{u}}{\partial x} \tag{3.7}$$

olur. **(3.1)**' deki yaklaşım ile bu şekil değiştirme

$$\varepsilon_x = -z \cdot \frac{d\theta}{dx} \tag{3.8}$$

dir. Benzer şekilde kayma gerilmesi γ_{xz} :

$$\gamma_{xz} = \frac{\partial \overline{u}}{\partial z} + \frac{\partial \overline{w}}{\partial x} \tag{3.9}$$

olur. Eğer **(3.2)** yaklaşımı benimsenir ise γ_{xz}:

$$\gamma_{xz} = -\vartheta + \frac{d\overline{w}}{dx} = \beta \tag{3.10}$$

olarak elde edilir.

3.1.3 Virtüel iş prensibi

Kalınlığı t olan ve genişliğin kalınlık boyunca tarafsız eksene göre simetrik değiştiği bir Timoshenko kirişini ele alalım. Kiriş q üniform yayılı yüküne maruz olsun.

Eğer kirişte bir grup virtüel yanal yer değiştirmeler (δw), virtüel normal dönmeler ($\delta\vartheta$) , bunlarla bağlantılı virtüel eğrilik $-z \cdot \left[d(\delta\theta)/dx \right]$ ve virtüel kayma şekil değiştirmeleri $\delta\beta$ meydana gelirse buradan virtüel iş denklemi:

$$\int_0^l \int_{-t/2}^{t/2} \int_{b(-t/2)}^{b(t/2)} \left(-z \frac{d(\delta\theta)}{dx} \sigma_x + \delta\beta\tau_{xz} \right) dydzdx - \int_0^l \delta wqdx = 0 \qquad \textbf{(3.11)}$$

olarak veya

$$\int_0^l (-\frac{d(\delta\vartheta)}{dx} M + \delta\beta Q)dx - \int_0^l \delta wqdx = 0$$

yazılabilir. Burada M eğilme momenti ve Q kesme kuvveti:

$$M = \int_{-t/2}^{t/2} \int_{b(-t/2)}^{b(t/2)} z \cdot \sigma_x \cdot dy \cdot dz \qquad \textbf{(3.12)}$$

$$Q = \int_{-t/2}^{t/2} \int_{b(-t/2)}^{b(t/2)} \tau_{xz} \cdot dy \cdot dz \qquad \textbf{(3.13)}$$

dir. M ve Q denklemlerinde σ_x ve τ_{xz} yerine konulursa

$$M = \left(\int_{-t/2}^{t/2} \int_{b(-t/2)}^{b(t/2)} z^2 E dydz \right) \left(-\frac{d\theta}{dx} \right) = EI(-\frac{d\theta}{dx}) \qquad \textbf{(3.14)}$$

$$Q = \left(\int_{-t/2}^{t/2} \int_{b(-t/2)}^{b(t/2)} G dydz \right) \beta = GA\beta \qquad \textbf{(3.15)}$$

bağıntıları elde edilir. Burada EI eğilme rijitliği, GA**:** kayma rijitliği olup kesit çarpılmasını göz önünde bulunduran α düzeltme çarpanını dikkate almak üzere $G\hat{A}$ ile değiştirilir($\hat{A} = A/\alpha$). Örneğin dikdörtgen kesit için α= 1.5 alınır.

(3.13) ve **(3.14)** eşitliklerindeki M ve Q değerleri yukarıdaki değişikliğe göre yeniden düzenlenirse **(3.11)** denklemi aşağıdaki gibi yazılabilir:

$$\int_0^l \left(\frac{d(\delta\theta)}{dx} EI \frac{d\theta}{dx} + \delta\beta G\hat{A}\beta - \delta w q \right) dx = 0 \qquad \textbf{(3.16)}$$

3.1.4 Kiriş yaklaşımlarının karşılaştırılması:

Bu karşılaştırma için düzgün yayılı q yükü etkisindeki dikdörtgen kesitli basit bir kirişi ele alalım. EI eğilme rijitliği, **ν** Poisson oranı, t kalınlık, L kiriş uzunluğu olmak üzere elastik bölge içindeki yanal yer değiştirmeler;

- Düzlem gerilme halinde;

$$w = \frac{q \cdot L^4}{24EI}\left(\left[\left(\frac{x}{L}\right)^4 - \frac{3}{2}\cdot\left(\frac{x}{L}\right)^2 + \frac{5}{16}\right] + \left(\frac{t}{L}\right)^2 \cdot \left[\frac{12}{5} + \frac{3\nu}{2}\right] \cdot \left[\frac{1}{4} - \left(\frac{x}{L}\right)^2\right]\right) \qquad \textbf{(3.17a)}$$

- Timoshenko kirişi halinde;

$$w = \frac{q \cdot L^4}{24EI}\left(\left[\left(\frac{x}{L}\right)^4 - \frac{3}{2}\cdot\left(\frac{x}{L}\right)^2 + \frac{5}{16}\right] + \left(\frac{t}{L}\right)^2 \cdot \left[2\alpha \cdot (1+\nu)\right] \cdot \left[\frac{1}{4} - \left(\frac{x}{L}\right)^2\right]\right) \qquad \textbf{(3.17b)}$$

- Euler-Bernoulli kirişi halinde;

$$w = \frac{q \cdot L^4}{24EI}\left(\left[\left(\frac{x}{L}\right)^4 - \frac{3}{2}\cdot\left(\frac{x}{L}\right)^2 + \frac{5}{16}\right]\right) \qquad \textbf{(3.17c)}$$

olarak elde edilir. Yaklaşımlar karşılaştırıldığında (t / L) oranının küçük olduğu uzun ve narin kirişlerde Euler-Bernoulli teoreminin uygun sonuçlar verdiği, Timoshenko yaklaşımının tüm boyutlardaki kirişlerde yeterli ve doğru bir teori olduğu görülmektedir.

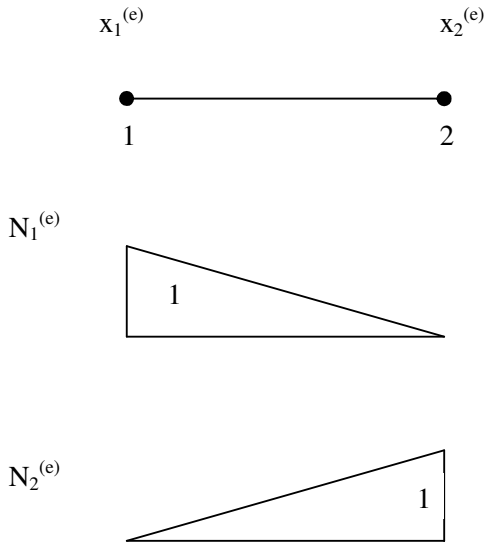
3.2 Doğrusal Elastik Timoshenko Kirişi için Sonlu Eleman Yaklaşımı

3.2.1 Yer değiştirme ve şekil değiştirme

Hughes elemanında yanal yer değiştirme (w):

$$w^{(e)} = N_1^{(e)} \cdot w_1^{(e)} + N_2^{(e)} \cdot w_2^{(e)} \qquad \textbf{(3.18)}$$

olup burada $w_1^{(e)}$ ve $w_2^{(e)}$ Şekil(3.2)' de gösterilen elemanın 1 ve 2 düğüm noktalarındaki yanal yer değiştirmeleri göstermektedir.



Şekil 3.2

$x_1^{(e)}$ ve $x_2^{(e)}$ **:** local düğüm noktaları 1 ve 2'nin x koordinatları, $l^{(e)}$**:** eleman uzunluğu, $x^{(e)}$: eleman üzerindeki bir noktanın x koordinatı olmak üzere,

$N_1^{(e)} = \dfrac{\left(x_2^{(e)} - x^{(e)}\right)}{l^{(e)}}$ ve $N_2^{(e)} = \dfrac{\left(x^{(e)} - x_1^{(e)}\right)}{l^{(e)}}$ olarak yazılır. Benzer şekilde eleman içinde herhangi bir noktadaki $\vartheta^{(e)}$ normal dönmesi

$$\vartheta^{(e)} = N_1^{(e)} \cdot \vartheta_1^{(e)} + N_2^{(e)} \cdot \vartheta_2^{(e)} \qquad \textbf{(3.19)}$$

İle verilir. Burada ϑ_1 ve ϑ_2 1 ve 2 düğüm noktalarındaki normal dönmeleri gösterir. Eğrilik-yer değiştirme bağıntıları:

$$-\left(\frac{d\vartheta}{dx}\right)^{(e)} = -\left(\frac{dN_1}{dx}\right)^{(e)} \vartheta_1^{(e)} - \left(\frac{dN_2}{dx}\right)^{(e)} \vartheta_2^{(e)} \qquad \textbf{(3.20)}$$

veya

$$\varepsilon_f^{(e)} = \begin{bmatrix} 0 & \dfrac{1}{l^{(e)}} & 0 & -\dfrac{1}{l^{(e)}} \end{bmatrix} \cdot \begin{bmatrix} w_1^{(e)} \\ \theta_1^{(e)} \\ w_2^{(e)} \\ \theta_2^{(e)} \end{bmatrix} = B_f^{(e)} \cdot \varphi^{(e)}$$ şeklinde yazılabilir.Burada $B_f^{(e)}$ eğrilik-yer değiştirme matrisidir. Kayma şekil değiştirmesi-yer değiştirme ilişkisi ise

$$\left(\frac{dw}{dx} - \vartheta\right)^{(e)} = \left(\frac{dN_1}{dx}\right)^{(e)} \cdot w_1^{(e)} - N_1^{(e)} \cdot \vartheta_1^{(e)} + \left(\frac{dN_2}{dx}\right)^{(e)} \cdot w_2^{(e)} - N_2^{(e)} \cdot \vartheta_2^{(e)} \qquad \textbf{(3.21)}$$

veya

$$\varepsilon_s^{(e)} = \begin{bmatrix} -\dfrac{1}{l^{(e)}} & -\dfrac{\left(x_2^{(e)} - x^{(e)}\right)}{l^{(e)}} & \dfrac{1}{l^{(e)}} & -\dfrac{\left(x^{(e)} - x_1^{(e)}\right)}{l^{(e)}} \end{bmatrix} \cdot \begin{bmatrix} w_1^{(e)} \\ \vartheta_1^{(e)} \\ w_2^{(e)} \\ \vartheta_2^{(e)} \end{bmatrix} = B_s^{(e)} \cdot \varphi^{(e)}$$

olarak yazılabilir. Burada da $B_s^{(e)}$ kayma şekil değiştirmesi-yer değiştirme matrisidir.

3.2.2 Rijitlik matrisinin teşkili

Önceki bölümde verilen eleman gerilme-şekil değiştirme ilişkilerini ve virtüel iş yaklaşımını kullanarak hakim denklem aşağıdaki gibi yazılabilir:

$$[K_f + K_s] \cdot \varphi - f = 0 \qquad \textbf{(3.22)}$$

Burada (e) elemanı için K_f , $K_{s\,v}$ alt matrisleri ile f alt vektörü aşağıda verilmiştir:

$$K_f^{(e)} = \int_{x_1^{(e)}}^{x_2^{(e)}} \left[B_f^{(e)}\right]^T \cdot (EI)^{(e)} \cdot B_f^{(e)} \cdot dx$$

$$K_s^{(e)} = \int_{x_1^{(e)}}^{x_2^{(e)}} \left[B_s^{(e)}\right]^T \cdot \left(G\hat{A}\right)^{(e)} \cdot B_s^{(e)} \cdot dx \qquad \textbf{(3.23)}$$

$$f^{(e)} = \int_{x_1^{(e)}}^{x_2^{(e)}} \left[N_1^{(e)} \quad 0 \quad N_2^{(e)} \quad 0\right]^T \cdot q \cdot dx$$

Eğilme elemanına ait rijitlik matrisi bir boyutlu Gauss-Legendre Kuralı kullanılarak aşağıdaki gibi yazılabilir:

$$K_f^{(e)} = \left(\frac{EI}{l}\right)^{(e)} \cdot \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \end{bmatrix} \qquad \textbf{(3.24)}$$

K_s'yi de iki boyutlu Gauss-Legendre kuralına göre yazarsak;

$$K_s^{(e)} = \left(\frac{G\tilde{A}}{l}\right)^{(e)} \cdot \begin{bmatrix} 1 & \frac{l}{2} & -1 & \frac{l}{2} \\ \frac{l}{2} & \frac{l^2}{3} & -\frac{l}{2} & \frac{l^2}{6} \\ -1 & -\frac{l}{2} & l & -\frac{l}{2} \\ \frac{l}{2} & \frac{l^2}{6} & -\frac{l}{2} & \frac{l^2}{3} \end{bmatrix} \quad \textbf{(3.25)}$$

olur.

Bu formülasyonla fazla rijit sonuçlar elde edildiği gösterilebilir. Kilitlenme adı verilen bu sorun $K_s^{(e)}$'yi bir boyutlu Gauss-Legendre kuralı ile elde ederek çözülmekte ve doğru sonuçlar elde edilebilmektedir:

$$K_s^{(e)} = \left(\frac{G\hat{A}}{l}\right)^{(e)} \begin{bmatrix} 1 & \frac{l}{2} & -1 & \frac{l}{2} \\ \frac{l}{2} & \frac{l^2}{4} & -\frac{l}{2} & \frac{l^2}{4} \\ -1 & -\frac{l}{2} & 1 & -\frac{l}{2} \\ \frac{l}{2} & \frac{l^2}{4} & -\frac{l}{2} & \frac{l^2}{4} \end{bmatrix} \quad \textbf{(3.26)}$$

Eşdeğer düğüm noktası kuvvet vektörü:

$$f^{(e)} = \begin{bmatrix} \frac{(ql)^{(e)}}{2} & 0 & \frac{(ql)^{(e)}}{2} & 0 \end{bmatrix} \quad \textbf{(3.27)}$$

dır. Burada Euler-Bernoulli kübik Hermitian elemanının aksine sadece yanal düğüm noktası kuvvetleri mevcuttur.

Tabakasız elastoplastik Timoshenko kirişinin sonlu elemanlar yöntemiyle analizinde kiriş eğilme momenti plastikleşme momenti (M_0) 'a ulaştığında bütün sistem plastik hale gelir. Böyle durumlarda eğilme rijitliği EI, elastoplastik eğilme rijitliği $(EI)_{ep}$ ile değiştirilir. Kesme rijitliği $G\hat{A}$'nın ise değişmediği kabul edilir.

3.2.2.1 Kayma şekil değiştirmelerini dikkate alan çubuk rijitlik matrisi

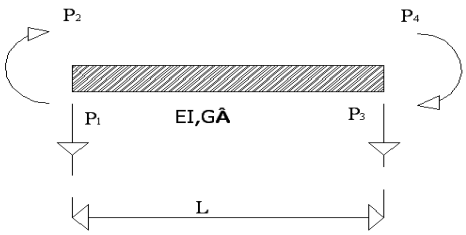
Bizim problemimize konu olan elastik zemine oturan tabakasız Timoshenko kirişinin çözümü için kullandığımız kayma şekil değiştirmelerini hesaba katan çubuk rijitlik matrisi aşağıdaki gibidir.

$$K_{e,k} = \begin{bmatrix} \frac{12EI}{l^3(1+\beta)} & \frac{6EI}{l^2(1+\beta)} & -\frac{12EI}{l^3(1+\beta)} & \frac{6EI}{l^2(1+\beta)} \\ \frac{6EI}{l^2(1+\beta)} & \frac{4EI(1+0.25\beta)}{l(1+\beta)} & -\frac{6EI}{l^2(1+\beta)} & \frac{2EI}{l}\cdot\frac{(1-0.5\beta)}{(1+\beta)} \\ -\frac{12EI}{l^3(1+\beta)} & -\frac{6EI}{l^2(1+\beta)} & \frac{12EI}{l^3(1+\beta)} & -\frac{6EI}{l^2(1+\beta)} \\ \frac{6EI}{l^2(1+\beta)} & \frac{2EI}{l}\cdot\frac{(1-0.5\beta)}{(1+\beta)} & -\frac{6EI}{l^2(1+\beta)} & \frac{4EI}{l}\cdot\frac{(1+0.25\beta)}{(1+\beta)} \end{bmatrix} \quad \textbf{(3.27)}$$

Burada $\beta = \frac{12EI}{G\hat{A}l^2}$ dır. Elastik zemin etkilerini içeren rijitlik matrisi ise;

$$K_{el,ze\min} = \begin{bmatrix} \frac{13}{35}\cdot K\cdot l & \frac{11}{210}\cdot K\cdot l^2 & \frac{9}{70}\cdot K\cdot l & -\frac{13}{420}\cdot K\cdot l^2 \\ \frac{11}{210}\cdot K\cdot l^2 & \frac{Kl^3}{105} & \frac{13}{420}\cdot K\cdot l^2 & -\frac{Kl^3}{140} \\ \frac{9}{70}\cdot K\cdot l & \frac{13}{420}\cdot K\cdot l^2 & \frac{13}{35}\cdot K\cdot l & -\frac{11}{210}\cdot K\cdot l^2 \\ -\frac{13}{420}\cdot K\cdot l^2 & -\frac{Kl^3}{140} & -\frac{11}{210}\cdot K\cdot l^2 & \frac{K\cdot l^3}{105} \end{bmatrix} \quad \textbf{(3.28)}$$

K= k_0(yatak katsayısı t/m^3) * b(kiriş genişliği)



Şekil 3.3

Elastik zemin halinde iki matrisin toplamı kullanılacaktır. K=0 halinde elastik yataklanmanın olmadığı açıktır.

3.2.3 Eleman iç kuvvetleri

(3.14) ve **(3.15)** denklemleri yardımıyla her bir eleman için eğilme momentini ve kesme kuvvetlerini hesaplayabileceğimiz ifadeleri elde edebiliriz.

Her eleman için sabit olan eğilme momenti

$$M^{(e)} = \left(EI\right)^{(e)} \cdot B_f^{(e)} \cdot \varphi^{(e)} = \left(EI\right)^{(e)} \cdot \left[0 \quad \frac{1}{l^{(e)}} \quad 0 \quad -\frac{1}{l^{(e)}}\right] \cdot \begin{bmatrix} w_1^{(e)} \\ \vartheta_1^{(e)} \\ w_2^{(e)} \\ \vartheta_2^{(e)} \end{bmatrix} = \left(\frac{EI}{l}\right)^{(e)} \cdot \left(\vartheta_1^{(e)} - \vartheta_2^{(e)}\right)$$

(3.29)

İfadesi ile bulunur. Kesme kuvveti her elemanda doğrusal olarak değişir, fakat bir yaklaşım olarak kesme kuvvetinin eleman ortasındaki ($x = \frac{x_1^{(e)} + x_2^{(e)}}{2}$) değeri alınıp kesme kuvvetinin eleman boyunca bu değere eşit olduğu varsayılacaktır. Kesme kuvveti aşağıdaki bağıntı ile elde edilir:

$$Q^{(e)} = \left(G\hat{A}\right)^{(e)} \cdot B_s^{(e)} \cdot \varphi^{(e)} = \left(G\hat{A}\right)^{(e)} \cdot \left[-\frac{1}{l^{(e)}} \quad -\frac{1}{2} \quad \frac{1}{l^{(e)}} \quad -\frac{1}{2}\right] \cdot \begin{bmatrix} w_1^{(e)} \\ \vartheta_1^{(e)} \\ w_2^{(e)} \\ \vartheta_2^{(e)} \end{bmatrix}$$

(3.30)

$$= \left(G\hat{A}\right)^{(e)} \cdot \left\{\left(\frac{w_2^{(e)} - w_1^{(e)}}{l^{(e)}}\right) - \left(\frac{\vartheta_1^{(e)} + \vartheta_2^{(e)}}{2}\right)\right\}$$

3.3 Elastoplastik Timoshenko Kirişleri

3.3.1 Akma momenti

Eğilme momenti etkisinde bir Timoshenko kirişini göz önüne alalım. Timoshenko yaklaşımına göre eksenel gerilme ve eksenel şekil değiştirme kesitin derinliği boyunca doğrusal olarak değişir. Eğilme momentinin artmasıyla beraber kesitin alt ve üst başlıklarındaki liflerde plastikleşme meydana gelir ve yükün biraz daha artmasıyla beraber plastikleşme tüm kesit plastikleşene kadar kesitin diğer kısımlarına da yayılmaya başlar. Sonunda en kesit tam plastik hale gelir. σ_x ve τ_{xz}'in etkileşimi kesitin akması boyunca ihmal edilmiştir. Bu ihmal doğru olmamakla beraber özellikle ince kirişlerde fark çok azdır.

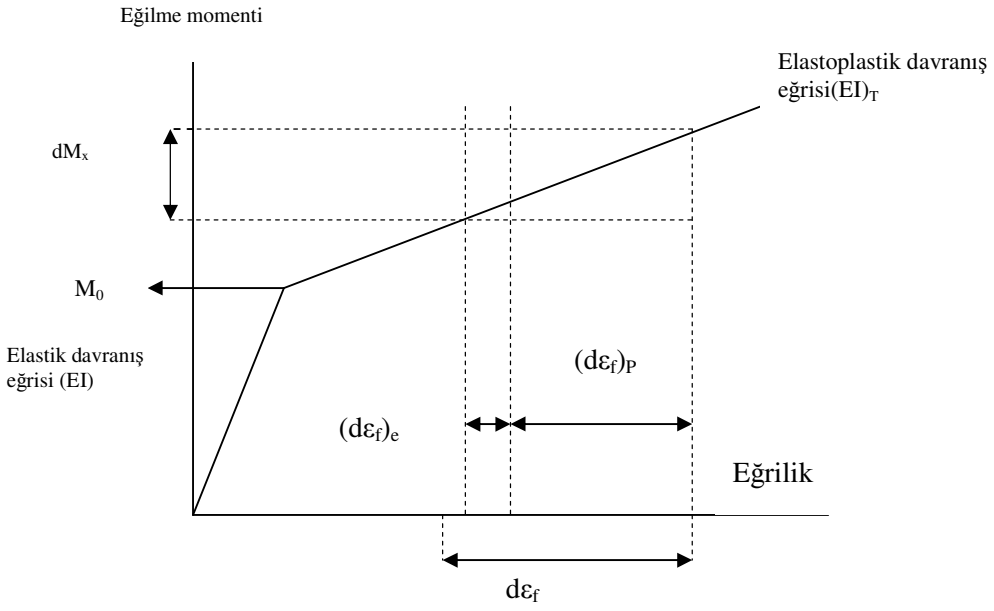
Tamamıyla plastikleşmiş kesitte meydana gelen limit momentin değeri, akma gerilmesi σ_0 cinsinden hesaplanabilir:

$$M_0 = \int_{b(-t/2)}^{b(t/2)} \int_{-t/2}^{t/2} z\,\sigma_0\,dz\,dy \qquad \textbf{(3.31)}$$

Bu değer genişliği b olan bir dikdörtgen kiriş için $M_0 = \sigma_0 \cdot \left(bt^2 \big/ 4\right)$ dir.

3.3.2 Elastoplastik eğilme

Önceki bölümlerde belirtildiği gibi elastoplastik davranış, başlangıçta elastik davranış gösteren malzemenin artan gerilme ile eğilme momenti akma momenti değerini geçtiğinde oluşan plastik şekil değiştirmeler ile tanımlanır. Plastik şekil değiştirme yüklemenin kaldırılmasıyla geri dönmez ve plastik şekil değiştirmenin başlaması akma kriteri ile belirlenir. Pekleşme anında malzeme rijitliğinde ciddi bir azalma görülür.



Şekil 3.4: Elastoplastik davranış

Elastoplastik malzemeli bir Timoshenko kirişi için moment-eğrilik ilişkisi yukarıda Şekil(3.4)'te görülmektedir. Kiriş başlangıçta eğilme rijitliğine (EI) bağlı olarak elastik bir şekilde şekil değiştirir. Bu deformasyon eğilme momentinin tüm kesitin plastikleştiği aşamadaki değerine gelmesine kadar sürer.

Yükün biraz daha arttırılmasıyla malzemenin teğetsel eğilme rijitliği $(EI)_T$ ile tanımlanan doğrusal plastik davranış gözlenir. Akma sınırı geçildikten sonra ilave bir yük artımı olduğunda bu artış eğilme momentinde eğriliğin değişimiyle sonuçlanan bir artış ($d\varepsilon_f$) meydana getirir. Eğriliği elastik ve plastik olmak üzere ikiye ayırırsak;

$$d\varepsilon_f = \left(d\varepsilon_f\right)_e + \left(d\varepsilon_f\right)_p \qquad \textbf{(3.32)}$$

Bu durumda pekleşme parametresi $H' = \dfrac{dM}{\left(d\varepsilon_f\right)_p}$ olarak tanımlanabilir. Bu parametrenin değeri elastik eğrilik kısmının çıkarılmasından sonra moment-eğrilik grafiğinin plastik kısmının eğimi olarak tanımlanabilir.

$$H' = \frac{dM}{d\varepsilon_f - (d\varepsilon_f)_e} = \frac{(EI)_T}{1 - \left[(EI)_T / EI \right]} \tag{3.33}$$

(3.31) bağıntısı biraz daha düzenlenirse

$$d\varepsilon_f = \frac{dM}{EI} + \frac{dM}{H'} = \frac{dM(H' + EI)}{EI \cdot H'} \tag{3.34}$$

ve artımsal moment-eğilme ilişkisi aşağıdaki gibi yazılabilir:

$$dM = \frac{EI \cdot H'}{(EI + H')} \cdot d\varepsilon_f \tag{3.35}$$

Akma esnasında artımsal gerilme-şekil değiştirme bağıntısı

$$dM = EI\left(1 - \frac{EI}{EI + H'}\right) \cdot d\varepsilon_f$$

$$dQ = G\hat{A} \cdot d\varepsilon_s \tag{3.36}$$

olur. Moment-eğrilik ilişkisinin elastoplastik olmasına karşılık kesme kuvveti-kayma gerilmesi ilişkisi her zaman elastiktir. Akmadan sonra eğilme rijitliği aşağıdaki değerle değiştirilecektir.

$$EI\left(1 - \frac{EI}{EI + H'}\right)$$

Pekleşme parametresi H' malzeme davranışı perfekt elastoplastik olduğunda sıfıra eşit olur. Bu durumda elastoplastik çubuk eleman teğetsel rijitlik matrisi tekil olur. Bu güçlük başlangıç rijitlik yöntemi kullanılarak yenilir.

3.3.3 Lineer olmayan denklemlerin çözümü

Elemana ait yanal yer değiştirmeleri, dönme, eğrilik ve kayma şekil değiştirmelerini bulabilmek için doğrusal olmayan denge denklemleri virtüel iş prensibi yardımıyla genelleştirilebilir. Sonlu eleman ağının herhangi bir noktasındaki yanal yer değiştirme ve dönmeler aşağıdaki ifade ile elde edilebilir:

$$\begin{bmatrix} w \\ \vartheta \end{bmatrix} = N \cdot \varphi \qquad \textbf{(3.37)}$$

Buradaki şekil fonksiyonu matrisi N,

$$N = \begin{bmatrix} N_1, 0, N_2, 0, ..., N_n, 0 \\ 0, N_1, 0, N_2, ..., 0, N_n \end{bmatrix} \qquad \textbf{(3.38)}$$

ve düğüm noktası yer değiştirmeleri vektörü φ,

$$\varphi = [w_1, \theta_1, w_2, \theta_2, ..., w_n, \theta_n]^T \qquad \textbf{(3.39)}$$

Yukarıdaki denklemlerde w yanal yer değiştirmeyi, θ dönmeyi, N_i herhangi bir düğüm noktasına ait global şekil fonksiyonunu temsil etmektedir. Sonlu eleman sisteminin tamamı için herhangi bir noktadaki eğrilik ve kayma şekil değiştirmesi ise

$$-\frac{d\theta}{dx} = B_f \cdot \varphi \qquad \text{ve} \qquad \frac{dw}{dx} - \theta = B_s \cdot \varphi \qquad \textbf{(3.40)}$$

olarak gösterilebilir. Burada

$$B_f = \left[0, -\frac{dN_1}{dx}, 0, -\frac{dN_2}{dx}, ..., 0, -\frac{dN_n}{dx} \right] \qquad \textbf{(3.41)}$$

$$B_s = \left[\frac{dN_1}{dx}, -N_1, \frac{dN_2}{dx}, -N_2, ..., \frac{dNn}{dx}, -N_n \right] \qquad \textbf{(3.42)}$$

Virtüel eğrilikler ve kayma şekil değiştirmeleri sırasıyla aşağıdaki gibidir.

$$-\frac{d(\delta\theta)}{dx} = B_f \cdot \delta\varphi \qquad \text{ve} \qquad \frac{d(\delta w)}{dx} - \delta\theta = B_s \cdot \delta\varphi \tag{3.43}$$

Düğüm noktası virtüel yer değiştirmeleri vektörü de

$$\delta\varphi = \left[\delta w_1, \delta\theta_1, \delta w_2, \delta\theta_2, ..., \delta w_n, \delta\theta_n\right]^T \tag{3.44}$$

olarak yazılır. Virtüel iş prensibi kullanılarak

$$\int_0^l \left[\delta\varphi\right]^T \cdot \left[B_f\right]^T \cdot M \cdot dx + \int_0^l \left[\delta\varphi\right]^T \cdot \left[B_s\right]^T \cdot Q \cdot dx - \int_0^l \left[\delta\varphi\right]^T \cdot \left[\bar{N}\right]^T \cdot q \cdot dx = 0 \tag{3.45}$$

olur. Burada $\bar{N}$;

$$\bar{N} = \left[N_1, 0, N_2, 0, ..., N_n, 0\right] \tag{3.46}$$

dir. **(3.45)** eşitliği virtüel yer değiştirmelerin ($\delta\varphi$) her bir değeri için doğru olmalıdır. Bunun sonucunda denklem aşağıdaki hali alır:

$$\left\{\int_0^l \left[B_f\right]^T \cdot M \cdot dx + \int_0^l \left[B_s\right]^T \cdot Q \cdot dx\right\} - \int_0^l \left[\bar{N}\right]^T \cdot q \cdot dx = 0 \tag{3.47}$$

Veya $p - f = 0$ olarak da yazılabilir. Bu eşitlik aslında plastikliğin söz konusu olmadığı **(3.22)** eşitliğine özdeştir.

Elastoplastik problemlerde M doğrusal olmayan bir fonksiyondur ve genellikle *p* vektörü ancak yaklaşık olarak bulunur. Bu yüzden **(3.47)** eşitliği doğrusal olmadığından ve *p* yaklaşık olarak bilinebildiğinden (*p-f*) değeri artık bir ψ(φ) değerine eşit olacaktır.

Bir e elemanının ***p***'ye yaptığı katkıyı genel biçimde gösterirsek,

$$p^{(e)} = \int_{x_1^{(e)}}^{x_2^{(e)}} \begin{bmatrix} 0 \\ \dfrac{1}{l^{(e)}} \\ 0 \\ -\dfrac{1}{l^{(e)}} \end{bmatrix} \cdot M^{(e)} \cdot dx + \int_{x_1^{(e)}}^{x_2^{(e)}} \begin{bmatrix} -\dfrac{1}{l^{(e)}} \\ \dfrac{x^{(e)} - x_2^{(e)}}{l^{(e)}} \\ \dfrac{1}{l^{(e)}} \\ \dfrac{x_1^{(e)} - x^{(e)}}{l^{(e)}} \end{bmatrix} \cdot Q^{(e)} \cdot dx$$

$$= \left[-Q^{(e)}, M^{(e)} - \frac{(Ql)^{(e)}}{2}, Q^{(e)}, -M^{(e)} - \frac{(Ql)^{(e)}}{2} \right]^T \qquad \textbf{(3.48)}$$

3.4 Elastoplastik Tabakalı Timoshenko Kirişleri

3.4.1 Tabakalı kirişlerde akma

Tabakalı yaklaşımda kiriş yüksekliği boyunca seçilen bir tabaka sayısına bölünür. Sonlu eleman yaklaşımında dıştaki tabakaların ortasındaki gerilme akma değerine ulaşır ulaşmaz bu tabaka plastikleşir, kesitin geri kalan kısmı elastiktir. Yük arttıkça plastikleşme iç tabakalara doğru devam eder ve tüm kesit plastikleşene kadar devam eder.

3.4.2 Tabakalı kiriş için rijitlik matrisinin oluşturulması

Tabakalı yaklaşımda, tabakasız yaklaşımda olduğu gibi iç kuvvetler cinsinden değil gerilmeler cinsinden çalışılır. Bir tabakanın ortasındaki gerilme değeri o tabakanın tamamı için mukayese gerilmesi olarak varsayılır. İç kuvvetlerin (M ve Q) katkıları, her tabaka için tabakanın kalınlığı üzerinde integrasyon yapılarak ayrı ayrı bulunur. Daha sonra her tabakaya ait katkılar eklenerek kirişin tamamına ait eğilme momentleri ve kesme kuvvetleri elde edilir.

Yer değiştirme alanı, gerilme-şekil değiştirme ilişkisi ve şekil değiştirme-yer değiştirme ilişkisi bu bölümün başında **(3.1)-(3.10)** bağıntıları ile verilmiştir.

(3.11) denkleminde verilen virtüel iş prensibinden, orta nokta kuralı kullanılarak eğilme momenti (M) ve kesme kuvveti (Q) değerleri bulunur:

$$M = EI\left(-\frac{d\theta}{dx}\right) \quad \text{ve} \quad Q = G\hat{A}\cdot\varepsilon_s \tag{3.49}$$

Burada;

$$EI = \sum_i E_i \cdot b_i \cdot z_i^2 \cdot t_i \tag{3.50}$$

ve

$$G\hat{A} = \sum_i G_i \cdot b_i \cdot t_i \tag{3.51}$$

Yukarıdaki ifadelerde;

b_i: tabaka genişliği

t_i: tabaka kalınlığı

z_i: tabakanın orta noktasına ait z koordinatı

E_i: tabaka malzemesinin elastisite modülü

G_i: tabaka malzemesinin kayma modülünü göstermektedir.

Eğer tabakanın ortasındaki gerilme değeri tabaka malzemesinin tek eksenli akma gerilmesi değerine ulaşırsa bütün tabakanın plastikleştiği kabul edilir ve E_i değeri aşağıdaki gibi değiştirilir:

$$E_i\left(1-\frac{E_i}{E_i+H'}\right)$$

3.4.3 Lineer olmayan denklemlerin çözümü

(3.11) eşitliği tekrar yazılırsa

$$\int_0^l \int_{-t/2}^{t/2} \int_{b(-t/2)}^{b(t/2)} \left(-z \cdot \frac{d(\delta\theta)}{dx} \cdot \sigma_x + \delta\beta \cdot \tau_{xz} \right) \cdot dy \cdot dz \cdot dx - \int_0^l \delta W \cdot q \cdot dx = 0 \qquad \textbf{(3.52)}$$

olur. İlk iki integralin elde edilebilmesi için orta nokta kuralı kullanılırsa

$$[\delta\varphi]^T \cdot [P_f + P_s] - [\delta\varphi]^T \cdot f = 0 \qquad \textbf{(3.53)}$$

yazılır. Burada P_f ve P_s ifadeleri aşağıda verilmiştir.

$$P_f = \int_0^l [B_f]^T \cdot \overline{M} \cdot dx \qquad \text{ve} \qquad P_s = \int_0^l [B_s]^T \cdot \overline{Q} \cdot dx$$

Burada B_f, B_s ve $\delta\varphi$ sırasıyla **(3.41)**, **(3.43)** ve **(3.44)** denklemlerinde gösterilmiştir.

$\overline{M}$ ve $\overline{Q}$

$$\overline{M} = \sum_i b_i \cdot \sigma_{xi} \cdot z_i \cdot t_i \qquad \textbf{(3.54)}$$

$$\overline{Q} = \sum_i b_i \cdot \tau_{xzi} \cdot t_i \qquad \textbf{(3.55)}$$

dir. **(3.52)** eşitliği virtüel yer değiştirmelerin herhangi bir durumu için doğru olduğundan

$$p_f + p_s - f = 0 \qquad \textbf{(3.56)}$$

yazılabilir. Her bir elemanın p_f ve p_s 'e olan katkıları ayrı ayrı aşağıda gösterildiği gibi elde edilebilir:

$$p_f^{(e)} = \int_{x_1^{(e)}}^{x_2^{(e)}} [Bf^{(e)}]^T \cdot \overline{M}^{(e)} \cdot dx = \int_{x_1^{(e)}}^{x_2^{(e)}} \begin{bmatrix} 0 & \left(\frac{\overline{M}}{l}\right)^{(e)} & 0 & -\left(\frac{\overline{M}}{l}\right)^{(e)} \end{bmatrix}^T dx = \begin{bmatrix} 0 & \overline{M}^{(e)} & 0 & -\overline{M}^{e)} \end{bmatrix}^T$$

(3.57)

$$p_s^{(e)} = \int_{x_1^{(e)}}^{x_2^{(e)}} \left[B_s^{(e)}\right]^T \cdot \overline{Q}^{(e)} \cdot dx = \int_{x_1^{(e)}}^{x_2^{(e)}} \left[-\frac{1}{l^{(e)}} \quad -\frac{1}{2} \quad \frac{1}{l^{(e)}} \quad -\frac{1}{2} \right]^T \cdot \overline{Q}^{(e)} \cdot dx$$

$$= \left[-\overline{Q}^{(e)} \quad -\frac{\left(\overline{Q}l\right)^{(e)}}{2} \quad \overline{Q}^{(e)} \quad -\frac{\left(\overline{Q}l\right)^{(e)}}{2} \right]^T$$

(3.58)

4. PROBLEMLERİN ÇÖZÜMÜNDE KULLANILAN BİLGİSAYAR PROGRAMLARINA AİT BİLGİLER

Timoshenko kirişlerinin elastoplastik analizi için tabakalı ve tabakasız olmak üzere iki yaklaşım mevcuttur. Problemlerin iki yaklaşım için farklı çözümlerini kolaylaştırmak üzere tabakalı yaklaşım için TIMLAY ve tabakasız yaklaşım için TIMOSH başlıkları altında düzenlenmiş FORTRAN programları kullanılmıştır. Bizim problemimizin çözümü için tabakasız yaklaşım durumuna elastik zemin özelliklerini de hesaba katan ilaveler yapılmıştır. Bu kısımlar koyu font ile ayrılmıştır. Gerekli olan yerlerde programların özgün halleri bölüm sonunda verilmiştir.

4.1 Tabakasız Kiriş Programı (TIMOSH)

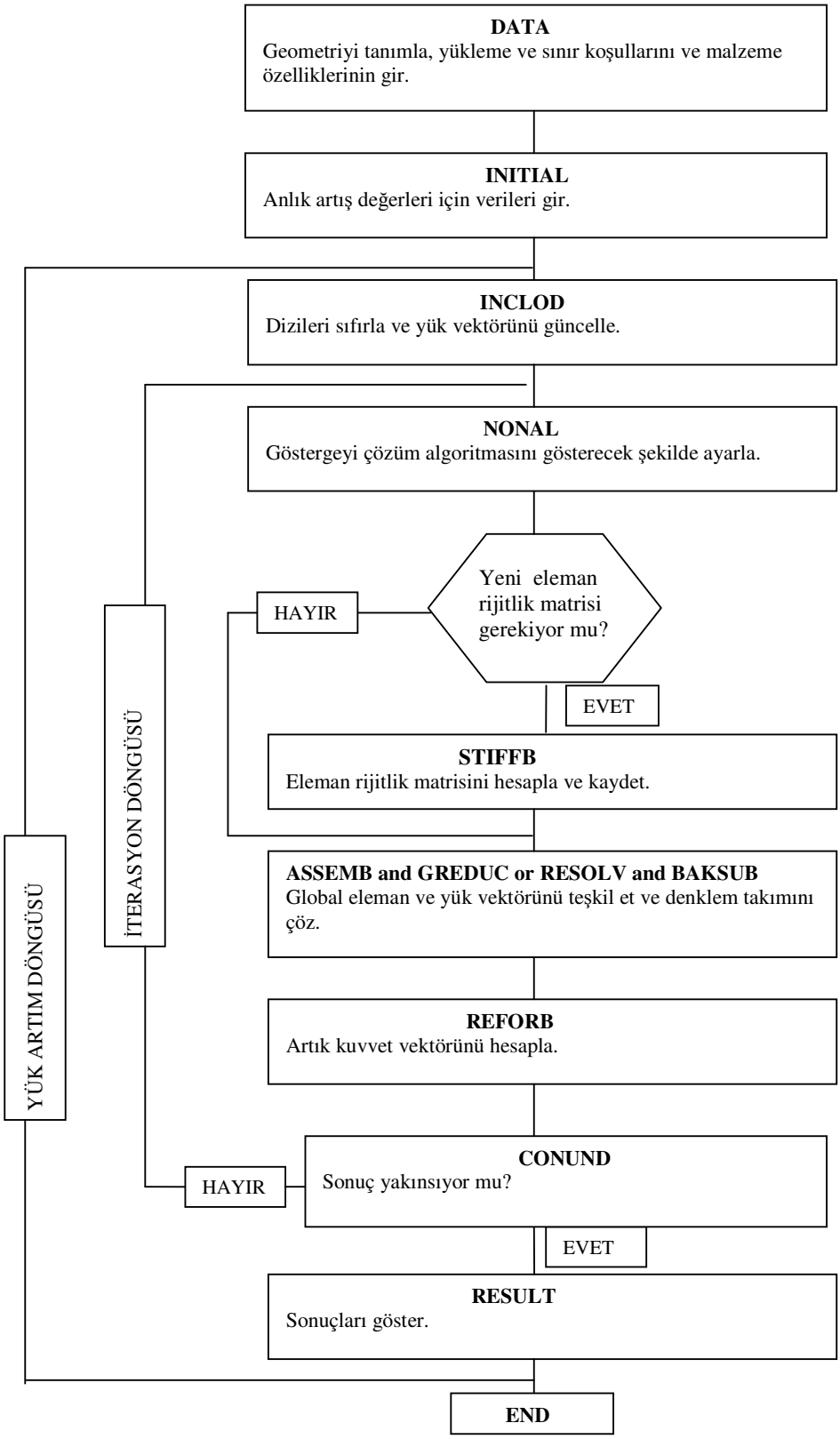
Tabakasız yaklaşım için kullanılmış olan ana program MASTER BEAM aşağıdaki gibidir.

PROGRAM MASTER BEAM

```
C*************************************************************************
C     ELASTOPLASTIC NONLAYERED TIMOSHENKO BEAM PROGRAM WITH ELASTIC
C                                FOUNDATION
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .             MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      CALL DATA
      CALL INITIAL
      DO 30 IINCS=1,NINCS
      CALL INCLOD
      DO 10 IITER=1,NITER
```

```
      CALL NONAL
      IF(KRESL.EQ.1) CALL STIFFB
      CALL ASSEMB
      IF(KRESL.EQ.1)CALL GREDUC
      IF(KRESL.EQ.2)CALL RESOLV
      CALL BAKSUB
      CALL REFORB
      CALL CONUND
      IF(NCHEK.EQ.0) GOTO 20
      IF(IITER.EQ.1.AND.NOUTP.EQ.1) CALL RESULT
      IF(NOUTP.EQ.2) CALL RESULT
10    CONTINUE
      WRITE(6,900)
900   FORMAT(1H0,5X,"SOLUTION NOT CONVERGED")
       STOP
20    CALL RESULT
30    CONTINUE
       STOP
       END
```

TIMOSH programının yapısı bir akış diyagramıyla gösterilecek olursa;



Şekil 4.1: TIMOSH programı akış diyagramı.

Şekil (4.1)'de görüldüğü gibi ana programın çalıştırılması için Data, Initial, Increm, Nonal, StiffB, Assemb, Greduc, Resolv, Baksub, Reforb, Conund ve Result alt programları kullanılmıştır. Sırasıyla işlevleri ve detaylı yapıları gösterilecek olursa;

4.1.1 Subroutine DATA

```
C*************************************************************************
C
C     INPUTS DATA DEFINING GEOMETRY LOADING BOUNDARY CONDITIONS ETC
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .            MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .            TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .            REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      DIMENSION ICODE(2),VALUE(2),TITLE(18)
      READ(5,965)TITLE
      WRITE(6,965)TITLE
965   FORMAT(18A4)
      READ(5,900)NPOIN,NELEM,NBOUN,NMATS,NPROP,NNODE,NINCS,NALGO,
     .           NDOFN
900   FORMAT(9I5)
      WRITE(6,905)NPOIN,NELEM,NBOUN,NMATS,NPROP,NNODE,NINCS,NALGO,
     .            NDOFN
905   FORMAT(1X,"NPOIN=",I5,3X,"NELEM=",I5,3X,"NBOUN=",I5,3X,
     .          "NMATS=",I5//1X,"NPROP=",I5,3X,"NNODE=",I5,3X,
     .          "NINCS=",I5,3X,"NALGO=",I5//1X,"NDOFN=",I5)
      NEVAB=NDOFN*NNODE
      NSVAB=NDOFN*NPOIN
      WRITE(6,910)
910   FORMAT(1H0,5X,'MATERIAL PROPERTIES')
      DO 10 IMATS=1,NMATS
      READ(5,915) JMATS,(PROPS(JMATS,IPROP),IPROP=1,NPROP)
10    WRITE(6,915) JMATS,(PROPS(JMATS,IPROP),IPROP=1,NPROP)
915   FORMAT(I10,4F15.5)
      WRITE(6,920)
920   FORMAT(1H0,3X,"EL NODES MAT.")
      DO 20 IELEM=1,NELEM
      READ(5,925) JELEM,(LNODS(JELEM,INODE),INODE=1,NNODE),MATNO(JELEM)
20    WRITE(6,925) JELEM,(LNODS(JELEM,INODE),INODE=1,NNODE),MATNO(JELEM)
925   FORMAT(4I5)
      WRITE(6,930)
930   FORMAT(1H0,5X,"NODE",5X,"COORD.")
      DO 30 IPOIN=1,NPOIN
      READ(5,935) JPOIN,COORD(JPOIN)
30    WRITE(6,935) JPOIN,COORD(JPOIN)
935   FORMAT(I10,F15.5)
      DO 40 ISVAB=1,NSVAB
      IFPRE(ISVAB)=0
40    PEFIX(ISVAB)=0.0
      IF(NDOFN.EQ.1) WRITE(6,940)
940   FORMAT(1H0,1X,"RES.NODE",2X,"CODE",3X,"PRES.VALUES")
```

```
      IF(NDOFN.EQ.2) WRITE(6,945)
945   FORMAT(1H0,1X,"RES.NODE",2X,"CODE",3X,"PRES.VALUES",2X,
     .          "CODE",3X,"PRES.VALUES")
      DO 50 IBOUN=1,NBOUN
      READ(5,950) NODFX,(ICODE(IDOFN),VALUE(IDOFN),IDOFN=1,NDOFN)
      WRITE(6,950) NODFX,(ICODE(IDOFN),VALUE(IDOFN),IDOFN=1,NDOFN)
950   FORMAT (I10,2(I5,F15.5))
      NPOSN=(NODFX-1)*NDOFN
      DO 50 IDOFN=1,NDOFN
      NPOSN=NPOSN+1
      IFPRE(NPOSN)=ICODE(IDOFN)
50    PEFIX(NPOSN)=VALUE(IDOFN)
      WRITE(6,955)
955   FORMAT(1H0,2X,"ELEMENT",10X,"NODAL LOADS")
      DO 60 IELEM=1,NELEM
      DO 60 IEVAB=1,NEVAB
60    RLOAD(IELEM,IEVAB)=0.0
70    READ(5,960)JELEM,(RLOAD(JELEM,IEVAB),IEVAB=1,NEVAB)
      IF(JELEM.NE.NELEM) GO TO 70
      DO 80 IELEM=1,NELEM
80    WRITE(6,960) IELEM,(RLOAD(IELEM,IEVAB),IEVAB=1,NEVAB)
      READ(5,970) EZK
970   FORMAT(E15.6)
      WRITE(6,971) EZK
971   FORMAT(" ELASTIC SOIL COEFFICIENT= ",E15.6)
960   FORMAT(I10,5F15.5)
      RETURN
      END
```

Herhangi bir sonlu eleman analizinde veri girişi 3 ana gruba bölünebilir. Birinci olarak yapının geometrisi ve mesnetlenme durumu veri olarak girilmeli, ikinci olarak malzeme özellikleri tanımlanmalı, üçüncü ve son olarak da yükleme durumlarını veren veri girişi sağlanmalıdır.

Veri girişi için kullanılan Subroutine Data alt programındaki kontrol parametrelerini kısaca açıklayacak olursak;

NPOIN: Yapıdaki toplam düğüm noktası sayısı,

NELEM: Yapıdaki toplam eleman sayısı,

NBOUN: Sınır koşullarının sayısı,

NMATS: Yapıdaki farklı malzemelerin toplam sayısı,

NPROP: Malzeme karakteristiğini tam olarak belirleyebilmek için gereken malzeme parametresine ait numara.

4-Elastoplastik problemler için

2-Diğer tüm uygulamalar için kullanılacak değer.

NNODE: Her bir eleman için düğüm sayısı,

NINCS: Tüm yükleme boyunca yapılan yük artımlarının sayısı,

NALGO: Problemin çözümü için kullanılacak çözüm algoritmasını tanımlayan gösterge.

1- Doğrudan iterasyon yöntemi

2- Newton-Raphson yöntemi (Quasiharmonik problemler için.)
Teğetsel rijitlik yöntemi (Lineer olmayan elastik ve elastoplastik problemler için.)

3-Başlangıç rijitliği yöntemi.

4-Sadece bir yük artımı için ilk iterasyonda rijitliğin yeniden hesaplandığı durumlar için başlangıç rijitliği ve teğetsel rijitlik yöntemlerinin kombinasyonunun kullanıldığı durumlar.

5-Rijitliğin ikinci iterasyonda yeniden hesaplandığı durumlar için başlangıç ve teğetsel rijitlik yöntemlerinin kombinasyonunun kullanıldığı durumlar.

NDOFN: Her bir düğüm noktası için serbestlik derecelerinin değeri.

1-Tek eksenli problemler için.

2-Timoshenko kirişleri için.

COORD(IPOIN): Her bir düğüm noktasının koordinatı referans eksen takımına göre tanımlanmalıdır. COORD ile koordinat, IPOIN ile düğüm noktalarının sayısı tanımlanır.

LNODS(NUME, INODE): Her bir elemanın geometrisini düğüm noktası sayısına bağlı tanımlamak için kullanılır. Burada NUMEL göz önüne alınan eleman sayısını belirtir. INODE ise 1'den NNODE(toplam düğüm noktası sayısı)'na kadar değişir.

MATNO(NUMEL): Her eleman malzeme özellikleri bakımından farklı olabileceği için bu farklılıkları tanımlayıcı olarak kullanılır. Burada eleman numarasını NUMEL

temsil eder ve MATNO(NUMEL) belirtilen numaralı elemanın farklı bir malzeme özelliğine sahip olduğunu gösterir.

PROPS(NUMAT, IPROP): Çözüm için gerekli olan malzeme özellikleri farklı uygulamalarda değişiklik gösterir. Burada NUMAT malzeme numarasını ve IPROP o malzemenin özelliklerini belirtir. Elastoplastik problemler için;
PROPS(NUMAT,1)-Malzemenin elastisite modülünü,
PROPS(NUMAT,2)-Elemanın kesit alanını,
PROPS(NUMAT,3)-Malzemenin tek eksenli akma gerilmesini,
PROPS(NUMAT,4)-Malzeme için lineer pekleşme parametresini (H') temsil etmektedir.

ICODE(IDOFN): İlgili düğüm noktasında hangi dereceden serbestlik değerinin atanacağını belirlemek için kullanılır.
VALUE(IDOFN): Serbestlik derecesinin değerini tanımlar.

RLOAD(IELEM, IEVAB): Yapıya ve dolayısıyla elemanlara uygulanan yükleri tanımlamak için kullanılır.

EZK(t/m^2): Elastik zemin katsayısı. Yatak katsayısı (k_0) ile kiriş genişliğinin (b) çarpımına eşit olan katsayı (K).

4.1.2 Subroutine INITIAL

```
C*****************************************************************************
C
C                 INITIALIZES TO ZERO ALL ACCUMULATIVE ARRAYS
C
C*****************************************************************************
      COMMON/UNIM1/NPOIN, NELEM, NBOUN, NLOAD, NPROP,NNODE,IINCS,IITER,
     .                    KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .                    NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .                   FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .                   MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .                   TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .                   REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      DO 20 IELEM=1,NELEM
      PLAST(IELEM)=0.0
      DO 10 IDOFN=1,NDOFN
```

```
 10      STRES(IELEM,IDOFN)=0.0
         DO 20 IEVAB=1,NEVAB
         ELOAD(IELEM,IEVAB)=0.0
 20      TLOAD(IELEM,IEVAB)=0.0
         DO 30 IPOIN=1,NPOIN
         DO 30 IDOFN=1,NDOFN
         TDISP(IPOIN,IDOFN)=0.0
 30      TREAC(IPOIN,IDOFN)=0.0
         RETURN
         END
```

INITIAL yardımcı programının fonksiyonu diğer yardımcı programlar tarafından da kullanılan bazı dizilerin değerini sıfırlamaktır.

4.1.3 Subroutine INCLOD

```
C*************************************************************************
C
C       INPUTS DATA FOR CURRENT INCREMENT AND UPDATES LOAD VECTOR
C
C*************************************************************************
         COMMON/UNIM1/NPOIN, NELEM, NLOAD, NPROP, NNODE, IINCS, IITER,
        .                   KRESL, NCHEK, TOLER, NALGO, NSVAB, NDOFN, NINCS, NEVAB,
        .                      NITER, NOUTP, FACTO, PVALU, EZK
         COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
        .                      FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
        .                      MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
        .                      TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
        .                      REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
         READ(5,900) NITER, NOUTP, FACTO, TOLER
 900     FORMAT(2I5,2F15.5)
          WRITE(6,905) IINCS, NITER, NOUTP, FACTO, TOLER
 905     FORMAT(1H0,5X,"IINCS=",I5,3X,"NITER=",I5,3X,"NOUTP=",I5,
        .                3X,"FACTO=",E14.6,3X,"TOLER=",E14.6)
         DO 10 IELEM=1,NELEM
         DO 10 IEVAB=1,NEVAB
         ELOAD(IELEM, IEVAB)=ELOAD(IELEM, IEVAB)+RLOAD(IELEM, IEVAB)*FACTO
         TLOAD(IELEM, IEVAB)=TLOAD(IELEM, IEVAB)+RLOAD(IELEM, IEVAB)*FACTO
 10      CONTINUE
         RETURN
         END
```

INCLOD yapıya uygulanan yüklerin artımını kontrol eden alt programdır. Her yük artımında iterasyonun üst limitlerine göre bu veri kontrol edilir. Çıktı sıklığı, yük artımının miktarı ve tolerans limitine yakınsama değerlendirme kriterleridir. Bu görevleri programa yaptıran terimler;

NITER: İzin verilebilir en fazla iterasyon sayısı. Bu çözüm süreci yakınsamadığında problemin çözümü açısından koruyucu bir önlemdir. Niter iterasyon döngüsü tamamlandıktan sonra program sona erer.

NOUTP: Çıktı sonuçlarının sıklığını kontrol eden parametredir. Kullanıcının çıktı almak istediği aşamalara göre değişir;

0- Her yük artımında ancak lineer olmayan çözüm için yakınsama olduğunda sonuçları bas.

1- İlk iterasyondan sonra ve her yük artımı için yakınsama olduğunda sonuçları bas.

2- Her yük artımında ve her iterasyondan sonra sonuçları bas.

FACTO: Yük artımının büyüklüğünü kontrol eden parametredir.

TOLER: Yakınsama için izin verilen toleransı kontrol eden parametredir.

4.1.4 Subroutine NONAL

```
C*******************************************************************************
C
C            SETS INDICATOR TO IDENTIFY_TYPE OF SOLUTION ALGORITHM
C
C*******************************************************************************
      COMMON/UNIM1/NPOIN, NELEM, NBOUN, NLOAD, NPROP, NNODE, IINCS, IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB, NDOFN,NINCS,NEVAB,
     .             NITER, NOUTP, FACTO, PVALU, EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .             MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      KRESL=2
      IF(NALGO.EQ.1)KRESL=1
      IF(NALGO.EQ.2)KRESL=1
      IF(NALGO.EQ.3.AND.IINCS.EQ.1.AND.IITER.EQ.1)KRESL=1
      IF(NALGO.EQ.4.AND.IITER.EQ.1)KRESL=1
      IF(NALGO.EQ.5.AND.IINCS.EQ.1.AND.IITER.EQ.1)KRESL=1
      IF(NALGO.EQ.5.AND.IITER.EQ.2)KRESL=1
      IF(IITER.EQ.1.OR.NALGO.EQ.1) GOTO 20
      DO 10 ISVAB=1,NSVAB
10    FIXED(ISVAB)=0.0
      RETURN
20    DO 30 ISVAB=1,NSVAB
30    FIXED(ISVAB)=PEFIX(ISVAB)*FACTO
      RETURN
      END
```

NONAL alt programının temel görevi çözüm yöntemi parametresinin(NALGO) değerine göre çözüm yöntemini kontrol etmektir. KRESL göstergesinin NALGO'ya,

iterasyon numarası IITER'e ve artım numarası IINCS'e bağlı olarak değerini (1 ya da 2) ayarlamaktır. Doğrudan İterasyon ve Newton-Raphson yöntemlerinin her aşaması için KRESL=1 iken, Başlangıç Rijitliği yönteminde yük artımının ilk iterasyonu için KRESL=1'dir ve bundan sonra 2 olarak alınır. Başlangıç Rijitliği ve Teğetsel Rijitlik yöntemlerinin birleşiminde de aynı şekilde ilk iterasyon için 1 ve diğer aşamalar için 2 alınır.

NONAL yardımcı programının diğer rolü de bilinmeyenlerin önceden tahmin edilmiş değerlerini gerçek değerleriyle değiştirmektir.

4.1.5 Subroutine STIFFB

```
C*************************************************************************
C
C                    CALCULATES ELEMENT STIFFNESS MATRICES
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .                    KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .                    NITER,NOUTP,FACTO,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .                    FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .                     MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .                     TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .                     REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      REWIND 1
      DO 20 IELEM=1,NELEM
      LPROP=MATNO(IELEM)
      EIVAL=PROPS(LPROP,1)
      SVALU=PROPS(LPROP,2)
      HARDS=PROPS(LPROP,4)
      NODE1=LNODS(IELEM,1)
      NODE2=LNODS(IELEM,2)
      ELENG=ABS(COORD(NODE2)-COORD(NODE1))
      IF(PLAST(IELEM).NE.0.0) EIVAL=EIVAL*(1.0-EIVAL/(EIVAL+HARDS))
       beta=12.*EIVAL/SVALU/ELENG**2
      VALU1=12.*EIVAL/ELENG**3/(1.+BETA)
      VALU2=6.*EIVAL/ELENG**2/(1.+BETA)
      VALU3=4.*EIVAL*(1.+0.25*BETA)/ELENG/(1.+BETA)
      VALU4=2.*EIVAL*(1.-0.5*BETA)/ELENG/(1.+BETA)
      ESTIF(1,1)=VALU1+(13./35.)*ezk*eleng
      ESTIF(1,2)=VALU2+(11./210.)*ezk*eleng**2
      ESTIF(1,3)=-VALU1+(9./70.)*ezk*eleng
      ESTIF(1,4)=VALU2-(13./420.)*ezk*eleng**2
      ESTIF(2,2)=VALU3+(1./105.)*ezk*eleng**3
      ESTIF(2,3)=-ESTIF(1,4)
      ESTIF(2,4)= VALU4-(1./140.)*ezk*eleng**3
      ESTIF(3,3)=ESTIF(1,1)
      ESTIF(3,4)=-ESTIF(1,2)
      ESTIF(4,4)=ESTIF(2,2)
      DO 10 ISTIF=1,4
      DO 10 JSTIF=ISTIF,4
 10   ESTIF(JSTIF,ISTIF)=ESTIF(ISTIF,JSTIF)
```

```
      WRITE(1) ESTIF
20    CONTINUE
      RETURN
      END
```

Bu yardımcı programın temel amacı eleman rijitlik matrislerinin elde edilmesi ve denklem çözüm rutinlerinde kullanılmak üzere kaydedilmesidir.

Bu yardımcı programın orijinal hali aşağıdaki gibidir (Owen-Hinton).

SUBROUTINE STIFFB

```
C*****************************************************************************
C                  CALCULATES ELEMENT STIFFNESS MATRICES
C*****************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .             MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      REWIND 1
      DO 20 IELEM=1,NELEM
      LPROP=MATNO(IELEM)
      EIVAL=PROPS(LPROP,1)
      SVALU=PROPS(LPROP,2)
      HARDS=PROPS(LPROP,4)
      NODE1=LNODS(IELEM,1)
       NODE2=LNODS(IELEM,2)
      ELENG=ABS(COORD(NODE2)-COORD(NODE1))
      IF(PLAST(IELEM).NE.0.0) EIVAL=EIVAL*(1.0-EIVAL/(EIVAL+HARDS))
      VALU1=0.5*SVALU
      VALU2=SVALU/ELENG
      VALU3=EIVAL/ELENG
      VALU4=0.25*SVALU*ELENG
       ESTIF(1,1)=VALU2
       ESTIF(1,2)=VALU1
       ESTIF(1,3)=-VALU2
       ESTIF(1,4)=VALU1
       ESTIF(2,2)=VALU3+VALU4
       ESTIF(2,3)=-VALU1
       ESTIF(2,4)=-VALU3+VALU4
       ESTIF(3,3)=VALU2
       ESTIF(3,4)=-VALU1
       ESTIF(4,4)=VALU3+VALU4
       DO 10 ISTIF=1,4
       DO 10 JSTIF=ISTIF,4
10     ESTIF(JSTIF,ISTIF)=ESTIF(ISTIF,JSTIF)
       WRITE(1) ESTIF
20     CONTINUE
       RETURN
       END
```

4.1.6 Subroutine ASSEMB

```
C*************************************************************************
C
C                              ELEMENT ASSEMBLY ROUTINE
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER, NOUTP, FACTO, PVALU, EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .             MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .              REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
C
C                          ELEMENT ASSEMBLY ROUTINE
C
      REWIND 1
      DO 10 ISVAB=1,NSVAB
 10   ASLOD(ISVAB)=0.0
      IF(KRESL.EQ.2) GOTO 30
      DO 20 ISVAB=1,NSVAB
      DO 20 JSVAB=1,NSVAB
 20   ASTIF(ISVAB, JSVAB)=0.0
 30   CONTINUE

C
C                          ASSEMBLE THE ELEMENT LOADS
C

      DO 50 IELEM=1,NELEM
C     read(1,'(4f15.6)')  ((ESTIF(i,j),j=1,4),i=1,4)
      READ(1,'(4E15.7)')  ((ESTIF(i,j),j=1,4),i=1,4)
      DO 40 INODE=1,NNODE
      NODEI=LNODS(IELEM,INODE)
      DO 40 IDOFN=1,NDOFN
      NROWS=(NODEI-1)*NDOFN+IDOFN
      NROWE=(INODE-1)*NDOFN+IDOFN
      ASLOD(NROWS)=ASLOD(NROWS)+ELOAD(IELEM,NROWE)

C
C                 ASSEMBLE THE ELEMENT STIFFNESS MATRICES
C

      IF(KRESL.EQ.2)GOTO 40
      DO 40 JNODE=1,NNODE
      NODEJ=LNODS(IELEM,JNODE)
      DO 40 JDOFN=1,NDOFN
      NCOLS=(NODEJ-1)*NDOFN+JDOFN
      NCOLE=(JNODE-1)*NDOFN+JDOFN
      ASTIF(NROWS,NCOLS)=ASTIF(NROWS,NCOLS)+ESTIF(NROWE,NCOLE)
 40   CONTINUE
 50   CONTINUE
      RETURN
      END
```

Bu alt programın görevi eleman düğüm noktası yüklerini toplayarak global yük vektörünü oluşturmaktır. Ayrıca her elemanın katkısını global rijitlik matrisinde bir araya getirir.

Bu alt programa özgü komutlar;

ASLOD(MSVAB): Birleşmiş yük vektörü.

ASTIF(MSVAB, MSVAB): Birleşmiş global rijitlik matrisi.

RLOAD(MEVAB): Eleman yük vektörü.

ESTIF(MEVAB, MEVAB): Eleman rijitlik matrisi.

IELEM, NELEM, MELEM: Sırasıyla bir elemana ait içerik, numara, maksimum değer.

IFILE: Dosya girişi.

IDOFN, JDOFN: Her bir düğüm noktası için serbestlik derecesi değeri.

NDOFN: Her bir düğüm noktası için serbestlik derecesi numarası.

INODE, JNODE: Her bir eleman için düğüm noktası içeriği.

NNODE: Her eleman için düğüm noktası numarası.

MNODE: Her eleman düğüm noktası için maksimum değer.

ISVAB, JSVAB: Global yapısal değişken endeksi.

MSVAB: Maksimum global yapısal değişken değeri.

NSVAB: Global yapısal değişken numarası.

JFILE: Dosya çıktısı.

KRESL: Denklem ayırma parametresi.

LNODS(MELEM, MNODE): Her eleman için listelenmiş düğüm noktası numarası.

NODE I: Düğüm noktası I

NODE J: Düğüm noktası J

NCOLS: Yapısal global rijitlik matrisindeki sütun sayısı.

NROWS: Yapısal global rijitlik matrisindeki ve yük vektöründeki satır sayısı.

NCOLE: Eleman rijitlik matrisindeki kolon sayısı.

NROWE: Eleman rijitlik matrisindeki ve yük vektöründeki satır sayısı.

MEVAB: Eleman değişkenlerinin maksimum değeri.

Bu programın ASSEMBLE THE ELEMENT LOADS kısmının orijinal hali (Owen-Hinton):

```
C
C                         ASSEMBLE THE ELEMENT LOADS
C
      DO 50 IELEM=1,NELEM
      READ(1) ESTIF
      DO 40 INODE=1,NNODE
      NODEI=LNODS(IELEM,INODE)
      DO 40 IDOFN=1,NDOFN
      NROWS=(NODEI-1)*NDOFN+IDOFN
      NROWE=(INODE-1)*NDOFN+IDOFN
     ASLOD(NROWS)=ASLOD(NROWS)+ELOAD(IELEM,NROWE)
```

4.1.7 Subroutine GREDUC

```
C*******************************************************************************
C
C                              GAUSSIAN REDUCTION ROUTINE
C
C*******************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .            MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .            TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)

C
C                    GAUSSIAN REDUCTION ROUTINE
C

      KOUNT=0
      NEQNS=NSVAB
      DO 70 IEQNS=1,NEQNS
      IF(IFPRE(IEQNS).EQ.1) GOTO 40

C
C                           REDUCE EQUATIONS
C

      PIVOT=ASTIF(IEQNS,IEQNS)
      IF(ABS(PIVOT).LT.1.0E-10) GOTO 60
      IF(IEQNS.EQ.NEQNS) GOTO 70
      IEQN1=IEQNS+1
      DO 30 IROWS=IEQN1,NEQNS
      KOUNT=KOUNT+1
      FACTR=ASTIF(IROWS,IEQNS)/PIVOT
      FRESV(KOUNT)=FACTR
      IF(FACTR.EQ.0.0) GOTO 30
      DO 10 ICOLS=IEQNS,NEQNS
      ASTIF(IROWS,ICOLS)=ASTIF(IROWS,ICOLS)-FACTR*ASTIF(IEQNS,ICOLS)
 10   CONTINUE
```

```
      ASLOD(IROWS)=ASLOD(IROWS)-FACTR*ASLOD(IEQNS)
 30   CONTINUE
      GOTO 70
C
C             ADJUST RHS(LOADS) FOR PRESCRIBED DISPLACEMENTS
C

 40     DO 50 IROWS=IEQNS,NEQNS
        ASLOD(IROWS)=ASLOD(IROWS)-ASTIF(IROWS,IEQNS)*FIXED(IEQNS)
 50     CONTINUE
        GOTO 70
 60     WRITE(6,900)
900     FORMAT(5X,15HINCORRECT PIVOT)
        STOP
 70     CONTINUE
        RETURN
        END
```

Bu program Gaussian indirgeme yöntemiyle çözülen denklemlerde denklem giderme işlemini yapan alt programdır. Farklı değişkenlerin isimleri ve görevleri;

ASLOD(MEQNS): Birleşmiş yük vektörü.

ASTIF(MEQNS, MEQNS): Birleşmiş global rijitlik matrisi.

IEQNS, NEQNS, MEQNS: Sırasıyla denklemlerin içeriği, numarası ve maksimum değeri.

IFPRE(MEQNS): Bir düğüm noktasının bağlılık(mesnetlenme biçimi) durumunu tanımlayan vektör.

0-Serbest

1-Bağlı

FIXED(MEQNS): Öngörülmüş yer değiştirmelerin vektörü (eğer önceden bir değer Verilmemişse 0 alınır.)

ICOLS: Yapısal rijitlik matrisindeki kolonların içeriği.

IROWS: Yapısal rijitlik matrisindeki satırların içeriği.

FACTR: Gaussian indirgeme faktörü.

FRESV( ): Kaydedilmiş Gaussian indirgeme faktörleri.

PIVOT: Silinmiş değişkenin köşegen terimi.

4.1.8 Subrotine RESOLV

```
C*************************************************************************
C
C                        RESOLVING GAUSSIANREDUCTION ROUTINE
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .            MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      KOUNT=0
      NEQNS=NSVAB
       DO 40 IEQNS=1,NEQNS
      IF(IFPRE(IEQNS).EQ.1) GOTO 20

C
C                                  REDUCE   RHS
C

      IF(IEQNS.EQ.NEQNS) GOTO 40
      IEQN1=IEQNS+1
      DO 10 IROWS=IEQN1,NEQNS
      KOUNT=KOUNT+1
      FACTR=FRESV(KOUNT)
      IF(FACTR.EQ.0)GOTO 10
      ASLOD(IROWS)=ASLOD(IROWS)-FACTR*ASLOD(IEQNS)
 10   CONTINUE
      GOTO 40


C
C                      ADJUST RHS TO PRESCRIBED DISPLACEMENTS
C

 20     DO 30 IROWS=IEQNS,NEQNS
        ASLOD(IROWS)=ASLOD(IROWS)-ASTIF(IROWS,IEQNS)*FIXED(IEQNS)
 30     CONTINUE
 40     CONTINUE
        RETURN
        END
```

RESOLV alt programı standart Gaussian yok etme yöntemini kullanarak yük terimlerini azaltır. Gaussian çarpanlara ayırma terimleri subroutine GREDUC alt programından elde edilir, kaydedilir ve RESOLV programında bu verilerden yararlanılır.

4.1.9 Subroutine BAKSUB

```
C*******************************************************************************
C
C                          BACK-SUBSTITUTION ROUTINE
C
C*******************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .             MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)

C
C                          BACK-SUBSTITUTION ROUTINE
C

      NEQNS=NSVAB
      DO 10 IEQNS=1,NEQNS
      REACT(IEQNS)=0.0
 10   CONTINUE
      NEQN1=NEQNS+1
      DO 40 IEQNS=1,NEQNS
      NBACK=NEQN1-IEQNS
      PIVOT=ASTIF(NBACK,NBACK)
      RESID=ASLOD(NBACK)
      IF(NBACK.EQ.NEQNS) GOTO 30
      NBAC1=NBACK+1
      DO 20 ICOLS=NBAC1,NEQNS
      RESID=RESID-ASTIF(NBACK,ICOLS)*XDISP(ICOLS)
20    CONTINUE
30    IF(IFPRE(NBACK).EQ.0) XDISP(NBACK)=RESID/PIVOT
      IF(IFPRE(NBACK).EQ.1) XDISP(NBACK)=FIXED(NBACK)
      IF(IFPRE(NBACK).EQ.1) REACT(NBACK)=-RESID
40    CONTINUE
      GO TO (100,110,110,110,110),NALGO
100   KOUNT=0
      DO 50 IPOIN=1,NPOIN
      DO 50 IDOFN=1,NDOFN
      KOUNT=KOUNT+1
      TDISP(IPOIN,IDOFN)=XDISP(KOUNT)
 50   TREAC(IPOIN,IDOFN)=REACT(KOUNT)
      GO TO 120
110   KOUNT=0
      DO 51 IPOIN=1,NPOIN
      DO 51 IDOFN=1,NDOFN
      KOUNT=KOUNT+1
      TDISP(IPOIN,IDOFN)=TDISP(IPOIN,IDOFN)+XDISP(KOUNT)
 51   TREAC(IPOIN,IDOFN)=TREAC(IPOIN,IDOFN)+REACT(KOUNT)
      DO 90  IPOIN=1,NPOIN
      DO 60  IELEM=1,NELEM
      DO 60  INODE=1,NNODE
      NLOCA=LNODS(IELEM,INODE)
 60   IF(IPOIN.EQ.NLOCA) GOTO 70
 70   DO 80 IDOFN=1,NDOFN
      NPOSN=(IPOIN-1)*NDOFN+IDOFN
```

```
      IEVAB=(INODE-1)*NDOFN+IDOFN
 80   TLOAD(IELEM,IEVAB) = TLOAD(IELEM,IEVAB)+REACT(NPOSN)
 90   CONTINUE
120   CONTINUE
      RETURN
      END
```

Bu alt programa özgü değişken parametreler;

ASLOD(MEQNS): İndirgenmiş yük vektörü.

ASTIF(MEQNS, MEQNS): İndirgenmiş global rijitlik matrisi.

IEQNS, NEQNS, MEQNS: Sırasıyla denklemlerin içeriği, numarası ve maksimum değeri.

IFPRE(MEQNS): Düğüm noktasının bağlanma durumunu tanımlayan parametrelerin vektörü.

FIXED(MEQNS): Öngörülmüş yer değiştirme vektörü. (Önceden bir değer atanmamışsa 0 alınır.)

PIVOT: Yok edilen değişkenin köşegen terimi.

REACT(MEQNS): Öngörülmüş yer değiştirmeli düğüm noktalarındaki tepkiler.

XDISP(MEQNS): Düğüm noktalarındaki yer değiştirmeler.

Bu programın yardımcı programın orjinal hali (Owen-Hinton):

SUBROUTINE BAKSUB

```
C*****************************************************************************
C                              BACK-SUBSTITUTION ROUTINE
C*****************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .             MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .             REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
C
C                              BACK-SUBSTITUTION ROUTINE
C
      NEQNS=NSVAB
      DO 10 IEQNS=1,NEQNS
      REACT(IEQNS)=0.0
10    CONTINUE
      NEQN1=NEQNS+1
      DO 40 IEQNS=1,NEQNS
      NBACK=NEQN1-IEQNS
```

```
      PIVOT=ASTIF(NBACK,NBACK)
      RESID=ASLOD(NBACK)
      IF(NBACK.EQ.NEQNS) GOTO 30
      NBAC1=NBACK+1
      DO 20 ICOLS=NBAC1,NEQNS
      RESID=RESID-ASTIF(NBACK,ICOLS)*XDISP(ICOLS)
20    CONTINUE
30    IF(IFPRE(NBACK).EQ.0) XDISP(NBACK)=RESID/PIVOT
      IF(IFPRE(NBACK).EQ.1) XDISP(NBACK)=FIXED(NBACK)
      IF(IFPRE(NBACK).EQ.1) REACT(NBACK)=-RESID
40    CONTINUE
      KOUNT=0
      DO 50 IPOIN=1,NPOIN
      DO 50 IDOFN=1,NDOFN
      KOUNT=KOUNT+1
      TDISP(IPOIN,IDOFN)=XDISP(KOUNT)
50    TREAC(IPOIN,IDOFN)=REACT(KOUNT)
      RETURN
      END
```

4.1.10 Subroutine REFORB

```
C*******************************************************************************
C
C                CALCULATES INTERNAL EQUIVALENT NODAL FORCES
C
C*******************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .            MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .            TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .            REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      DO 10 IELEM=1,NELEM
      DO 10 IEVAB=1,NEVAB
10    ELOAD(IELEM,IEVAB)=0.0
      DO 70 IELEM=1,NELEM
      LPROP=MATNO(IELEM)
      EIVAL=PROPS(LPROP,1)
      SVALU=PROPS(LPROP,2)
      YIELD=PROPS(LPROP,3)
      HARDS=PROPS(LPROP,4)
      NODE1=LNODS(IELEM,1)
      NODE2=LNODS(IELEM,2)
      ELENG=ABS(COORD(NODE2)-COORD(NODE1))
      beta=12.*EIVAL/SVALU/ELENG**2
      ELAML=(EZK/4./EIVAL)**0.25*ELENG
C
      VALU1=12.*EIVAL/ELENG**3/(1.+BETA)
      VALU2=6.*EIVAL/ELENG**2/(1.+BETA)
      VALU3=4.*EIVAL*(1.+0.25*BETA)/ELENG/(1.+BETA)
      VALU4=2.*EIVAL*(1.-0.5*BETA)/ELENG/(1.+BETA)
      EK(1,1)=VALU1+(13./35.)*ezk*eleng
      EK(1,2)=VALU2+(11./210.)*ezk*eleng**2
      EK(1,3)=-VALU1+(9./70.)*ezk*eleng
      EK(1,4)=VALU2-(13./420.)*ezk*eleng**2
```

```
      EK(2,2)=VALU3+(1./105.)*ezk*eleng**3
      EK(2,3)=-ESTIF(1,4)
      EK(2,4)=VALU4-(1./140.)*ezk*eleng**3
       EK(3,3)=EK(1,1)
       EK(3,4)=-EK(1,2)
       EK(4,4)= EK(2,2)
       DO 11  ISTIF=1,4
       DO 11  JSTIF=ISTIF,4
   11  EK(JSTIF,ISTIF)=EK(ISTIF,JSTIF)
C
      WNOD1=XDISP(NODE1*NDOFN-1)
      WNOD2=XDISP(NODE2*NDOFN-1)
      THTA1=XDISP(NODE1*NDOFN)
      THTA2=XDISP(NODE2*NDOFN)
C
       P1=EK(1,1)*WNOD1+EK(1,2)*THTA1+EK(1,3)*WNOD2+EK(1,4)*THTA2
       P2=EK(2,1)*WNOD1+EK(2,2)*THTA1+EK(2,3)*WNOD2+EK(2,4)*THTA2
       P3=EK(3,1)*WNOD1+EK(3,2)*THTA1+EK(3,3)*WNOD2+EK(3,4)*THTA2
       P4=EK(4,1)*WNOD1+EK(4,2)*THTA1+EK(4,3)*WNOD2+EK(4,4)*THTA2
       EMORT=0.5*(1.-ELAML**4/96.)*(P2-P4)-0.125*(1.-13./1440.*ELAML**4)*(P1+P3)
C

      STRAN=(THTA1-THTA2)/ELENG
      STLIN=EMORT
      STCUR=STRES(IELEM,1)+STLIN
      PREYS=YIELD+HARDS*ABS(PLAST(IELEM))
      IF(ABS(STRES(IELEM,1)).GE.PREYS) GOTO 20
      ESCUR=ABS(STCUR)-PREYS
      IF(ESCUR.LE.0.0) GOTO 40
      RFACT=ESCUR/ABS(STLIN)
      GOTO 30
20    IF(STRES(IELEM,1).GT.0.0.AND.STLIN.LE.0.0) GOTO 40
      IF(STRES(IELEM,1).LT.0.0.AND.STLIN.GE.0.0) GOTO 40
      RFACT=1.0
30    REDUC=1.0-RFACT
      STRES(IELEM,1)=STRES(IELEM,1)+REDUC*STLIN+
.     RFACT*EIVAL*(1.0-EIVAL/(EIVAL+HARDS))*STRAN
      PLAST(IELEM)=PLAST(IELEM)+RFACT*STRAN*EIVAL/(EIVAL+HARDS)
      GOTO 50
40    STRES(IELEM,1)=STRES(IELEM,1)+STLIN
C 50  STRES(IELEM,2)=STRES(IELEM,2)+(SVALU/ELENG)*(WNOD2-WNOD1)
C     .                  -0.5*SVALU*(THTA1+THTA2)
50    STRES(IELEM,2)=STRES(IELEM,2)+0.5*(P3-P1)
       ELOAD(IELEM,1)=ELOAD(IELEM,1)-STRES(IELEM,2)
       ELOAD(IELEM,2)=ELOAD(IELEM,2)+STRES(IELEM,1)
.                     -0.5*ELENG*STRES(IELEM,2)
       ELOAD(IELEM,3)=ELOAD(IELEM,3)+STRES(IELEM,2)
       ELOAD(IELEM,4)=ELOAD(IELEM,4)-STRES(IELEM,1)
.                     -0.5*ELENG*STRES(IELEM,2)
70     CONTINUE
       RETURN
       END
```

Yararlanılan kaynaktaki özgün hali aşağıdaki gibidir. (Owen-Hinton)

SUBROUTINE REFORB

```
C*****************************************************************************
C                    CALCULATES INTERNAL EQUIVALENT NODAL FORCES
C*****************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .            MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .            TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .            REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      DO 10 IELEM=1,NELEM
      DO 10 IEVAB=1,NEVAB
 10   ELOAD(IELEM,IEVAB)=0.0
      DO 70 IELEM=1,NELEM
      LPROP=MATNO(IELEM)
      EIVAL=PROPS(LPROP,1)
      SVALU=PROPS(LPROP,2)
      YIELD=PROPS(LPROP,3)
      HARDS=PROPS(LPROP,4)
      NODE1=LNODS(IELEM,1)
      NODE2=LNODS(IELEM,2)
      ELENG=ABS(COORD(NODE2)-COORD(NODE1))
      WNOD1=XDISP(NODE1*NDOFN-1)
      WNOD2=XDISP(NODE2*NDOFN-1)
      THTA1=XDISP(NODE1*NDOFN)
      THTA2=XDISP(NODE2*NDOFN)
      STRAN=(THTA1-THTA2)/ELENG
      STLIN=STRAN*EIVAL
      STCUR=STRES(IELEM,1)+STLIN
      PREYS=YIELD+HARDS*ABS(PLAST(IELEM))
      IF(ABS(STRES(IELEM,1)).GE.PREYS) GOTO 20
      ESCUR=ABS(STCUR)-PREYS
      IF(ESCUR.LE.0.0) GOTO 40
      RFACT=ESCUR/ABS(STLIN)
      GOTO 30
 20   IF(STRES(IELEM,1).GT.0.0.AND.STLIN.LE.0.0) GOTO 40
      IF(STRES(IELEM,1).LT.0.0.AND.STLIN.GE.0.0) GOTO 40
      RFACT=1.0
 30   REDUC=1.0-RFACT
      STRES(IELEM,1)=STRES(IELEM,1)+REDUC*STLIN+
     .      RFACT*EIVAL*(1.0-EIVAL/(EIVAL+HARDS))*STRAN
      PLAST(IELEM)=PLAST(IELEM)+RFACT*STRAN*EIVAL/(EIVAL+HARDS)
      GOTO 50
 40   STRES(IELEM,1)=STRES(IELEM,1)+STLIN
 50   STRES(IELEM,2)=STRES(IELEM,2)+(SVALU/ELENG)*(WNOD2-WNOD1)
     .                -0.5*SVALU*(THTA1+THTA2)
      ELOAD(IELEM,1)=ELOAD(IELEM,1)-STRES(IELEM,2)
      ELOAD(IELEM,2)=ELOAD(IELEM,2)+STRES(IELEM,1)
     .                -0.5*ELENG*STRES(IELEM,2)
      ELOAD(IELEM,3)=ELOAD(IELEM,3)+STRES(IELEM,2)
      ELOAD(IELEM,4)=ELOAD(IELEM,4)-STRES(IELEM,1)
     .-0.5*ELENG*STRES(IELEM,2)
 70   CONTINUE
      RETURN
      END
```

4.1.11 Subroutine CONUND

```
C*************************************************************************
C
C                          CHECKS FOR SOLUTION CONVERGENCE
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .                    KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .                    NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .                    FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .                     MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .                     TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .                     REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      DIMENSION STFOR(52),TOFOR(52)
      NCHEK=0
      RESID=0.0
      RETOT=0.0
      DO 10 ISVAB=1,NSVAB
      STFOR (ISVAB)=0.0
10    TOFOR (ISVAB)=0.0
       DO 20 IELEM=1,NELEM
      IEVAB=0
      DO 20 INODE=1,NNODE
      NODNO=LNODS(IELEM, INODE)
      DO 20 IDOFN=1,NDOFN
      IEVAB=IEVAB+1
      NPOSN=(NODNO -1)*NDOFN+IDOFN
      STFOR(NPOSN)=STFOR(NPOSN)+ELOAD(IELEM, IEVAB)
20    TOFOR(NPOSN)=TOFOR(NPOSN)+TLOAD(IELEM, IEVAB)
      DO 30 ISVAB=1,NSVAB
      REFOR=TOFOR(ISVAB)-STFOR(ISVAB)
      RESID=RESID+REFOR*REFOR
30    RETOT=RETOT+TOFOR(ISVAB)*TOFOR(ISVAB)
       DO 40 IELEM=1,NELEM
       DO 40 IEVAB=1,NEVAB
40     ELOAD(IELEM, IEVAB)=TLOAD(IELEM, IEVAB)-ELOAD(IELEM, IEVAB)
      RATIO=100.0*SQRT(RESID/RETOT)
      IF(RATIO.GT.TOLER) NCHEK=1
      IF(IITER.EQ.1) GOTO 50
      IF(RATIO.GT.PVALU) NCHEK=999
50    PVALU=RATIO
      WRITE(6,900) IITER,NCHEK,RATIO
900    FORMAT(1H0,5X,"ITERATION NUMBER=",I5/
     .          1H0,5X,"CONVERGENCE CODE=",I4,3X,
     .          "NORM OF RESIDUAL SUM RATIO=",E14.6)
       RETURN
       END
```

CONUND yardımcı programı yakınsamanın artık kuvvet değerlerine bağlı hesaplandığı alt programdır.

Yakınsama kriteri;

$$\frac{\sqrt{\left[\sum_{i=1}^{N}\left(\psi_i^r\right)^2\right]}}{\sqrt{\left[\sum_{i=1}^{N}\left(f_i\right)^2\right]}}\times 100 \le TOLER \qquad \textbf{(4.1)}$$

Burada N;toplam düğüm noktası sayısı ve r; iterasyon sayısıdır. Yakınsamanın olup olmadığını gösteren parametre ise **NCHEK**'dir.

4.1.12 Subroutine RESULT

```
C*************************************************************************
C
C                    OUTPUTS DISPLACEMENT,REACTIONS AND STRESSES
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLOAD,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO,PVALU,EZK
      COMMON/UNIM2/PROPS(5,4),COORD(26),LNODS(25,2),IFPRE(52),
     .            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .            MATNO(25),STRES(25,2),PLAST(25),XDISP(52),
     .             TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .            REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4)
      IF(NDOFN.EQ.1) WRITE(6,900)
  900 FORMAT(1H0,5X,"NODE",4X,"DISPL.",12X,"REACTIONS")
      IF(NDOFN.EQ.2) WRITE(6,910)
  910 FORMAT(1H0,5X,"NODE",4X,"DISPL.",12X,"REACTION",
     .       7X,"DISPL.",12X,"REACTION")
      DO 10 IPOIN=1,NPOIN
   10 WRITE(6,920) IPOIN,(TDISP(IPOIN,IDOFN),TREAC(IPOIN,IDOFN),
     . IDOFN=1,NDOFN)
  920 FORMAT(I10,2(E14.6,5X,E14.6))
      IF(NDOFN.EQ.2) WRITE(6,930)
  930 FORMAT(1H0,2X,"ELEMENT",12X,"STRESSES",12X,"PL.STRAIN")
      IF(NDOFN.EQ.1) WRITE(6,940)
  940 FORMAT(1H0,2X,"ELEMENT",5X,"STRESSES",5X,"PL.STRAIN")
      DO 20 IELEM=1,NELEM
   20 WRITE(6,950) IELEM,(STRES(IELEM,IDOFN),IDOFN=1,NDOFN),
     . PLAST(IELEM)
  950 FORMAT(I10,3E14.6)
      RETURN
      END
```

Çıktı sıklığı INCLOD alt programı ile ayarlanan ana programın sonuçlarını ve çıktılarını almayı sağlayan programdır.

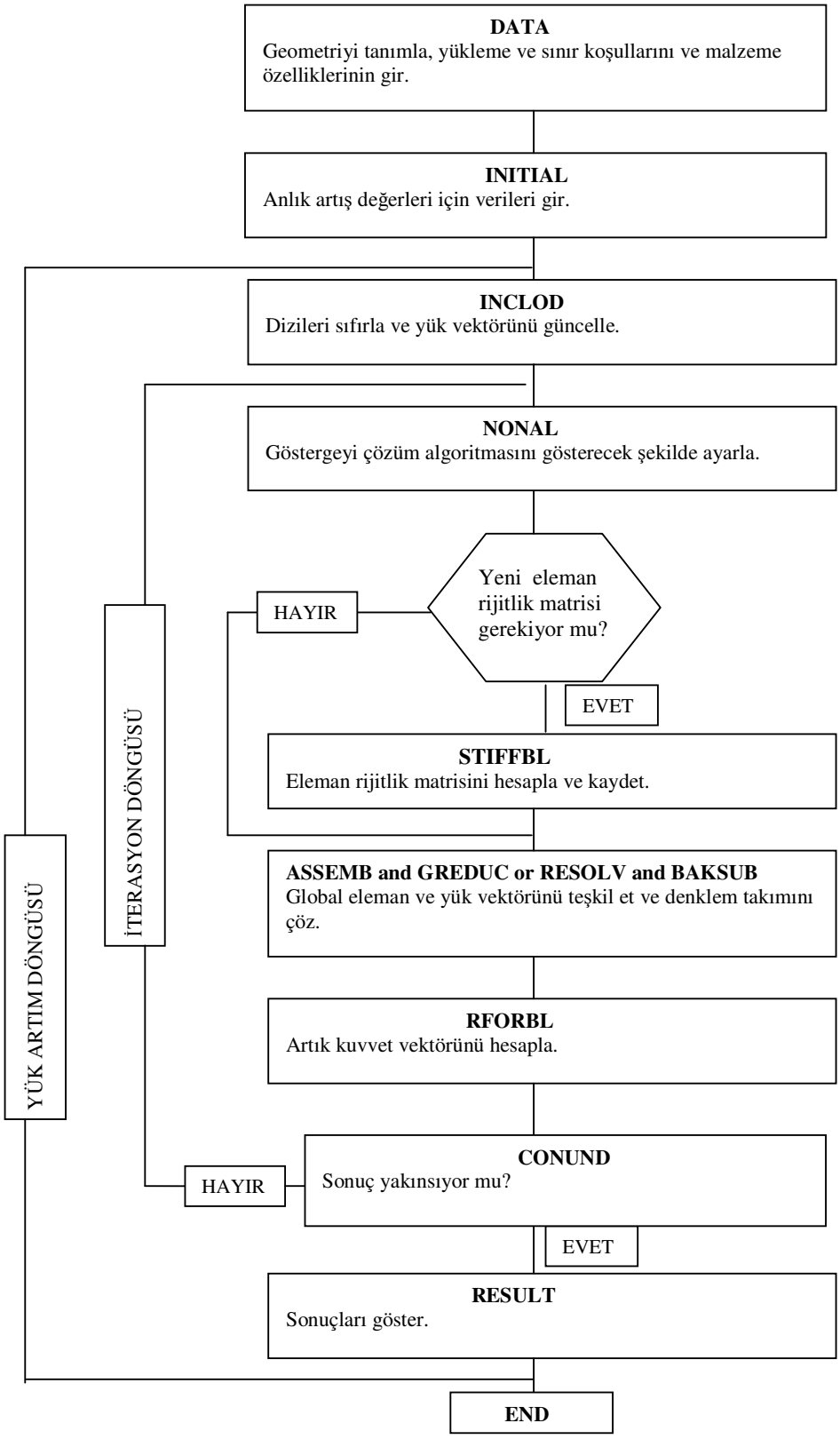
4.2 Tabakalı Kiriş Programı (TIMLAY)

Tabakalı kiriş programının yapısı Şekil (4.1)'de gösterile akış diyagramıyla aynıdır. Burada sadece STIFFB alt programının yerine STIFBL ve REFORB alt programı yerine de RFORBL gelir. STIFBL alt programı da ilave bir LAYER alt programını çağırır. Tabakalı kiriş ana programı MASTER BEML aşağıdaki gibidir.

PROGRAM MASTER BEML

```
C*************************************************************************
C
C              ELASTOPLASTIC LAYERED TIMOSHENKO BEAM PROGRAM
C
C*************************************************************************
      COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLAYR,NPROP,NNODE,IINCS,IITER,
     .             KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
     .             NITER,NOUTP,FACTO
      COMMON/UNIM2/PROPS(5,25),COORD(26),LNODS(25,2),IFPRE(52),
     .             FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
     .              MATNO(25),STRES(25,2),PLAST(250),XDISP(52),
     .              TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
     .              REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4),
     .              STRSL(250,2)
      CALL DATA
      CALL INITIAL
      DO 30 IINCS=1,NINCS
      CALL INCLOD
      DO 10 IITER=1,NITER
      CALL NONAL
      IF(KRESL.EQ.1) CALL STIFBL
      CALL ASSEMB
      IF(KRESL.EQ.1) CALL GREDUC
      IF(KRESL.EQ.2) CALL RESOLV
      CALL BAKSUB
      CALL RFORBL
      CALL CONUND
      IF(NCHEK.EQ.0) GOTO 20
      IF(IITER.EQ.1.AND.NOUTP.EQ.1) CALL RESULT
      IF(NOUTP.EQ.2) CALL RESULT
10    CONTINUE
      WRITE(6,900)
 900  FORMAT(1H0,5X,"SOLUTION NOT CONVERGED")
      STOP
20    CALL RESULT
30    CONTINUE
      STOP
      END
```

Program bir akış diyagramı ile gösterilecek olursa;



Şekil 4.2: TIMLAY programı akış diyagramı.

TIMOSH programından farklı olan alt programların içerikleri ve görevleri aşağıdaki gibidir.

4.2.1 Subroutine STIFBL

```
C*************************************************************************
C
C                    CALCULATES ELEMENT STIFFNESS MATRICES
C
C*************************************************************************
COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLAYR,NPROP,NNODE,IINCS,IITER,
.            KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
.            NITER,NOUTP,FACTO
COMMON/UNIM2/PROPS(5,25),COORD(26),LNODS(25,2),IFPRE(52),
.            FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
.            MATNO(25),STRES(25,2),PLAST(250),XDISP(52),
.            TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
.            REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4),
.            STRSL(250,2)
REWIND 1
DO 20 IELEM=1,NELEM
LPROP=MATNO(IELEM)
CALL LAYER(IELEM,EIVAL,SVALU)
HARDS=PROPS(LPROP,4)
NODE1=LNODS(IELEM,1)
NODE2=LNODS(IELEM,2)
ELENG=ABS(COORD(NODE2)-COORD(NODE1))
VALU1=0.5*SVALU
VALU2=SVALU/ELENG
VALU3=EIVAL/ELENG
VALU4=0.25*SVALU*ELENG
ESTIF(1,1)=VALU2
ESTIF(1,2)=VALU1
ESTIF(1,3)=-VALU2
ESTIF(1,4)=VALU1
ESTIF(2,2)=VALU3+VALU4
ESTIF(2,3)=-VALU1
ESTIF(2,4)=-VALU3+VALU4
ESTIF(3,3)=VALU2
ESTIF(3,4)=-VALU1
ESTIF(4,4)=VALU3+VALU4
DO 10 ISTIF=1,4
DO 10 JSTIF=ISTIF,4
10      ESTIF(JSTIF,ISTIF)=ESTIF(ISTIF,JSTIF)
        WRITE(1) ESTIF
20      CONTINUE
        RETURN
        END
```

STIFBL elastoplastik-tabakalı Timoshenko kirişi için eleman rijitlik matrislerini hesaplayan alt programdır.

4.2.2 Subroutine RFORBL

```
C*************************************************************************
C
C               CALCULATES INTERNAL EQUIVALENT NODAL FORCES
C
C*************************************************************************
COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLAYR,NPROP,NNODE,IINCS,IITER,
.                    KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
.                   NITER,NOUTP,FACTO
COMMON/UNIM2/PROPS(5,25),COORD(26),LNODS(25,2),IFPRE(52),
.                    FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
.                    MATNO(25),STRES(25,2),PLAST(250),XDISP(52),
.                    TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
.                    REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4),
.                    STRSL(250,2)
DIMENSION STRAN(2)
DO 15 IELEM=1,NELEM
DO 10 IEVAB=1,NEVAB
  10ELOAD(IELEM,IEVAB)=0.0
        DO 15 IDOFN=1,NDOFN
  15STRES(IELEM,IDOFN)=0.0
        KLAYR=0
DO 70 IELEM=1,NELEM
LPROP=MATNO(IELEM)
YOUNG=PROPS(LPROP,1)
SHEAR=PROPS(LPROP,2)
YIELD=PROPS(LPROP,3)
HARDS=PROPS(LPROP,4)
THKTO=PROPS(LPROP,5)
NODE1=LNODS(IELEM,1)
NODE2=LNODS(IELEM,2)
ELENG=ABS(COORD(NODE2)-COORD(NODE1))
WNOD1=XDISP(NODE1*NDOFN-1)
WNOD2=XDISP(NODE2*NDOFN-1)
THTA1=XDISP(NODE1*NDOFN)
THTA2=XDISP(NODE2*NDOFN)
STRAN(1)=(THTA1-THTA2)/ELENG
STRAN(2)=(WNOD2-WNOD1)/ELENG
.             -0.5*(THTA1+THTA2)
ZMIDL=-THKTO/2.0
KOUNT=5
DO 50 ILAYR=1,NLAYR
KLAYR=KLAYR+1
KOUNT=KOUNT+1
BRDTH=PROPS(LPROP,KOUNT)
KOUNT=KOUNT+1
THICK=PROPS(LPROP,KOUNT)
ZMIDL=ZMIDL+THICK/2.0
STLIN=YOUNG*STRAN(1)*ZMIDL
STCUR=STRSL(KLAYR,1)+STLIN
PREYS=YIELD+HARDS*ABS(PLAST(KLAYR))
IF(ABS(STRSL(KLAYR,1)).GE.PREYS) GOTO 20
ESCUR=ABS(STCUR)-PREYS
IF(ESCUR.LE.0.0) GOTO 40
RFACT=ESCUR/ABS(STLIN)
GOTO 30
  20      IF(STRSL(KLAYR,1).GT.0.0.AND.STLIN.LE.0.0) GOTO 40
          IF(STRSL(KLAYR,1).LT.0.0.AND.STLIN.GE.0.0) GOTO 40
```

```
 RFACT=1.0
   30     REDUC=1.0-RFACT
          STRSL(KLAYR,1)=STRSL(KLAYR,1)+REDUC*STLIN+ RFACT*YOUNG
     .                          *(1.0- YOUNG/(YOUNG+HARDS))*STRAN(1)*ZMIDL
          PLAST(KLAYR)=PLAST(KLAYR)+RFACT*STRAN(1)*YOUNG/(YOUNG+HARDS)
     .                 *ZMIDL
          GOTO 45
   40     STRSL(KLAYR,1)=STRSL(KLAYR,1)+STLIN
   45     STRSL(KLAYR,2)=STRSL(KLAYR,2)+STRAN(2)*SHEAR
          STRES(IELEM,1)=STRES(IELEM,1)+STRSL(KLAYR,1)*
     .                          BRDTH*THICK*ZMIDL
          STRES(IELEM,2)=STRES(IELEM,2)+STRSL(KLAYR,2)*
     .          BRDTH*THICK
          ZMIDL=ZMIDL+THICK/2.0
   50     CONTINUE
          ELOAD(IELEM,1)=ELOAD(IELEM,1)-STRES(IELEM,2)
          ELOAD(IELEM,2)=ELOAD(IELEM,2)+STRES(IELEM,1)
     .                  -0.5*ELENG*STRES(IELEM,2)
          ELOAD(IELEM,3)=ELOAD(IELEM,3)+STRES(IELEM,2)
          ELOAD(IELEM,4)=ELOAD(IELEM,4)-STRES(IELEM,1)
     .                   -0.5*ELENG*STRES(IELEM,2)
   70     CONTINUE
          RETURN
          END
```

RFORBL orta nokta kuralını kullanarak tabakalı kiriş için **p** değerini elde eder.

4.2.3 Subroutine LAYER (IELEM, EIVAL, SVALU)

```
C*************************************************************************
C
C       CALCULATES INTEGRATED VALUES FOR EI AND GA THROUGH DEPTH
C
C*************************************************************************
COMMON/UNIM1/NPOIN,NELEM,NBOUN,NLAYR,NPROP,NNODE,IINCS,IITER,
.                   KRESL,NCHEK,TOLER,NALGO,NSVAB,NDOFN,NINCS,NEVAB,
.                   NITER,NOUTP,FACTO
COMMON/UNIM2/PROPS(5,25),COORD(26),LNODS(25,2),IFPRE(52),
.                   FIXED(52),TLOAD(25,4),RLOAD(25,4),ELOAD(25,4),
.                   MATNO(25),STRES(25,2),PLAST(250),XDISP(52),
.                   TDISP(26,2),TREAC(26,2),ASTIF(52,52),ASLOD(52),
.                   REACT(52),FRESV(1352),PEFIX(52),ESTIF(4,4),
.                   STRSL(250,2)
EIVAL=0.0
SVALU=0.0
LPROP=MATNO(IELEM)
KLAYR=(IELEM-1)*NLAYR
SHEAR=PROPS(LPROP,2)
HARDS=PROPS(LPROP,4)
THKTO=PROPS(LPROP,5)
ZMIDL=-THKTO/2.0
KOUNT=5
DO 10 ILAYR=1,NLAYR
KLAYR=KLAYR+1
YOUNG=PROPS(LPROP,1)
IF(PLAST(KLAYR).NE.0.0) YOUNG=YOUNG*(1.0-YOUNG/(YOUNG+HARDS))
```

```
KOUNT=KOUNT+1
BRDTH=PROPS(LPROP, KOUNT)
KOUNT=KOUNT+1
THICK=PROPS(LPROP,KOUNT)
ZMIDL=ZMIDL+THICK/2.0
EIVAL=EIVAL+YOUNG*BRDTH*THICK*ZMIDL*ZMIDL
SVALU=SVALU+SHEAR*BRDTH*THICK
ZMIDL=ZMIDL+THICK/2.0
10      CONTINUE
        RETURN
        END
```

LAYER eğilme rijitliği EI'nın yaklaşık değerini ve GA'nın gerçek değerini orta nokta kuralı ile bulan alt programdır.

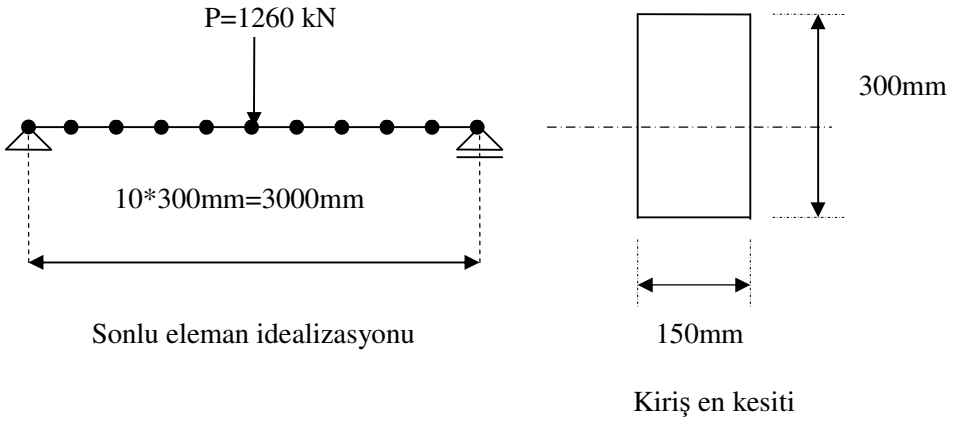
5. UYGULAMALAR

Önceki bölümlerde açıklanan tabakalı ve tabakasız Timoshenko kirişi elastoplastik çözümleri ile ilgili olarak 2 farklı yükleme (tekil ve yayılı yükleme) için çözüm yapılacaktır. Ayrıca tabakasız yaklaşımda kirişin elastik zemine oturması durumu için de uygulamalar yapılacaktır.

5.1 Tabakasız Elastoplastik Timoshenko Kiriş Örnekleri

5.1.1 Tekil yüklü tabakasız Timoshenko kiriş örneği

Aşağıda geometrisi ve yükleme şekli verilen basit kirişe ait elastoplastik çözüm aranmaktadır.



Şekil 5.1: Tekil yük etkisi altındaki kiriş

Problemin girişi ile ilgili parametreler aşağıda verilmiştir:

11(NPOIN) **10**(NELEM) **2**(NBOUN) **1**(NMATS) **4**(NPROP) **2**(NNODE)**14**(NINCS) **2**(NALGO) **2**(NDOFN)

1(1nolu malzeme) **7.0875e10**(EI) **2423070.**(GA/1.5) **843750.**(M_0) **0.**(H^I)

Elemanlara ait giriş bilgileri aşağıda tablo halinde özetlenmiştir:

Çizelge 5.1: Eleman idealleştirilmesi ile ilgili giriş bilgileri.

Eleman No	i	j	x_i	x_j	Malzeme No
1	1	2	0	300	1
2	2	3	300	600	1
3	3	4	600	900	1
4	4	5	900	1200	1
5	5	6	1200	1500	1
6	6	7	1500	1800	1
7	7	8	1800	2100	1
8	8	9	2100	2400	1
9	9	10	2400	2700	1
10	10	11	2700	3000	1

Düğüm nokta numarası	**Mesnetlenme durumu**	**Moment çökme değeri**	**Dönme değeri**	**Dışarıdan verilmiş dönme**
1(ilk)	**1**(tutulu)	0.	0.	0.
11(son)	**1**(tutulu)	0.	0.	0.

Eleman numarası	**İlk D.N.'daki yük**	**İlk D.N'daki moment**	**Son D.N'daki yük**	**Son D.N'daki moment**
6	1260.	0.	0.	0.
10	0.	0.	0.	0.

0.0E-3 (elastik zemin değeri=0)

100(iterasyon sayısı yük için kN)	**2**(NOUTP her yük artımı ve iterasyonda sonuçları basar.)	**0.30**(yükün %30'u ile hesaba başlanır ve her sefer için bu sütundaki oran kadar arttırılarak bir önceki değere eklenir.İlk değeri **378kN**)	**0.5**(tolerans değeri)
100	2	0.20 (**630kN**)	0.5
100	2	0.10 (**756kN**)	0.5
100	2	0.10 (**882kN**)	0.5
100	2	0.05 (**945kN**)	0.5
100	2	0.05 (**1008kN**)	0.5
100	2	0.05 (**1071**kN)	0.5
100	2	0.05 (**1134kN**)	0.5
100	2	0.02 (**1159kN**)	0.5
100	2	0.02 (**1184kN**)	0.5
100	2	0.02 (**1209kN**)	0.5
100	2	0.02 (**1234kN**)	0.5
100	2	0.01 (**1247kN**)	0.5
100	2	0.01 (**1260kN**)	0.5

Formatlı veri girişi:

```
 11   10    2    1    4    2   14    2    2
        1 7.0875e10       2423070.        843750.        0.
 1    1    2    1
 2    2    3    1
 3    3    4    1
 4    4    5    1
 5    5    6    1
 6    6    7    1
 7    7    8    1
 8    8    9    1
 9    9   10    1
10   10   11    1
        1            0.
        2          300.
        3          600.
```

```
         4         900.
         5        1200.
         6        1500.
         7        1800.
         8        2100.
         9        2400.
        10        2700.
        11        3000.
         1   1        0.   0        0.
        11   1        0.   0        0.
         6       1260.        0.        0.        0.
        10          0.        0.        0.        0.
0.0E-3
  100   2        0.30        0.5
  100   2        0.20        0.5
  100   2        0.10        0.5
  100   2        0.10        0.5
  100   2        0.05        0.5
  100   2        0.05        0.5
  100   2        0.05        0.5
  100   2        0.05        0.5
  100   2        0.02        0.5
  100   2        0.02        0.5
  100   2        0.02        0.5
  100   2        0.02        0.5
  100   2        0.01        0.5
  100   2        0.01        0.5
```

Veri girişi sonrası alınan sonuçlar:

```
 NPOIN=   11   NELEM=   10   NBOUN=    2   NMATS=    1

 NPROP=    4   NNODE=    2   NINCS=   14   NALGO=    2

 NDOFN=    2
0    MATERIAL PROPERTIES
       1   .7087500E+11   .2423070E+07   .8437500E+06   .0000000E+00
0   EL NODES MAT.
   1    1    2    1
   2    2    3    1
   3    3    4    1
   4    4    5    1
   5    5    6    1
   6    6    7    1
   7    7    8    1
   8    8    9    1
   9    9   10    1
  10   10   11    1
0    NODE     COORD.
       1        .00000
       2     300.00000
       3     600.00000
       4     900.00000
```

```
      5    1200.00000
      6    1500.00000
      7    1800.00000
      8    2100.00000
      9    2400.00000
     10    2700.00000
     11    3000.00000
0 RES.NODE  CODE   PRES.VALUES  CODE   PRES.VALUES
      1   1        .00000   0        .00000
     11   1        .00000   0        .00000
0  ELEMENT          NODAL LOADS
      1        .00000        .00000        .00000        .00000
      2        .00000        .00000        .00000        .00000
      3        .00000        .00000        .00000        .00000
      4        .00000        .00000        .00000        .00000
      5        .00000        .00000        .00000        .00000
      6     1260.00000        .00000        .00000        .00000
      7        .00000        .00000        .00000        .00000
      8        .00000        .00000        .00000        .00000
      9        .00000        .00000        .00000        .00000
     10        .00000        .00000        .00000        .00000
  ELASTIC SOIL COEFFICIENT=      .000000E+00
0    IINCS=   1   NITER= 100   NOUTP=   2   FACTO=   .300000E+00   TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .892957E-01
0    NODE    DISPL.           REACTION       DISPL.           REACTION
      1   .000000E+00       -.189001E+03   .300001E-02       .000000E+00
      2   .911402E+00        .000000E+00   .288001E-02       .000000E+00
      3   .175080E+01        .000000E+00   .252001E-02       .000000E+00
      4   .244621E+01        .000000E+00   .192000E-02       .000000E+00
      5   .292561E+01        .000000E+00   .108000E-02       .000000E+00
      6   .311701E+01        .000000E+00  -.424235E-09       .000000E+00
      7   .292561E+01        .000000E+00  -.108000E-02       .000000E+00
      8   .244620E+01        .000000E+00  -.192000E-02       .000000E+00
      9   .175080E+01        .000000E+00  -.252000E-02       .000000E+00
     10   .911402E+00        .000000E+00  -.288001E-02       .000000E+00
     11   .000000E+00       -.189001E+03  -.300001E-02       .000000E+00
0  ELEMENT           STRESSES           PL.STRAIN
      1   .283500E+05   .189001E+03   .000000E+00
      2   .850501E+05   .189001E+03   .000000E+00
      3   .141750E+06   .189001E+03   .000000E+00
      4   .198451E+06   .189000E+03   .000000E+00
      5   .255150E+06   .188999E+03   .000000E+00
      6   .255150E+06  -.188999E+03   .000000E+00
      7   .198450E+06  -.189000E+03   .000000E+00
      8   .141750E+06  -.189001E+03   .000000E+00
      9   .850502E+05  -.189000E+03   .000000E+00
     10   .283500E+05  -.189000E+03   .000000E+00
0    IINCS=   2   NITER= 100   NOUTP=   2   FACTO=   .200000E+00   TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .382387E-01
0    NODE    DISPL.           REACTION       DISPL.           REACTION
      1   .000000E+00       -.315001E+03   .500000E-02       .000000E+00
      2   .151900E+01        .000000E+00   .480000E-02       .000000E+00
      3   .291800E+01        .000000E+00   .420000E-02       .000000E+00
      4   .407700E+01        .000000E+00   .320000E-02       .000000E+00
      5   .487600E+01        .000000E+00   .180000E-02       .000000E+00
      6   .519500E+01        .000000E+00  -.268042E-09       .000000E+00
      7   .487600E+01        .000000E+00  -.180000E-02       .000000E+00
      8   .407700E+01        .000000E+00  -.320000E-02       .000000E+00
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      9  .291800E+01      .000000E+00  -.420000E-02      .000000E+00
     10  .151900E+01      .000000E+00  -.480000E-02      .000000E+00
     11  .000000E+00     -.315001E+03  -.500000E-02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .472501E+05  .315000E+03  .000000E+00
      2  .141750E+06  .315000E+03  .000000E+00
      3  .236250E+06  .315001E+03  .000000E+00
      4  .330750E+06  .315000E+03  .000000E+00
      5  .425250E+06  .315000E+03  .000000E+00
      6  .425250E+06 -.315000E+03  .000000E+00
      7  .330750E+06 -.315001E+03  .000000E+00
      8  .236250E+06 -.315000E+03  .000000E+00
      9  .141750E+06 -.315000E+03  .000000E+00
     10  .472500E+05 -.315000E+03  .000000E+00
0   IINCS=  3  NITER= 100  NOUTP=  2  FACTO=  .100000E+00  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .189532E-01
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00     -.378000E+03  .600000E-02      .000000E+00
      2  .182280E+01      .000000E+00  .576000E-02      .000000E+00
      3  .350160E+01      .000000E+00  .504000E-02      .000000E+00
      4  .489240E+01      .000000E+00  .384000E-02      .000000E+00
      5  .585120E+01      .000000E+00  .216000E-02      .000000E+00
      6  .623400E+01      .000000E+00 -.104533E-09      .000000E+00
      7  .585120E+01      .000000E+00 -.216000E-02      .000000E+00
      8  .489240E+01      .000000E+00 -.384000E-02      .000000E+00
      9  .350160E+01      .000000E+00 -.504000E-02      .000000E+00
     10  .182280E+01      .000000E+00 -.576000E-02      .000000E+00
     11  .000000E+00     -.378000E+03 -.600000E-02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .567001E+05  .378000E+03  .000000E+00
      2  .170100E+06  .378000E+03  .000000E+00
      3  .283500E+06  .378000E+03  .000000E+00
      4  .396900E+06  .378000E+03  .000000E+00
      5  .510300E+06  .377999E+03  .000000E+00
      6  .510300E+06 -.378000E+03  .000000E+00
      7  .396900E+06 -.378000E+03  .000000E+00
      8  .283500E+06 -.378000E+03  .000000E+00
      9  .170100E+06 -.378000E+03  .000000E+00
     10  .567000E+05 -.378000E+03  .000000E+00
0   IINCS=  4  NITER= 100  NOUTP=  2  FACTO=  .100000E+00  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .221761E-01
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00     -.441001E+03  .700000E-02      .000000E+00
      2  .212660E+01      .000000E+00  .672000E-02      .000000E+00
      3  .408520E+01      .000000E+00  .588000E-02      .000000E+00
      4  .570780E+01      .000000E+00  .448000E-02      .000000E+00
      5  .682640E+01      .000000E+00  .252000E-02      .000000E+00
      6  .727300E+01      .000000E+00  .101090E-09      .000000E+00
      7  .682640E+01      .000000E+00 -.252000E-02      .000000E+00
      8  .570780E+01      .000000E+00 -.448000E-02      .000000E+00
      9  .408520E+01      .000000E+00 -.588000E-02      .000000E+00
     10  .212660E+01      .000000E+00 -.672000E-02      .000000E+00
     11  .000000E+00     -.441000E+03 -.700000E-02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .661500E+05  .441000E+03  .000000E+00
      2  .198450E+06  .441000E+03  .000000E+00
      3  .330750E+06  .441000E+03  .000000E+00
      4  .463050E+06  .441000E+03  .000000E+00
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      5  .595350E+06  .441000E+03  .000000E+00
      6  .595350E+06 -.441001E+03  .000000E+00
      7  .463050E+06 -.441001E+03  .000000E+00
      8  .330750E+06 -.441000E+03  .000000E+00
      9  .198450E+06 -.441000E+03  .000000E+00
     10  .661500E+05 -.441000E+03  .000000E+00
0   IINCS=  5 NITER= 100 NOUTP=  2 FACTO=  .500000E-01 TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0 NORM OF RESIDUAL SUM RATIO=  .146137E-01
0   NODE   DISPL.        REACTION      DISPL.        REACTION
      1  .000000E+00     -.472500E+03  .750000E-02     .000000E+00
      2  .227850E+01      .000000E+00  .720000E-02     .000000E+00
      3  .437700E+01      .000000E+00  .630000E-02     .000000E+00
      4  .611550E+01      .000000E+00  .480000E-02     .000000E+00
      5  .731400E+01      .000000E+00  .270000E-02     .000000E+00
      6  .779250E+01      .000000E+00  .233608E-09     .000000E+00
      7  .731400E+01      .000000E+00 -.270000E-02     .000000E+00
      8  .611550E+01      .000000E+00 -.480000E-02     .000000E+00
      9  .437700E+01      .000000E+00 -.630000E-02     .000000E+00
     10  .227850E+01      .000000E+00 -.720000E-02     .000000E+00
     11  .000000E+00     -.472500E+03 -.750000E-02     .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .708750E+05  .472500E+03  .000000E+00
      2  .212625E+06  .472500E+03  .000000E+00
      3  .354375E+06  .472500E+03  .000000E+00
      4  .496125E+06  .472500E+03  .000000E+00
      5  .637875E+06  .472500E+03  .000000E+00
      6  .637875E+06 -.472500E+03  .000000E+00
      7  .496125E+06 -.472500E+03  .000000E+00
      8  .354375E+06 -.472500E+03  .000000E+00
      9  .212625E+06 -.472500E+03  .000000E+00
     10  .708750E+05 -.472500E+03  .000000E+00
0   IINCS=  6 NITER= 100 NOUTP=  2 FACTO=  .500000E-01 TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0 NORM OF RESIDUAL SUM RATIO=  .891275E-02
0   NODE   DISPL.        REACTION      DISPL.        REACTION
      1  .000000E+00     -.504000E+03  .800000E-02     .000000E+00
      2  .243040E+01      .000000E+00  .768000E-02     .000000E+00
      3  .466880E+01      .000000E+00  .672000E-02     .000000E+00
      4  .652320E+01      .000000E+00  .512000E-02     .000000E+00
      5  .780160E+01      .000000E+00  .288000E-02     .000000E+00
      6  .831200E+01      .000000E+00 -.220702E-10     .000000E+00
      7  .780160E+01      .000000E+00 -.288000E-02     .000000E+00
      8  .652320E+01      .000000E+00 -.512000E-02     .000000E+00
      9  .466880E+01      .000000E+00 -.672000E-02     .000000E+00
     10  .243040E+01      .000000E+00 -.768000E-02     .000000E+00
     11  .000000E+00     -.504000E+03 -.800000E-02     .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .756000E+05  .504000E+03  .000000E+00
      2  .226800E+06  .504000E+03  .000000E+00
      3  .378000E+06  .504000E+03  .000000E+00
      4  .529200E+06  .504000E+03  .000000E+00
      5  .680400E+06  .504000E+03  .000000E+00
      6  .680400E+06 -.504000E+03  .000000E+00
      7  .529200E+06 -.504000E+03  .000000E+00
      8  .378000E+06 -.504000E+03  .000000E+00
      9  .226800E+06 -.504000E+03  .000000E+00
     10  .756000E+05 -.504000E+03  .000000E+00
0   IINCS=  7 NITER= 100 NOUTP=  2 FACTO=  .500000E-01 TOLER=  .500000E+00
0   ITERATION NUMBER=  1
```

0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .963762E-02
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.535500E+03 .850000E-02 .000000E+00
2 .258230E+01 .000000E+00 .816000E-02 .000000E+00
3 .496060E+01 .000000E+00 .714000E-02 .000000E+00
4 .693090E+01 .000000E+00 .544000E-02 .000000E+00
5 .828920E+01 .000000E+00 .306000E-02 .000000E+00
6 .883150E+01 .000000E+00 .128388E-09 .000000E+00
7 .828920E+01 .000000E+00 -.306000E-02 .000000E+00
8 .693090E+01 .000000E+00 -.544000E-02 .000000E+00
9 .496060E+01 .000000E+00 -.714000E-02 .000000E+00
10 .258230E+01 .000000E+00 -.816000E-02 .000000E+00
11 .000000E+00 -.535500E+03 -.850000E-02 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .803250E+05 .535500E+03 .000000E+00
2 .240975E+06 .535500E+03 .000000E+00
3 .401625E+06 .535500E+03 .000000E+00
4 .562275E+06 .535500E+03 .000000E+00
5 .722925E+06 .535500E+03 .000000E+00
6 .722925E+06 -.535500E+03 .000000E+00
7 .562275E+06 -.535500E+03 .000000E+00
8 .401625E+06 -.535500E+03 .000000E+00
9 .240975E+06 -.535500E+03 .000000E+00
10 .803250E+05 -.535500E+03 .000000E+00
0 IINCS= 8 NITER= 100 NOUTP= 2 FACTO= .500000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .884383E-02
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.567000E+03 .900000E-02 .000000E+00
2 .273420E+01 .000000E+00 .864000E-02 .000000E+00
3 .525240E+01 .000000E+00 .756000E-02 .000000E+00
4 .733860E+01 .000000E+00 .576000E-02 .000000E+00
5 .877680E+01 .000000E+00 .324000E-02 .000000E+00
6 .935100E+01 .000000E+00 -.716963E-10 .000000E+00
7 .877680E+01 .000000E+00 -.324000E-02 .000000E+00
8 .733860E+01 .000000E+00 -.576000E-02 .000000E+00
9 .525240E+01 .000000E+00 -.756000E-02 .000000E+00
10 .273420E+01 .000000E+00 -.864000E-02 .000000E+00
11 .000000E+00 -.567000E+03 -.900000E-02 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .850500E+05 .567000E+03 .000000E+00
2 .255150E+06 .567000E+03 .000000E+00
3 .425250E+06 .567000E+03 .000000E+00
4 .595350E+06 .567000E+03 .000000E+00
5 .765450E+06 .567000E+03 .000000E+00
6 .765450E+06 -.567000E+03 .000000E+00
7 .595350E+06 -.567000E+03 .000000E+00
8 .425250E+06 -.567000E+03 .000000E+00
9 .255150E+06 -.567000E+03 .000000E+00
10 .850500E+05 -.567000E+03 .000000E+00
0 IINCS= 9 NITER= 100 NOUTP= 2 FACTO= .200000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .470999E-02
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.579600E+03 .920000E-02 .000000E+00
2 .279496E+01 .000000E+00 .883200E-02 .000000E+00
3 .536912E+01 .000000E+00 .772800E-02 .000000E+00
4 .750168E+01 .000000E+00 .588800E-02 .000000E+00
5 .897184E+01 .000000E+00 .331200E-02 .000000E+00
6 .955880E+01 .000000E+00 .581999E-10 .000000E+00

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      7  .897184E+01       .000000E+00  -.331200E-02       .000000E+00
      8  .750168E+01       .000000E+00  -.588800E-02       .000000E+00
      9  .536912E+01       .000000E+00  -.772800E-02       .000000E+00
     10  .279496E+01       .000000E+00  -.883200E-02       .000000E+00
     11  .000000E+00      -.579600E+03  -.920000E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .869400E+05   .579600E+03   .000000E+00
      2  .260820E+06   .579600E+03   .000000E+00
      3  .434700E+06   .579600E+03   .000000E+00
      4  .608580E+06   .579600E+03   .000000E+00
      5  .782460E+06   .579600E+03   .000000E+00
      6  .782460E+06  -.579600E+03   .000000E+00
      7  .608580E+06  -.579600E+03   .000000E+00
      8  .434700E+06  -.579600E+03   .000000E+00
      9  .260820E+06  -.579600E+03   .000000E+00
     10  .869400E+05  -.579600E+03   .000000E+00
0   IINCS=  10  NITER= 100  NOUTP=   2  FACTO=  .200000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .219712E-02
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.592200E+03   .940000E-02       .000000E+00
      2  .285572E+01       .000000E+00   .902400E-02       .000000E+00
      3  .548584E+01       .000000E+00   .789600E-02       .000000E+00
      4  .766476E+01       .000000E+00   .601600E-02       .000000E+00
      5  .916688E+01       .000000E+00   .338400E-02       .000000E+00
      6  .976660E+01       .000000E+00   .484551E-10       .000000E+00
      7  .916688E+01       .000000E+00  -.338400E-02       .000000E+00
      8  .766476E+01       .000000E+00  -.601600E-02       .000000E+00
      9  .548584E+01       .000000E+00  -.789600E-02       .000000E+00
     10  .285572E+01       .000000E+00  -.902400E-02       .000000E+00
     11  .000000E+00      -.592200E+03  -.940000E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .888300E+05   .592200E+03   .000000E+00
      2  .266490E+06   .592200E+03   .000000E+00
      3  .444150E+06   .592200E+03   .000000E+00
      4  .621810E+06   .592200E+03   .000000E+00
      5  .799470E+06   .592200E+03   .000000E+00
      6  .799470E+06  -.592200E+03   .000000E+00
      7  .621810E+06  -.592200E+03   .000000E+00
      8  .444150E+06  -.592200E+03   .000000E+00
      9  .266490E+06  -.592200E+03   .000000E+00
     10  .888300E+05  -.592200E+03   .000000E+00
0   IINCS=  11  NITER= 100  NOUTP=   2  FACTO=  .200000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .474426E-02
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.604800E+03   .960000E-02       .000000E+00
      2  .291648E+01       .000000E+00   .921600E-02       .000000E+00
      3  .560256E+01       .000000E+00   .806400E-02       .000000E+00
      4  .782784E+01       .000000E+00   .614400E-02       .000000E+00
      5  .936192E+01       .000000E+00   .345600E-02       .000000E+00
      6  .997440E+01       .000000E+00   .410544E-10       .000000E+00
      7  .936192E+01       .000000E+00  -.345600E-02       .000000E+00
      8  .782784E+01       .000000E+00  -.614400E-02       .000000E+00
      9  .560256E+01       .000000E+00  -.806400E-02       .000000E+00
     10  .291648E+01       .000000E+00  -.921600E-02       .000000E+00
     11  .000000E+00      -.604800E+03  -.960000E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .907200E+05   .604800E+03   .000000E+00
      2  .272160E+06   .604800E+03   .000000E+00
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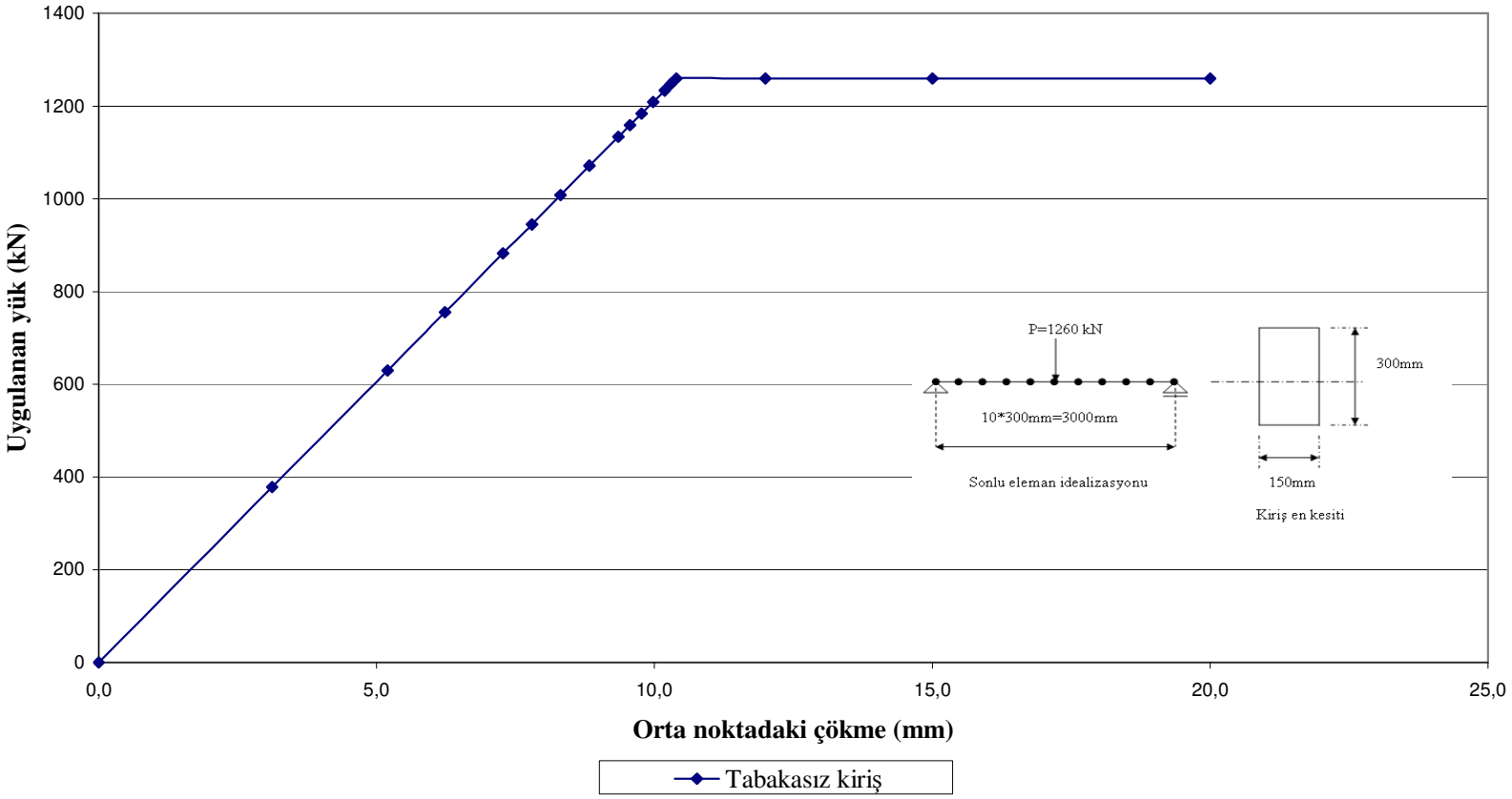
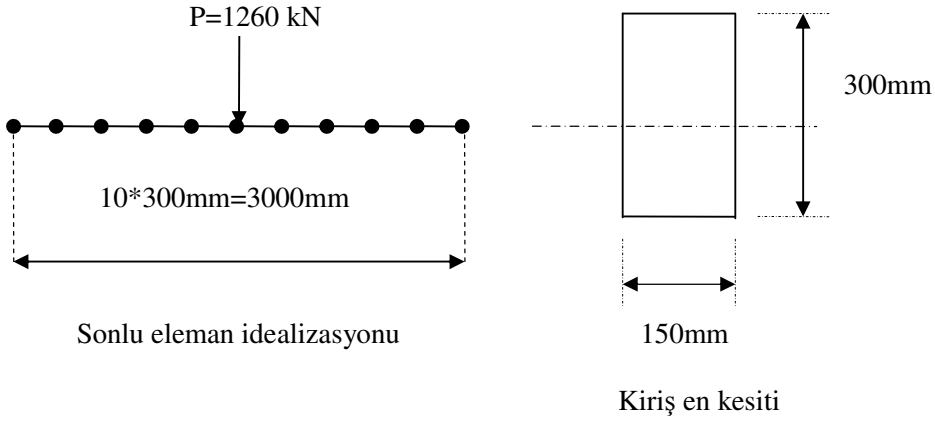
      3  .453600E+06   .604800E+03   .000000E+00
      4  .635040E+06   .604800E+03   .000000E+00
      5  .816480E+06   .604800E+03   .000000E+00
      6  .816480E+06  -.604800E+03   .000000E+00
      7  .635040E+06  -.604800E+03   .000000E+00
      8  .453600E+06  -.604800E+03   .000000E+00
      9  .272160E+06  -.604800E+03   .000000E+00
     10  .907200E+05  -.604800E+03   .000000E+00
0   IINCS=  12  NITER=  100  NOUTP=   2  FACTO=  .200000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .232051E-02
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.617400E+03   .980000E-02      .000000E+00
      2  .297724E+01       .000000E+00   .940800E-02      .000000E+00
      3  .571928E+01       .000000E+00   .823200E-02      .000000E+00
      4  .799092E+01       .000000E+00   .627200E-02      .000000E+00
      5  .955696E+01       .000000E+00   .352800E-02      .000000E+00
      6  .101822E+02       .000000E+00   .250100E-09      .000000E+00
      7  .955696E+01       .000000E+00  -.352800E-02      .000000E+00
      8  .799092E+01       .000000E+00  -.627200E-02      .000000E+00
      9  .571928E+01       .000000E+00  -.823200E-02      .000000E+00
     10  .297724E+01       .000000E+00  -.940800E-02      .000000E+00
     11  .000000E+00      -.617400E+03  -.980000E-02      .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .926100E+05   .617400E+03   .000000E+00
      2  .277830E+06   .617400E+03   .000000E+00
      3  .463050E+06   .617400E+03   .000000E+00
      4  .648270E+06   .617400E+03   .000000E+00
      5  .833490E+06   .617400E+03   .000000E+00
      6  .833490E+06  -.617400E+03   .000000E+00
      7  .648270E+06  -.617400E+03   .000000E+00
      8  .463050E+06  -.617400E+03   .000000E+00
      9  .277830E+06  -.617400E+03   .000000E+00
     10  .926100E+05  -.617400E+03   .000000E+00
0   IINCS=  13  NITER=  100  NOUTP=   2  FACTO=  .100000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .751606E-02
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.623700E+03   .990000E-02      .000000E+00
      2  .300762E+01       .000000E+00   .950400E-02      .000000E+00
      3  .577764E+01       .000000E+00   .831600E-02      .000000E+00
      4  .807246E+01       .000000E+00   .633600E-02      .000000E+00
      5  .965448E+01       .000000E+00   .356400E-02      .000000E+00
      6  .102861E+02       .000000E+00   .296988E-09      .000000E+00
      7  .965448E+01       .000000E+00  -.356400E-02      .000000E+00
      8  .807246E+01       .000000E+00  -.633600E-02      .000000E+00
      9  .577764E+01       .000000E+00  -.831600E-02      .000000E+00
     10  .300762E+01       .000000E+00  -.950400E-02      .000000E+00
     11  .000000E+00      -.623700E+03  -.990000E-02      .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .935550E+05   .623700E+03   .000000E+00
      2  .280665E+06   .623700E+03   .000000E+00
      3  .467775E+06   .623700E+03   .000000E+00
      4  .654885E+06   .623700E+03   .000000E+00
      5  .841995E+06   .623700E+03   .000000E+00
      6  .841995E+06  -.623700E+03   .000000E+00
      7  .654885E+06  -.623700E+03   .000000E+00
      8  .467775E+06  -.623700E+03   .000000E+00
      9  .280665E+06  -.623700E+03   .000000E+00
     10  .935550E+05  -.623700E+03   .000000E+00
```

0 IINCS= 14 NITER= 100 NOUTP= 2 FACTO= .100000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .618578E+03
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.630000E+03 .100000E-01 .000000E+00
2 .303800E+01 .000000E+00 .960000E-02 .000000E+00
3 .583600E+01 .000000E+00 .840000E-02 .000000E+00
4 .815400E+01 .000000E+00 .640000E-02 .000000E+00
5 .975200E+01 .000000E+00 .360000E-02 .000000E+00
6 .103900E+02 .000000E+00 .245570E-09 .000000E+00
7 .975200E+01 .000000E+00 -.360000E-02 .000000E+00
8 .815400E+01 .000000E+00 -.640000E-02 .000000E+00
9 .583600E+01 .000000E+00 -.840000E-02 .000000E+00
10 .303800E+01 .000000E+00 -.960000E-02 .000000E+00
11 .000000E+00 -.630000E+03 -.100000E-01 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .945000E+05 .630000E+03 .000000E+00
2 .283500E+06 .630000E+03 .000000E+00
3 .472500E+06 .630000E+03 .000000E+00
4 .661500E+06 .630000E+03 .000000E+00
5 .843750E+06 .630000E+03 .952363E-07
6 .843750E+06 -.630000E+03 .952363E-07
7 .661500E+06 -.630000E+03 .000000E+00
8 .472500E+06 -.630000E+03 .000000E+00
9 .283500E+06 -.630000E+03 .000000E+00
10 .945000E+05 -.630000E+03 .000000E+00



Şekil 5.2: Tekil yüklü tabakasız Timoshenko kirişi örneği

5.1.2 Elastik zemine oturan tekil yüklü tabakasız Timoshenko kirişi örneği



Şekil 5.3: Tekil yük etkisi altındaki kiriş

Bu örnekte elastik zemin etkilerini daha iyi gözlemleyebilmek için mesnetler kaldırılarak çözüm yapılmıştır. Kayma şekil değiştirmelerini içeren sistem rijitlik matrisi ilk örnekte olduğu gibi hesaba katılmıştır.

Kiriş malzeme özellikleri ilk örnekteki gibi olup $\mathbf{k_0}$(Elastik zemin katsayısı) 6000t/m^3 alınmıştır.Bu durumda;

$EZK=k_0*b = 6.10^{-5}$(kN/mm^3)*150(mm)=9.10^{-3} kN/mm

Kiriş malzeme özellikleri ilk örnekteki gibidir. Veri giriş bilgilerinde ilk örnekten farklı olarak kiriş mesnetlenmesinden kaynaklanan farklılık aşağıda gösterilmiştir. Mesnetlenme durumu ve elastik zemin katsayısı değeri dışında veri girişi örnek 5.1 ile aynıdır.

Düğüm nokta numarası	**Mesnetlenme durumu**	**Moment çökme değeri**	**Dönme değeri**	**Dışarıdan verilmiş dönme**
1(ilk)	**0** (serbest)	0.	0.	0.
11(son)	**0** (serbest)	0.	0.	0.

Veri girişi sonrası alınan sonuçlar;

```
NPOIN=   11   NELEM=   10   NBOUN=    2   NMATS=    1

 NPROP=    4   NNODE=    2   NINCS=   14   NALGO=    2

 NDOFN=    2
0    MATERIAL PROPERTIES
       1   .7087500E+11   .2423070E+07   .8437500E+06   .0000000E+00
0   EL NODES MAT.
   1    1    2    1
   2    2    3    1
   3    3    4    1
   4    4    5    1
   5    5    6    1
   6    6    7    1
   7    7    8    1
   8    8    9    1
   9    9   10    1
  10   10   11    1
0    NODE     COORD.
       1        .00000
       2      300.00000
       3      600.00000
       4      900.00000
       5     1200.00000
       6     1500.00000
       7     1800.00000
       8     2100.00000
       9     2400.00000
      10     2700.00000
      11     3000.00000
0 RES.NODE  CODE   PRES.VALUES  CODE   PRES.VALUES
       1    0        .00000    0        .00000
      11    0        .00000    0        .00000
0  ELEMENT          NODAL LOADS
       1        .00000        .00000        .00000        .00000
       2        .00000        .00000        .00000        .00000
       3        .00000        .00000        .00000        .00000
       4        .00000        .00000        .00000        .00000
       5        .00000        .00000        .00000        .00000
       6     1260.00000        .00000        .00000        .00000
       7        .00000        .00000        .00000        .00000
       8        .00000        .00000        .00000        .00000
       9        .00000        .00000        .00000        .00000
      10        .00000        .00000        .00000        .00000
  ELASTIC SOIL COEFFICIENT=      .900000E-02
0    IINCS=    1   NITER=  100   NOUTP=    2   FACTO=   .300000E+00   TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .336351E+02
0    NODE    DISPL.           REACTION       DISPL.           REACTION
       1   .133092E+02       .000000E+00   .977460E-03       .000000E+00
       2   .136042E+02       .000000E+00   .969804E-03       .000000E+00
       3   .138955E+02       .000000E+00   .915887E-03       .000000E+00
       4   .141626E+02       .000000E+00   .768534E-03       .000000E+00
       5   .143701E+02       .000000E+00   .479602E-03       .000000E+00
```

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      6  .144684E+02       .000000E+00   .139451E-06       .000000E+00
      7  .143702E+02       .000000E+00  -.479327E-03       .000000E+00
      8  .141627E+02       .000000E+00  -.768266E-03       .000000E+00
      9  .138958E+02       .000000E+00  -.915625E-03       .000000E+00
     10  .136045E+02       .000000E+00  -.969544E-03       .000000E+00
     11  .133096E+02       .000000E+00  -.977204E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .271286E+04  .181826E+02  .000000E+00
      2  .136619E+05  .549391E+02  .000000E+00
      3  .357551E+05  .924781E+02  .000000E+00
      4  .692193E+05  .130723E+03  .000000E+00
      5  .114243E+06  .169502E+03  .000000E+00
      6  .114243E+06 -.169509E+03  .000000E+00
      7  .692209E+05 -.130719E+03  .000000E+00
      8  .357563E+05 -.924745E+02  .000000E+00
      9  .136625E+05 -.549402E+02  .000000E+00
     10  .271384E+04 -.181772E+02  .000000E+00
0    ITERATION NUMBER=    2
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308732E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .272934E+02       .000000E+00   .980206E-03       .000000E+00
      2  .275897E+02       .000000E+00   .976034E-03       .000000E+00
      3  .278835E+02       .000000E+00   .923957E-03       .000000E+00
      4  .281532E+02       .000000E+00   .775983E-03       .000000E+00
      5  .283628E+02       .000000E+00   .484097E-03       .000000E+00
      6  .284619E+02       .000000E+00   .267290E-06       .000000E+00
      7  .283629E+02       .000000E+00  -.483567E-03       .000000E+00
      8  .281535E+02       .000000E+00  -.775460E-03       .000000E+00
      9  .278840E+02       .000000E+00  -.923438E-03       .000000E+00
     10  .275904E+02       .000000E+00  -.975518E-03       .000000E+00
     11  .272941E+02       .000000E+00  -.979695E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .282956E+04  .188959E+02  .000000E+00
      2  .141671E+05  .566872E+02  .000000E+00
      3  .368415E+05  .944785E+02  .000000E+00
      4  .708572E+05  .132289E+03  .000000E+00
      5  .116215E+06  .170095E+03  .000000E+00
      6  .116216E+06 -.170093E+03  .000000E+00
      7  .708589E+05 -.132281E+03  .000000E+00
      8  .368428E+05 -.944778E+02  .000000E+00
      9  .141678E+05 -.566788E+02  .000000E+00
     10  .283064E+04 -.188928E+02  .000000E+00
0    ITERATION NUMBER=    3
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308614E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .412920E+02       .000000E+00   .960905E-03       .000000E+00
      2  .415832E+02       .000000E+00   .960703E-03       .000000E+00
      3  .418730E+02       .000000E+00   .912560E-03       .000000E+00
      4  .421399E+02       .000000E+00   .768469E-03       .000000E+00
      5  .423478E+02       .000000E+00   .480417E-03       .000000E+00
      6  .424463E+02       .000000E+00   .392654E-06       .000000E+00
      7  .423480E+02       .000000E+00  -.479636E-03       .000000E+00
      8  .421403E+02       .000000E+00  -.767695E-03       .000000E+00
      9  .418737E+02       .000000E+00  -.911791E-03       .000000E+00
     10  .415841E+02       .000000E+00  -.959937E-03       .000000E+00
     11  .412932E+02       .000000E+00  -.960143E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283206E+04  .189067E+02  .000000E+00
      2  .141778E+05  .567215E+02  .000000E+00
      3  .368643E+05  .945234E+02  .000000E+00
```

```
      4  .708912E+05   .132318E+03   .000000E+00
      5  .116255E+06   .170102E+03   .000000E+00
      6  .116256E+06  -.170105E+03   .000000E+00
      7  .708929E+05  -.132322E+03   .000000E+00
      8  .368656E+05  -.945218E+02   .000000E+00
      9  .141785E+05  -.567185E+02   .000000E+00
     10  .283313E+04  -.189092E+02   .000000E+00
0    ITERATION NUMBER=    4
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308624E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .552910E+02       .000000E+00   .941146E-03       .000000E+00
      2  .555769E+02       .000000E+00   .944925E-03       .000000E+00
      3  .558625E+02       .000000E+00   .900760E-03       .000000E+00
      4  .561264E+02       .000000E+00   .760645E-03       .000000E+00
      5  .563326E+02       .000000E+00   .476568E-03       .000000E+00
      6  .564306E+02       .000000E+00   .517624E-06       .000000E+00
      7  .563329E+02       .000000E+00  -.475537E-03       .000000E+00
      8  .561270E+02       .000000E+00  -.759621E-03       .000000E+00
      9  .558634E+02       .000000E+00  -.899741E-03       .000000E+00
     10  .555781E+02       .000000E+00  -.943908E-03       .000000E+00
     11  .552926E+02       .000000E+00  -.940134E-03       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189151E+02   .000000E+00
      2  .141780E+05   .567250E+02   .000000E+00
      3  .368648E+05   .945198E+02   .000000E+00
      4  .708919E+05   .132323E+03   .000000E+00
      5  .116256E+06   .170113E+03   .000000E+00
      6  .116257E+06  -.170107E+03   .000000E+00
      7  .708936E+05  -.132318E+03   .000000E+00
      8  .368660E+05  -.945282E+02   .000000E+00
      9  .141787E+05  -.567262E+02   .000000E+00
     10  .283318E+04  -.189036E+02   .000000E+00
0    ITERATION NUMBER=    5
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308666E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .692900E+02       .000000E+00   .921377E-03       .000000E+00
      2  .695705E+02       .000000E+00   .929137E-03       .000000E+00
      3  .698520E+02       .000000E+00   .888951E-03       .000000E+00
      4  .701130E+02       .000000E+00   .752815E-03       .000000E+00
      5  .703174E+02       .000000E+00   .472715E-03       .000000E+00
      6  .704149E+02       .000000E+00   .642217E-06       .000000E+00
      7  .703178E+02       .000000E+00  -.471435E-03       .000000E+00
      8  .701138E+02       .000000E+00  -.751541E-03       .000000E+00
      9  .698532E+02       .000000E+00  -.887683E-03       .000000E+00
     10  .695720E+02       .000000E+00  -.927871E-03       .000000E+00
     11  .692919E+02       .000000E+00  -.920116E-03       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189112E+02   .000000E+00
      2  .141780E+05   .567275E+02   .000000E+00
      3  .368648E+05   .945309E+02   .000000E+00
      4  .708919E+05   .132314E+03   .000000E+00
      5  .116256E+06   .170109E+03   .000000E+00
      6  .116257E+06  -.170111E+03   .000000E+00
      7  .708936E+05  -.132318E+03   .000000E+00
      8  .368661E+05  -.945233E+02   .000000E+00
      9  .141787E+05  -.567308E+02   .000000E+00
     10  .283319E+04  -.189081E+02   .000000E+00
0    ITERATION NUMBER=    6
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308717E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
```

```
      1  .832890E+02      .000000E+00  .901611E-03      .000000E+00
      2  .835642E+02      .000000E+00  .913351E-03      .000000E+00
      3  .838415E+02      .000000E+00  .877145E-03      .000000E+00
      4  .840996E+02      .000000E+00  .744987E-03      .000000E+00
      5  .843022E+02      .000000E+00  .468865E-03      .000000E+00
      6  .843991E+02      .000000E+00  .769919E-06      .000000E+00
      7  .843027E+02      .000000E+00 -.467330E-03      .000000E+00
      8  .841005E+02      .000000E+00 -.743458E-03      .000000E+00
      9  .838429E+02      .000000E+00 -.875621E-03      .000000E+00
     10  .835660E+02      .000000E+00 -.911829E-03      .000000E+00
     11  .832913E+02      .000000E+00 -.900093E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189152E+02  .000000E+00
      2  .141780E+05  .567193E+02  .000000E+00
      3  .368648E+05  .945251E+02  .000000E+00
      4  .708919E+05  .132318E+03  .000000E+00
      5  .116256E+06  .170112E+03  .000000E+00
      6  .116257E+06 -.170104E+03  .000000E+00
      7  .708935E+05 -.132312E+03  .000000E+00
      8  .368660E+05 -.945262E+02  .000000E+00
      9  .141787E+05 -.567197E+02  .000000E+00
     10  .283315E+04 -.189097E+02  .000000E+00
0   ITERATION NUMBER=   7
0   CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308738E+02
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .972880E+02      .000000E+00  .881844E-03      .000000E+00
      2  .975578E+02      .000000E+00  .897565E-03      .000000E+00
      3  .978311E+02      .000000E+00  .865339E-03      .000000E+00
      4  .980861E+02      .000000E+00  .737159E-03      .000000E+00
      5  .982870E+02      .000000E+00  .465015E-03      .000000E+00
      6  .983834E+02      .000000E+00  .897078E-06      .000000E+00
      7  .982876E+02      .000000E+00 -.463225E-03      .000000E+00
      8  .980872E+02      .000000E+00 -.735376E-03      .000000E+00
      9  .978327E+02      .000000E+00 -.863560E-03      .000000E+00
     10  .975600E+02      .000000E+00 -.895790E-03      .000000E+00
     11  .972906E+02      .000000E+00 -.880073E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189130E+02  .000000E+00
      2  .141780E+05  .567233E+02  .000000E+00
      3  .368648E+05  .945254E+02  .000000E+00
      4  .708919E+05  .132322E+03  .000000E+00
      5  .116256E+06  .170109E+03  .000000E+00
      6  .116257E+06 -.170107E+03  .000000E+00
      7  .708936E+05 -.132316E+03  .000000E+00
      8  .368660E+05 -.945203E+02  .000000E+00
      9  .141787E+05 -.567172E+02  .000000E+00
     10  .283319E+04 -.189129E+02  .000000E+00
0   ITERATION NUMBER=   8
0   CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308706E+02
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .111287E+03      .000000E+00  .862079E-03      .000000E+00
      2  .111551E+03      .000000E+00  .881781E-03      .000000E+00
      3  .111821E+03      .000000E+00  .853534E-03      .000000E+00
      4  .112073E+03      .000000E+00  .729333E-03      .000000E+00
      5  .112272E+03      .000000E+00  .461166E-03      .000000E+00
      6  .112368E+03      .000000E+00  .102571E-05      .000000E+00
      7  .112272E+03      .000000E+00 -.459119E-03      .000000E+00
      8  .112074E+03      .000000E+00 -.727292E-03      .000000E+00
      9  .111822E+03      .000000E+00 -.851498E-03      .000000E+00
     10  .111554E+03      .000000E+00 -.879748E-03      .000000E+00
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      11  .111290E+03       .000000E+00  -.860050E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189145E+02   .000000E+00
      2  .141780E+05   .567250E+02   .000000E+00
      3  .368648E+05   .945234E+02   .000000E+00
      4  .708919E+05   .132318E+03   .000000E+00
      5  .116256E+06   .170110E+03   .000000E+00
      6  .116257E+06  -.170101E+03   .000000E+00
      7  .708936E+05  -.132318E+03   .000000E+00
      8  .368661E+05  -.945237E+02   .000000E+00
      9  .141788E+05  -.567243E+02   .000000E+00
     10  .283321E+04  -.189138E+02   .000000E+00
0    ITERATION NUMBER=    9
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308743E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .125286E+03       .000000E+00   .842310E-03       .000000E+00
      2  .125545E+03       .000000E+00   .865992E-03       .000000E+00
      3  .125810E+03       .000000E+00   .841725E-03       .000000E+00
      4  .126059E+03       .000000E+00   .721502E-03       .000000E+00
      5  .126257E+03       .000000E+00   .457313E-03       .000000E+00
      6  .126352E+03       .000000E+00   .114991E-05       .000000E+00
      7  .126257E+03       .000000E+00  -.455017E-03       .000000E+00
      8  .126061E+03       .000000E+00  -.719213E-03       .000000E+00
      9  .125812E+03       .000000E+00  -.839441E-03       .000000E+00
     10  .125548E+03       .000000E+00  -.863711E-03       .000000E+00
     11  .125289E+03       .000000E+00  -.840032E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189114E+02   .000000E+00
      2  .141780E+05   .567160E+02   .000000E+00
      3  .368648E+05   .945229E+02   .000000E+00
      4  .708919E+05   .132316E+03   .000000E+00
      5  .116256E+06   .170106E+03   .000000E+00
      6  .116257E+06  -.170111E+03   .000000E+00
      7  .708936E+05  -.132322E+03   .000000E+00
      8  .368661E+05  -.945243E+02   .000000E+00
      9  .141787E+05  -.567225E+02   .000000E+00
     10  .283319E+04  -.189121E+02   .000000E+00
0    ITERATION NUMBER=   10
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308653E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .139285E+03       .000000E+00   .822542E-03       .000000E+00
      2  .139539E+03       .000000E+00   .850205E-03       .000000E+00
      3  .139800E+03       .000000E+00   .829916E-03       .000000E+00
      4  .140046E+03       .000000E+00   .713672E-03       .000000E+00
      5  .140241E+03       .000000E+00   .453461E-03       .000000E+00
      6  .140336E+03       .000000E+00   .127557E-05       .000000E+00
      7  .140242E+03       .000000E+00  -.450914E-03       .000000E+00
      8  .140047E+03       .000000E+00  -.711132E-03       .000000E+00
      9  .139802E+03       .000000E+00  -.827381E-03       .000000E+00
     10  .139542E+03       .000000E+00  -.847671E-03       .000000E+00
     11  .139289E+03       .000000E+00  -.820011E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189008E+02   .000000E+00
      2  .141780E+05   .567239E+02   .000000E+00
      3  .368648E+05   .945270E+02   .000000E+00
      4  .708919E+05   .132324E+03   .000000E+00
      5  .116256E+06   .170113E+03   .000000E+00
      6  .116257E+06  -.170112E+03   .000000E+00
      7  .708935E+05  -.132319E+03   .000000E+00
      8  .368660E+05  -.945233E+02   .000000E+00
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9 .141787E+05 -.567197E+02 .000000E+00
10 .283315E+04 -.189158E+02 .000000E+00
0 ITERATION NUMBER= 11
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .308690E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .153284E+03 .000000E+00 .802773E-03 .000000E+00
2 .153532E+03 .000000E+00 .834417E-03 .000000E+00
3 .153789E+03 .000000E+00 .818108E-03 .000000E+00
4 .154032E+03 .000000E+00 .705842E-03 .000000E+00
5 .154226E+03 .000000E+00 .449609E-03 .000000E+00
6 .154320E+03 .000000E+00 .140045E-05 .000000E+00
7 .154227E+03 .000000E+00 -.446812E-03 .000000E+00
8 .154034E+03 .000000E+00 -.703052E-03 .000000E+00
9 .153792E+03 .000000E+00 -.815323E-03 .000000E+00
10 .153536E+03 .000000E+00 -.831634E-03 .000000E+00
11 .153288E+03 .000000E+00 -.799993E-03 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189027E+02 .000000E+00
2 .141780E+05 .567259E+02 .000000E+00
3 .368648E+05 .945314E+02 .000000E+00
4 .708919E+05 .132326E+03 .000000E+00
5 .116256E+06 .170108E+03 .000000E+00
6 .116257E+06 -.170111E+03 .000000E+00
7 .708936E+05 -.132318E+03 .000000E+00
8 .368661E+05 -.945245E+02 .000000E+00
9 .141787E+05 -.567306E+02 .000000E+00
10 .283319E+04 -.189143E+02 .000000E+00
0 ITERATION NUMBER= 12
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .308595E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .167283E+03 .000000E+00 .783004E-03 .000000E+00
2 .167526E+03 .000000E+00 .818629E-03 .000000E+00
3 .167779E+03 .000000E+00 .806299E-03 .000000E+00
4 .168019E+03 .000000E+00 .698012E-03 .000000E+00
5 .168211E+03 .000000E+00 .445757E-03 .000000E+00
6 .168305E+03 .000000E+00 .152541E-05 .000000E+00
7 .168212E+03 .000000E+00 -.442710E-03 .000000E+00
8 .168021E+03 .000000E+00 -.694972E-03 .000000E+00
9 .167781E+03 .000000E+00 -.803264E-03 .000000E+00
10 .167530E+03 .000000E+00 -.815596E-03 .000000E+00
11 .167287E+03 .000000E+00 -.779975E-03 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189048E+02 .000000E+00
2 .141780E+05 .567220E+02 .000000E+00
3 .368648E+05 .945239E+02 .000000E+00
4 .708919E+05 .132323E+03 .000000E+00
5 .116256E+06 .170110E+03 .000000E+00
6 .116257E+06 -.170104E+03 .000000E+00
7 .708936E+05 -.132325E+03 .000000E+00
8 .368661E+05 -.945270E+02 .000000E+00
9 .141787E+05 -.567246E+02 .000000E+00
10 .283319E+04 -.189142E+02 .000000E+00
0 ITERATION NUMBER= 13
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .308835E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .181282E+03 .000000E+00 .763237E-03 .000000E+00
2 .181520E+03 .000000E+00 .802842E-03 .000000E+00
3 .181768E+03 .000000E+00 .794492E-03 .000000E+00
4 .182006E+03 .000000E+00 .690183E-03 .000000E+00
5 .182196E+03 .000000E+00 .441906E-03 .000000E+00

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      6  .182289E+03      .000000E+00   .165202E-05      .000000E+00
      7  .182197E+03      .000000E+00  -.438605E-03      .000000E+00
      8  .182008E+03      .000000E+00  -.686890E-03      .000000E+00
      9  .181771E+03      .000000E+00  -.791203E-03      .000000E+00
     10  .181524E+03      .000000E+00  -.799556E-03      .000000E+00
     11  .181287E+03      .000000E+00  -.759953E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189170E+02   .000000E+00
      2  .141780E+05   .567282E+02   .000000E+00
      3  .368648E+05   .945263E+02   .000000E+00
      4  .708919E+05   .132323E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170107E+03   .000000E+00
      7  .708936E+05  -.132311E+03   .000000E+00
      8  .368661E+05  -.945216E+02   .000000E+00
      9  .141787E+05  -.567231E+02   .000000E+00
     10  .283319E+04  -.189128E+02   .000000E+00
0    ITERATION NUMBER=   14
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308754E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .195281E+03      .000000E+00   .743468E-03      .000000E+00
      2  .195513E+03      .000000E+00   .787055E-03      .000000E+00
      3  .195758E+03      .000000E+00   .782684E-03      .000000E+00
      4  .195992E+03      .000000E+00   .682353E-03      .000000E+00
      5  .196181E+03      .000000E+00   .438054E-03      .000000E+00
      6  .196273E+03      .000000E+00   .177730E-05      .000000E+00
      7  .196182E+03      .000000E+00  -.434503E-03      .000000E+00
      8  .195994E+03      .000000E+00  -.678809E-03      .000000E+00
      9  .195761E+03      .000000E+00  -.779144E-03      .000000E+00
     10  .195518E+03      .000000E+00  -.783517E-03      .000000E+00
     11  .195286E+03      .000000E+00  -.739934E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189120E+02   .000000E+00
      2  .141780E+05   .567233E+02   .000000E+00
      3  .368648E+05   .945300E+02   .000000E+00
      4  .708919E+05   .132324E+03   .000000E+00
      5  .116256E+06   .170103E+03   .000000E+00
      6  .116257E+06  -.170113E+03   .000000E+00
      7  .708936E+05  -.132318E+03   .000000E+00
      8  .368660E+05  -.945308E+02   .000000E+00
      9  .141787E+05  -.567180E+02   .000000E+00
     10  .283316E+04  -.189141E+02   .000000E+00
0    ITERATION NUMBER=   15
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308728E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .209280E+03      .000000E+00   .723698E-03      .000000E+00
      2  .209507E+03      .000000E+00   .771265E-03      .000000E+00
      3  .209747E+03      .000000E+00   .770874E-03      .000000E+00
      4  .209979E+03      .000000E+00   .674522E-03      .000000E+00
      5  .210166E+03      .000000E+00   .434200E-03      .000000E+00
      6  .210257E+03      .000000E+00   .190059E-05      .000000E+00
      7  .210167E+03      .000000E+00  -.430402E-03      .000000E+00
      8  .209981E+03      .000000E+00  -.670731E-03      .000000E+00
      9  .209751E+03      .000000E+00  -.767088E-03      .000000E+00
     10  .209512E+03      .000000E+00  -.767481E-03      .000000E+00
     11  .209286E+03      .000000E+00  -.719917E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189050E+02   .000000E+00
      2  .141780E+05   .567165E+02   .000000E+00
      3  .368648E+05   .945195E+02   .000000E+00
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      4  .708919E+05   .132312E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170108E+03   .000000E+00
      7  .708936E+05  -.132314E+03   .000000E+00
      8  .368661E+05  -.945234E+02   .000000E+00
      9  .141787E+05  -.567264E+02   .000000E+00
     10  .283317E+04  -.189102E+02   .000000E+00
0    ITERATION NUMBER=   16
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308681E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .223279E+03       .000000E+00   .703930E-03       .000000E+00
      2  .223501E+03       .000000E+00   .755477E-03       .000000E+00
      3  .223737E+03       .000000E+00   .759066E-03       .000000E+00
      4  .223965E+03       .000000E+00   .666692E-03       .000000E+00
      5  .224150E+03       .000000E+00   .430348E-03       .000000E+00
      6  .224242E+03       .000000E+00   .202627E-05       .000000E+00
      7  .224152E+03       .000000E+00  -.426299E-03       .000000E+00
      8  .223968E+03       .000000E+00  -.662650E-03       .000000E+00
      9  .223740E+03       .000000E+00  -.755028E-03       .000000E+00
     10  .223506E+03       .000000E+00  -.751441E-03       .000000E+00
     11  .223285E+03       .000000E+00  -.699897E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189067E+02   .000000E+00
      2  .141780E+05   .567244E+02   .000000E+00
      3  .368648E+05   .945236E+02   .000000E+00
      4  .708919E+05   .132320E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170109E+03   .000000E+00
      7  .708935E+05  -.132317E+03   .000000E+00
      8  .368660E+05  -.945163E+02   .000000E+00
      9  .141787E+05  -.567234E+02   .000000E+00
     10  .283318E+04  -.189133E+02   .000000E+00
0    ITERATION NUMBER=   17
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308727E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .237278E+03       .000000E+00   .684162E-03       .000000E+00
      2  .237494E+03       .000000E+00   .739691E-03       .000000E+00
      3  .237726E+03       .000000E+00   .747258E-03       .000000E+00
      4  .237952E+03       .000000E+00   .658863E-03       .000000E+00
      5  .238135E+03       .000000E+00   .426497E-03       .000000E+00
      6  .238226E+03       .000000E+00   .215285E-05       .000000E+00
      7  .238137E+03       .000000E+00  -.422195E-03       .000000E+00
      8  .237954E+03       .000000E+00  -.654568E-03       .000000E+00
      9  .237730E+03       .000000E+00  -.742968E-03       .000000E+00
     10  .237500E+03       .000000E+00  -.735402E-03       .000000E+00
     11  .237284E+03       .000000E+00  -.679876E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189121E+02   .000000E+00
      2  .141780E+05   .567177E+02   .000000E+00
      3  .368648E+05   .945254E+02   .000000E+00
      4  .708919E+05   .132320E+03   .000000E+00
      5  .116256E+06   .170113E+03   .000000E+00
      6  .116257E+06  -.170099E+03   .000000E+00
      7  .708936E+05  -.132326E+03   .000000E+00
      8  .368660E+05  -.945217E+02   .000000E+00
      9  .141787E+05  -.567204E+02   .000000E+00
     10  .283319E+04  -.189164E+02   .000000E+00
0    ITERATION NUMBER=   18
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308728E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
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      1  .251277E+03      .000000E+00  .664394E-03      .000000E+00
      2  .251488E+03      .000000E+00  .723903E-03      .000000E+00
      3  .251716E+03      .000000E+00  .735450E-03      .000000E+00
      4  .251938E+03      .000000E+00  .651033E-03      .000000E+00
      5  .252120E+03      .000000E+00  .422644E-03      .000000E+00
      6  .252210E+03      .000000E+00  .227748E-05      .000000E+00
      7  .252121E+03      .000000E+00 -.418093E-03      .000000E+00
      8  .251941E+03      .000000E+00 -.646489E-03      .000000E+00
      9  .251720E+03      .000000E+00 -.730910E-03      .000000E+00
     10  .251493E+03      .000000E+00 -.719365E-03      .000000E+00
     11  .251284E+03      .000000E+00 -.659858E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189082E+02  .000000E+00
      2  .141780E+05  .567263E+02  .000000E+00
      3  .368648E+05  .945242E+02  .000000E+00
      4  .708919E+05  .132310E+03  .000000E+00
      5  .116256E+06  .170109E+03  .000000E+00
      6  .116257E+06 -.170110E+03  .000000E+00
      7  .708936E+05 -.132319E+03  .000000E+00
      8  .368661E+05 -.945226E+02  .000000E+00
      9  .141787E+05 -.567309E+02  .000000E+00
     10  .283317E+04 -.189147E+02  .000000E+00
0    ITERATION NUMBER=   19
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308703E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .265276E+03      .000000E+00  .644622E-03      .000000E+00
      2  .265482E+03      .000000E+00  .708112E-03      .000000E+00
      3  .265705E+03      .000000E+00  .723638E-03      .000000E+00
      4  .265925E+03      .000000E+00  .643200E-03      .000000E+00
      5  .266105E+03      .000000E+00  .418789E-03      .000000E+00
      6  .266194E+03      .000000E+00  .239958E-05      .000000E+00
      7  .266106E+03      .000000E+00 -.413993E-03      .000000E+00
      8  .265928E+03      .000000E+00 -.638411E-03      .000000E+00
      9  .265710E+03      .000000E+00 -.718854E-03      .000000E+00
     10  .265487E+03      .000000E+00 -.703329E-03      .000000E+00
     11  .265283E+03      .000000E+00 -.639841E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189040E+02  .000000E+00
      2  .141780E+05  .567160E+02  .000000E+00
      3  .368648E+05  .945164E+02  .000000E+00
      4  .708919E+05  .132319E+03  .000000E+00
      5  .116256E+06  .170110E+03  .000000E+00
      6  .116257E+06 -.170110E+03  .000000E+00
      7  .708936E+05 -.132315E+03  .000000E+00
      8  .368661E+05 -.945266E+02  .000000E+00
      9  .141787E+05 -.567207E+02  .000000E+00
     10  .283317E+04 -.189107E+02  .000000E+00
0    ITERATION NUMBER=   20
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308558E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .279275E+03      .000000E+00  .624853E-03      .000000E+00
      2  .279475E+03      .000000E+00  .692324E-03      .000000E+00
      3  .279695E+03      .000000E+00  .711830E-03      .000000E+00
      4  .279912E+03      .000000E+00  .635370E-03      .000000E+00
      5  .280090E+03      .000000E+00  .414936E-03      .000000E+00
      6  .280179E+03      .000000E+00  .252458E-05      .000000E+00
      7  .280091E+03      .000000E+00 -.409891E-03      .000000E+00
      8  .279915E+03      .000000E+00 -.630331E-03      .000000E+00
      9  .279699E+03      .000000E+00 -.706795E-03      .000000E+00
     10  .279481E+03      .000000E+00 -.687291E-03      .000000E+00
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      11  .279282E+03      .000000E+00  -.619823E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
       1  .283211E+04  .189062E+02  .000000E+00
       2  .141780E+05  .567245E+02  .000000E+00
       3  .368648E+05  .945273E+02  .000000E+00
       4  .708919E+05  .132321E+03  .000000E+00
       5  .116256E+06  .170111E+03  .000000E+00
       6  .116257E+06 -.170103E+03  .000000E+00
       7  .708936E+05 -.132321E+03  .000000E+00
       8  .368661E+05 -.945290E+02  .000000E+00
       9  .141787E+05 -.567208E+02  .000000E+00
      10  .283320E+04 -.189108E+02  .000000E+00
0   ITERATION NUMBER=  21
0   CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .308629E+02
0   NODE   DISPL.          REACTION      DISPL.          REACTION
       1  .293274E+03      .000000E+00  .605084E-03      .000000E+00
       2  .293469E+03      .000000E+00  .676536E-03      .000000E+00
       3  .293684E+03      .000000E+00  .700021E-03      .000000E+00
       4  .293898E+03      .000000E+00  .627539E-03      .000000E+00
       5  .294075E+03      .000000E+00  .411084E-03      .000000E+00
       6  .294163E+03      .000000E+00  .264932E-05      .000000E+00
       7  .294076E+03      .000000E+00 -.405789E-03      .000000E+00
       8  .293901E+03      .000000E+00 -.622251E-03      .000000E+00
       9  .293689E+03      .000000E+00 -.694737E-03      .000000E+00
      10  .293475E+03      .000000E+00 -.671253E-03      .000000E+00
      11  .293282E+03      .000000E+00 -.599804E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
       1  .283211E+04  .189084E+02  .000000E+00
       2  .141780E+05  .567269E+02  .000000E+00
       3  .368648E+05  .945260E+02  .000000E+00
       4  .708919E+05  .132312E+03  .000000E+00
       5  .116256E+06  .170107E+03  .000000E+00
       6  .116257E+06 -.170108E+03  .000000E+00
       7  .708936E+05 -.132315E+03  .000000E+00
       8  .368661E+05 -.945308E+02  .000000E+00
       9  .141787E+05 -.567262E+02  .000000E+00
      10  .283320E+04 -.189099E+02  .000000E+00
0   ITERATION NUMBER=  22
0   CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .308601E+02
0   NODE   DISPL.          REACTION      DISPL.          REACTION
       1  .307273E+03      .000000E+00  .585314E-03      .000000E+00
       2  .307463E+03      .000000E+00  .660747E-03      .000000E+00
       3  .307674E+03      .000000E+00  .688212E-03      .000000E+00
       4  .307885E+03      .000000E+00  .619708E-03      .000000E+00
       5  .308059E+03      .000000E+00  .407230E-03      .000000E+00
       6  .308147E+03      .000000E+00  .277350E-05      .000000E+00
       7  .308061E+03      .000000E+00 -.401687E-03      .000000E+00
       8  .307888E+03      .000000E+00 -.614172E-03      .000000E+00
       9  .307679E+03      .000000E+00 -.682679E-03      .000000E+00
      10  .307469E+03      .000000E+00 -.655216E-03      .000000E+00
      11  .307281E+03      .000000E+00 -.579786E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
       1  .283211E+04  .189065E+02  .000000E+00
       2  .141780E+05  .567189E+02  .000000E+00
       3  .368648E+05  .945265E+02  .000000E+00
       4  .708919E+05  .132316E+03  .000000E+00
       5  .116256E+06  .170110E+03  .000000E+00
       6  .116257E+06 -.170112E+03  .000000E+00
       7  .708936E+05 -.132314E+03  .000000E+00
       8  .368661E+05 -.945259E+02  .000000E+00
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      9  .141787E+05  -.567252E+02   .000000E+00
     10  .283320E+04  -.189091E+02   .000000E+00
0    ITERATION NUMBER=  23
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=  .308720E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .321272E+03       .000000E+00   .565543E-03       .000000E+00
      2  .321456E+03       .000000E+00   .644956E-03       .000000E+00
      3  .321663E+03       .000000E+00   .676400E-03       .000000E+00
      4  .321871E+03       .000000E+00   .611875E-03       .000000E+00
      5  .322044E+03       .000000E+00   .403375E-03       .000000E+00
      6  .322131E+03       .000000E+00   .289545E-05       .000000E+00
      7  .322046E+03       .000000E+00  -.397588E-03       .000000E+00
      8  .321875E+03       .000000E+00  -.606094E-03       .000000E+00
      9  .321669E+03       .000000E+00  -.670624E-03       .000000E+00
     10  .321463E+03       .000000E+00  -.639181E-03       .000000E+00
     11  .321280E+03       .000000E+00  -.559770E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189082E+02   .000000E+00
      2  .141780E+05   .567208E+02   .000000E+00
      3  .368648E+05   .945247E+02   .000000E+00
      4  .708919E+05   .132312E+03   .000000E+00
      5  .116256E+06   .170112E+03   .000000E+00
      6  .116257E+06  -.170112E+03   .000000E+00
      7  .708936E+05  -.132315E+03   .000000E+00
      8  .368661E+05  -.945229E+02   .000000E+00
      9  .141788E+05  -.567198E+02   .000000E+00
     10  .283321E+04  -.189158E+02   .000000E+00
0    ITERATION NUMBER=  24
0    CONVERGENCE CODE=  1   NORM OF RESIDUAL SUM RATIO=  .308681E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .335271E+03       .000000E+00   .545772E-03       .000000E+00
      2  .335450E+03       .000000E+00   .629165E-03       .000000E+00
      3  .335653E+03       .000000E+00   .664589E-03       .000000E+00
      4  .335858E+03       .000000E+00   .604042E-03       .000000E+00
      5  .336029E+03       .000000E+00   .399520E-03       .000000E+00
      6  .336116E+03       .000000E+00   .301802E-05       .000000E+00
      7  .336031E+03       .000000E+00  -.393488E-03       .000000E+00
      8  .335862E+03       .000000E+00  -.598017E-03       .000000E+00
      9  .335658E+03       .000000E+00  -.658568E-03       .000000E+00
     10  .335457E+03       .000000E+00  -.623145E-03       .000000E+00
     11  .335280E+03       .000000E+00  -.539754E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189030E+02   .000000E+00
      2  .141780E+05   .567157E+02   .000000E+00
      3  .368648E+05   .945220E+02   .000000E+00
      4  .708919E+05   .132314E+03   .000000E+00
      5  .116256E+06   .170112E+03   .000000E+00
      6  .116257E+06  -.170106E+03   .000000E+00
      7  .708936E+05  -.132316E+03   .000000E+00
      8  .368661E+05  -.945204E+02   .000000E+00
      9  .141788E+05  -.567272E+02   .000000E+00
     10  .283321E+04  -.189110E+02   .000000E+00
0    ITERATION NUMBER=  25
0    CONVERGENCE CODE=  1   NORM OF RESIDUAL SUM RATIO=  .308660E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .349270E+03       .000000E+00   .526002E-03       .000000E+00
      2  .349444E+03       .000000E+00   .613377E-03       .000000E+00
      3  .349642E+03       .000000E+00   .652780E-03       .000000E+00
      4  .349844E+03       .000000E+00   .596212E-03       .000000E+00
      5  .350014E+03       .000000E+00   .395668E-03       .000000E+00
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      6  .350100E+03      .000000E+00   .314297E-05      .000000E+00
      7  .350016E+03      .000000E+00  -.389385E-03      .000000E+00
      8  .349848E+03      .000000E+00  -.589936E-03      .000000E+00
      9  .349648E+03      .000000E+00  -.646508E-03      .000000E+00
     10  .349451E+03      .000000E+00  -.607106E-03      .000000E+00
     11  .349279E+03      .000000E+00  -.519734E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189057E+02   .000000E+00
      2  .141780E+05   .567186E+02   .000000E+00
      3  .368648E+05   .945272E+02   .000000E+00
      4  .708919E+05   .132317E+03   .000000E+00
      5  .116256E+06   .170107E+03   .000000E+00
      6  .116257E+06  -.170112E+03   .000000E+00
      7  .708936E+05  -.132324E+03   .000000E+00
      8  .368660E+05  -.945242E+02   .000000E+00
      9  .141787E+05  -.567169E+02   .000000E+00
     10  .283319E+04  -.189071E+02   .000000E+00
0    ITERATION NUMBER=   26
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308823E+02
0    NODE    DISPL.          REACTION      DISPL.          REACTION
      1  .363269E+03      .000000E+00   .506236E-03      .000000E+00
      2  .363437E+03      .000000E+00   .597592E-03      .000000E+00
      3  .363632E+03      .000000E+00   .640974E-03      .000000E+00
      4  .363831E+03      .000000E+00   .588384E-03      .000000E+00
      5  .363999E+03      .000000E+00   .391818E-03      .000000E+00
      6  .364084E+03      .000000E+00   .327089E-05      .000000E+00
      7  .364001E+03      .000000E+00  -.385280E-03      .000000E+00
      8  .363835E+03      .000000E+00  -.581853E-03      .000000E+00
      9  .363638E+03      .000000E+00  -.634446E-03      .000000E+00
     10  .363445E+03      .000000E+00  -.591065E-03      .000000E+00
     11  .363279E+03      .000000E+00  -.499711E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189153E+02   .000000E+00
      2  .141780E+05   .567221E+02   .000000E+00
      3  .368648E+05   .945269E+02   .000000E+00
      4  .708919E+05   .132320E+03   .000000E+00
      5  .116256E+06   .170109E+03   .000000E+00
      6  .116257E+06  -.170098E+03   .000000E+00
      7  .708935E+05  -.132312E+03   .000000E+00
      8  .368660E+05  -.945208E+02   .000000E+00
      9  .141787E+05  -.567237E+02   .000000E+00
     10  .283318E+04  -.189140E+02   .000000E+00
0    ITERATION NUMBER=   27
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308761E+02
0    NODE    DISPL.          REACTION      DISPL.          REACTION
      1  .377268E+03      .000000E+00   .486465E-03      .000000E+00
      2  .377431E+03      .000000E+00   .581802E-03      .000000E+00
      3  .377621E+03      .000000E+00   .629163E-03      .000000E+00
      4  .377818E+03      .000000E+00   .580552E-03      .000000E+00
      5  .377983E+03      .000000E+00   .387963E-03      .000000E+00
      6  .378068E+03      .000000E+00   .339325E-05      .000000E+00
      7  .377985E+03      .000000E+00  -.381180E-03      .000000E+00
      8  .377822E+03      .000000E+00  -.573776E-03      .000000E+00
      9  .377628E+03      .000000E+00  -.622391E-03      .000000E+00
     10  .377439E+03      .000000E+00  -.575030E-03      .000000E+00
     11  .377278E+03      .000000E+00  -.479696E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189032E+02   .000000E+00
      2  .141780E+05   .567163E+02   .000000E+00
      3  .368648E+05   .945175E+02   .000000E+00
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      4  .708919E+05   .132321E+03   .000000E+00
      5  .116256E+06   .170104E+03   .000000E+00
      6  .116257E+06  -.170105E+03   .000000E+00
      7  .708936E+05  -.132313E+03   .000000E+00
      8  .368661E+05  -.945236E+02   .000000E+00
      9  .141788E+05  -.567176E+02   .000000E+00
     10  .283319E+04  -.189137E+02   .000000E+00
0    ITERATION NUMBER=   28
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308705E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .391267E+03       .000000E+00   .466698E-03       .000000E+00
      2  .391425E+03       .000000E+00   .566015E-03       .000000E+00
      3  .391611E+03       .000000E+00   .617356E-03       .000000E+00
      4  .391804E+03       .000000E+00   .572723E-03       .000000E+00
      5  .391968E+03       .000000E+00   .384112E-03       .000000E+00
      6  .392053E+03       .000000E+00   .351936E-05       .000000E+00
      7  .391970E+03       .000000E+00  -.377077E-03       .000000E+00
      8  .391808E+03       .000000E+00  -.565694E-03       .000000E+00
      9  .391617E+03       .000000E+00  -.610331E-03       .000000E+00
     10  .391433E+03       .000000E+00  -.558991E-03       .000000E+00
     11  .391277E+03       .000000E+00  -.459675E-03       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189094E+02   .000000E+00
      2  .141780E+05   .567227E+02   .000000E+00
      3  .368648E+05   .945263E+02   .000000E+00
      4  .708919E+05   .132322E+03   .000000E+00
      5  .116256E+06   .170115E+03   .000000E+00
      6  .116257E+06  -.170112E+03   .000000E+00
      7  .708936E+05  -.132322E+03   .000000E+00
      8  .368661E+05  -.945285E+02   .000000E+00
      9  .141787E+05  -.567204E+02   .000000E+00
     10  .283318E+04  -.189167E+02   .000000E+00
0    ITERATION NUMBER=   29
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308718E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .405266E+03       .000000E+00   .446927E-03       .000000E+00
      2  .405418E+03       .000000E+00   .550225E-03       .000000E+00
      3  .405600E+03       .000000E+00   .605545E-03       .000000E+00
      4  .405791E+03       .000000E+00   .564891E-03       .000000E+00
      5  .405953E+03       .000000E+00   .380257E-03       .000000E+00
      6  .406037E+03       .000000E+00   .364228E-05       .000000E+00
      7  .405955E+03       .000000E+00  -.372976E-03       .000000E+00
      8  .405795E+03       .000000E+00  -.557616E-03       .000000E+00
      9  .405607E+03       .000000E+00  -.598275E-03       .000000E+00
     10  .405427E+03       .000000E+00  -.542955E-03       .000000E+00
     11  .405277E+03       .000000E+00  -.439659E-03       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189032E+02   .000000E+00
      2  .141780E+05   .567166E+02   .000000E+00
      3  .368648E+05   .945227E+02   .000000E+00
      4  .708919E+05   .132310E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170101E+03   .000000E+00
      7  .708936E+05  -.132318E+03   .000000E+00
      8  .368661E+05  -.945204E+02   .000000E+00
      9  .141787E+05  -.567281E+02   .000000E+00
     10  .283320E+04  -.189121E+02   .000000E+00
0    ITERATION NUMBER=   30
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308796E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
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1 .419265E+03 .000000E+00 .427159E-03 .000000E+00
2 .419412E+03 .000000E+00 .534437E-03 .000000E+00
3 .419590E+03 .000000E+00 .593737E-03 .000000E+00
4 .419777E+03 .000000E+00 .557061E-03 .000000E+00
5 .419938E+03 .000000E+00 .376406E-03 .000000E+00
6 .420021E+03 .000000E+00 .376820E-05 .000000E+00
7 .419940E+03 .000000E+00 -.368873E-03 .000000E+00
8 .419782E+03 .000000E+00 -.549535E-03 .000000E+00
9 .419597E+03 .000000E+00 -.586215E-03 .000000E+00
10 .419421E+03 .000000E+00 -.526915E-03 .000000E+00
11 .419276E+03 .000000E+00 -.419638E-03 .000000E+00

0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189105E+02 .000000E+00
2 .141780E+05 .567240E+02 .000000E+00
3 .368648E+05 .945263E+02 .000000E+00
4 .708919E+05 .132317E+03 .000000E+00
5 .116256E+06 .170114E+03 .000000E+00
6 .116257E+06 -.170109E+03 .000000E+00
7 .708936E+05 -.132321E+03 .000000E+00
8 .368661E+05 -.945136E+02 .000000E+00
9 .141787E+05 -.567193E+02 .000000E+00
10 .283316E+04 -.189158E+02 .000000E+00

0 ITERATION NUMBER= 31
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .308655E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .433264E+03 .000000E+00 .407392E-03 .000000E+00
2 .433405E+03 .000000E+00 .518651E-03 .000000E+00
3 .433579E+03 .000000E+00 .581931E-03 .000000E+00
4 .433764E+03 .000000E+00 .549233E-03 .000000E+00
5 .433923E+03 .000000E+00 .372555E-03 .000000E+00
6 .434005E+03 .000000E+00 .389503E-05 .000000E+00
7 .433925E+03 .000000E+00 -.364769E-03 .000000E+00
8 .433769E+03 .000000E+00 -.541453E-03 .000000E+00
9 .433587E+03 .000000E+00 -.574155E-03 .000000E+00
10 .433415E+03 .000000E+00 -.510876E-03 .000000E+00
11 .433275E+03 .000000E+00 -.399618E-03 .000000E+00

0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189151E+02 .000000E+00
2 .141780E+05 .567288E+02 .000000E+00
3 .368648E+05 .945212E+02 .000000E+00
4 .708919E+05 .132323E+03 .000000E+00
5 .116256E+06 .170112E+03 .000000E+00
6 .116257E+06 -.170105E+03 .000000E+00
7 .708936E+05 -.132318E+03 .000000E+00
8 .368661E+05 -.945255E+02 .000000E+00
9 .141787E+05 -.567227E+02 .000000E+00
10 .283320E+04 -.189067E+02 .000000E+00

0 ITERATION NUMBER= 32
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .308668E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .447263E+03 .000000E+00 .387622E-03 .000000E+00
2 .447399E+03 .000000E+00 .502862E-03 .000000E+00
3 .447569E+03 .000000E+00 .570121E-03 .000000E+00
4 .447750E+03 .000000E+00 .541401E-03 .000000E+00
5 .447908E+03 .000000E+00 .368701E-03 .000000E+00
6 .447990E+03 .000000E+00 .401840E-05 .000000E+00
7 .447910E+03 .000000E+00 -.360668E-03 .000000E+00
8 .447755E+03 .000000E+00 -.533375E-03 .000000E+00
9 .447576E+03 .000000E+00 -.562098E-03 .000000E+00
10 .447409E+03 .000000E+00 -.494839E-03 .000000E+00

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      11  .447275E+03       .000000E+00  -.379600E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189078E+02  .000000E+00
      2  .141780E+05  .567155E+02  .000000E+00
      3  .368648E+05  .945227E+02  .000000E+00
      4  .708919E+05  .132310E+03  .000000E+00
      5  .116256E+06  .170105E+03  .000000E+00
      6  .116257E+06 -.170102E+03  .000000E+00
      7  .708936E+05 -.132322E+03  .000000E+00
      8  .368661E+05 -.945249E+02  .000000E+00
      9  .141787E+05 -.567261E+02  .000000E+00
     10  .283319E+04 -.189042E+02  .000000E+00
0   ITERATION NUMBER=  33
0   CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .308638E+02
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .461262E+03       .000000E+00  .367852E-03       .000000E+00
      2  .461393E+03       .000000E+00  .487072E-03       .000000E+00
      3  .461558E+03       .000000E+00  .558311E-03       .000000E+00
      4  .461737E+03       .000000E+00  .533570E-03       .000000E+00
      5  .461892E+03       .000000E+00  .364848E-03       .000000E+00
      6  .461974E+03       .000000E+00  .414225E-05       .000000E+00
      7  .461895E+03       .000000E+00 -.356567E-03       .000000E+00
      8  .461742E+03       .000000E+00 -.525295E-03       .000000E+00
      9  .461566E+03       .000000E+00 -.550040E-03       .000000E+00
     10  .461403E+03       .000000E+00 -.478802E-03       .000000E+00
     11  .461274E+03       .000000E+00 -.359582E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189126E+02  .000000E+00
      2  .141780E+05  .567204E+02  .000000E+00
      3  .368648E+05  .945238E+02  .000000E+00
      4  .708919E+05  .132315E+03  .000000E+00
      5  .116256E+06  .170109E+03  .000000E+00
      6  .116257E+06 -.170105E+03  .000000E+00
      7  .708936E+05 -.132320E+03  .000000E+00
      8  .368661E+05 -.945255E+02  .000000E+00
      9  .141787E+05 -.567305E+02  .000000E+00
     10  .283317E+04 -.189086E+02  .000000E+00
0   ITERATION NUMBER=  34
0   CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .308619E+02
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .475261E+03       .000000E+00  .348083E-03       .000000E+00
      2  .475386E+03       .000000E+00  .471284E-03       .000000E+00
      3  .475548E+03       .000000E+00  .546502E-03       .000000E+00
      4  .475724E+03       .000000E+00  .525739E-03       .000000E+00
      5  .475877E+03       .000000E+00  .360995E-03       .000000E+00
      6  .475958E+03       .000000E+00  .426694E-05       .000000E+00
      7  .475880E+03       .000000E+00 -.352464E-03       .000000E+00
      8  .475729E+03       .000000E+00 -.517215E-03       .000000E+00
      9  .475556E+03       .000000E+00 -.537982E-03       .000000E+00
     10  .475397E+03       .000000E+00 -.462764E-03       .000000E+00
     11  .475273E+03       .000000E+00 -.339563E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189093E+02  .000000E+00
      2  .141780E+05  .567233E+02  .000000E+00
      3  .368648E+05  .945230E+02  .000000E+00
      4  .708919E+05  .132312E+03  .000000E+00
      5  .116256E+06  .170111E+03  .000000E+00
      6  .116257E+06 -.170110E+03  .000000E+00
      7  .708936E+05 -.132314E+03  .000000E+00
      8  .368661E+05 -.945278E+02  .000000E+00
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9 .141787E+05 -.567245E+02 .000000E+00
10 .283320E+04 -.189087E+02 .000000E+00
0 ITERATION NUMBER= 35
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .308838E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .489260E+03 .000000E+00 .328313E-03 .000000E+00
2 .489380E+03 .000000E+00 .455495E-03 .000000E+00
3 .489538E+03 .000000E+00 .534693E-03 .000000E+00
4 .489710E+03 .000000E+00 .517909E-03 .000000E+00
5 .489862E+03 .000000E+00 .357142E-03 .000000E+00
6 .489943E+03 .000000E+00 .439131E-05 .000000E+00
7 .489865E+03 .000000E+00 -.348363E-03 .000000E+00
8 .489715E+03 .000000E+00 -.509136E-03 .000000E+00
9 .489546E+03 .000000E+00 -.525924E-03 .000000E+00
10 .489391E+03 .000000E+00 -.446726E-03 .000000E+00
11 .489273E+03 .000000E+00 -.319545E-03 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189127E+02 .000000E+00
2 .141780E+05 .567147E+02 .000000E+00
3 .368648E+05 .945167E+02 .000000E+00
4 .708919E+05 .132310E+03 .000000E+00
5 .116256E+06 .170107E+03 .000000E+00
6 .116257E+06 -.170108E+03 .000000E+00
7 .708936E+05 -.132319E+03 .000000E+00
8 .368661E+05 -.945232E+02 .000000E+00
9 .141787E+05 -.567236E+02 .000000E+00
10 .283320E+04 -.189078E+02 .000000E+00
0 ITERATION NUMBER= 36
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .308592E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .503259E+03 .000000E+00 .308542E-03 .000000E+00
2 .503374E+03 .000000E+00 .439705E-03 .000000E+00
3 .503527E+03 .000000E+00 .522882E-03 .000000E+00
4 .503697E+03 .000000E+00 .510076E-03 .000000E+00
5 .503847E+03 .000000E+00 .353287E-03 .000000E+00
6 .503927E+03 .000000E+00 .451416E-05 .000000E+00
7 .503849E+03 .000000E+00 -.344263E-03 .000000E+00
8 .503702E+03 .000000E+00 -.501058E-03 .000000E+00
9 .503535E+03 .000000E+00 -.513867E-03 .000000E+00
10 .503385E+03 .000000E+00 -.430691E-03 .000000E+00
11 .503272E+03 .000000E+00 -.299528E-03 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189067E+02 .000000E+00
2 .141780E+05 .567211E+02 .000000E+00
3 .368648E+05 .945194E+02 .000000E+00
4 .708919E+05 .132316E+03 .000000E+00
5 .116256E+06 .170113E+03 .000000E+00
6 .116257E+06 -.170103E+03 .000000E+00
7 .708936E+05 -.132321E+03 .000000E+00
8 .368661E+05 -.945274E+02 .000000E+00
9 .141787E+05 -.567255E+02 .000000E+00
10 .283318E+04 -.189099E+02 .000000E+00
0 ITERATION NUMBER= 37
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .308817E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .517258E+03 .000000E+00 .288771E-03 .000000E+00
2 .517367E+03 .000000E+00 .423915E-03 .000000E+00
3 .517517E+03 .000000E+00 .511071E-03 .000000E+00
4 .517683E+03 .000000E+00 .502243E-03 .000000E+00
5 .517832E+03 .000000E+00 .349432E-03 .000000E+00

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      6  .517911E+03      .000000E+00   .463624E-05      .000000E+00
      7  .517834E+03      .000000E+00  -.340163E-03      .000000E+00
      8  .517689E+03      .000000E+00  -.492981E-03      .000000E+00
      9  .517525E+03      .000000E+00  -.501811E-03      .000000E+00
     10  .517379E+03      .000000E+00  -.414655E-03      .000000E+00
     11  .517271E+03      .000000E+00  -.279512E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189144E+02   .000000E+00
      2  .141780E+05   .567167E+02   .000000E+00
      3  .368648E+05   .945236E+02   .000000E+00
      4  .708919E+05   .132312E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170109E+03   .000000E+00
      7  .708936E+05  -.132317E+03   .000000E+00
      8  .368661E+05  -.945246E+02   .000000E+00
      9  .141787E+05  -.567203E+02   .000000E+00
     10  .283321E+04  -.189167E+02   .000000E+00
0    ITERATION NUMBER=   38
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308584E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .531257E+03      .000000E+00   .269002E-03      .000000E+00
      2  .531361E+03      .000000E+00   .408127E-03      .000000E+00
      3  .531506E+03      .000000E+00   .499262E-03      .000000E+00
      4  .531670E+03      .000000E+00   .494413E-03      .000000E+00
      5  .531816E+03      .000000E+00   .345580E-03      .000000E+00
      6  .531895E+03      .000000E+00   .476175E-05      .000000E+00
      7  .531819E+03      .000000E+00  -.336060E-03      .000000E+00
      8  .531676E+03      .000000E+00  -.484900E-03      .000000E+00
      9  .531515E+03      .000000E+00  -.489752E-03      .000000E+00
     10  .531373E+03      .000000E+00  -.398616E-03      .000000E+00
     11  .531271E+03      .000000E+00  -.259492E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189040E+02   .000000E+00
      2  .141780E+05   .567248E+02   .000000E+00
      3  .368648E+05   .945279E+02   .000000E+00
      4  .708919E+05   .132321E+03   .000000E+00
      5  .116256E+06   .170102E+03   .000000E+00
      6  .116257E+06  -.170109E+03   .000000E+00
      7  .708935E+05  -.132318E+03   .000000E+00
      8  .368660E+05  -.945231E+02   .000000E+00
      9  .141787E+05  -.567230E+02   .000000E+00
     10  .283319E+04  -.189074E+02   .000000E+00
0    ITERATION NUMBER=   39
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308783E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .545256E+03      .000000E+00   .249234E-03      .000000E+00
      2  .545355E+03      .000000E+00   .392340E-03      .000000E+00
      3  .545496E+03      .000000E+00   .487455E-03      .000000E+00
      4  .545656E+03      .000000E+00   .486584E-03      .000000E+00
      5  .545801E+03      .000000E+00   .341729E-03      .000000E+00
      6  .545880E+03      .000000E+00   .488788E-05      .000000E+00
      7  .545804E+03      .000000E+00  -.331956E-03      .000000E+00
      8  .545662E+03      .000000E+00  -.476818E-03      .000000E+00
      9  .545505E+03      .000000E+00  -.477692E-03      .000000E+00
     10  .545367E+03      .000000E+00  -.382576E-03      .000000E+00
     11  .545270E+03      .000000E+00  -.239472E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189101E+02   .000000E+00
      2  .141780E+05   .567249E+02   .000000E+00
      3  .368648E+05   .945304E+02   .000000E+00
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      4  .708919E+05  .132327E+03  .000000E+00
      5  .116256E+06  .170114E+03  .000000E+00
      6  .116257E+06 -.170111E+03  .000000E+00
      7  .708935E+05 -.132321E+03  .000000E+00
      8  .368660E+05 -.945160E+02  .000000E+00
      9  .141787E+05 -.567198E+02  .000000E+00
     10  .283318E+04 -.189104E+02  .000000E+00
0    ITERATION NUMBER=  40
0    CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .308588E+02
0    NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .559255E+03       .000000E+00  .229466E-03       .000000E+00
      2  .559348E+03       .000000E+00  .376552E-03       .000000E+00
      3  .559485E+03       .000000E+00  .475647E-03       .000000E+00
      4  .559643E+03       .000000E+00  .478754E-03       .000000E+00
      5  .559786E+03       .000000E+00  .337876E-03       .000000E+00
      6  .559864E+03       .000000E+00  .501279E-05       .000000E+00
      7  .559789E+03       .000000E+00 -.327854E-03       .000000E+00
      8  .559649E+03       .000000E+00 -.468739E-03       .000000E+00
      9  .559494E+03       .000000E+00 -.465634E-03       .000000E+00
     10  .559361E+03       .000000E+00 -.366539E-03       .000000E+00
     11  .559270E+03       .000000E+00 -.219454E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189056E+02  .000000E+00
      2  .141780E+05  .567205E+02  .000000E+00
      3  .368648E+05  .945286E+02  .000000E+00
      4  .708919E+05  .132317E+03  .000000E+00
      5  .116256E+06  .170109E+03  .000000E+00
      6  .116257E+06 -.170110E+03  .000000E+00
      7  .708936E+05 -.132315E+03  .000000E+00
      8  .368661E+05 -.945293E+02  .000000E+00
      9  .141787E+05 -.567305E+02  .000000E+00
     10  .283319E+04 -.189088E+02  .000000E+00
0    ITERATION NUMBER=  41
0    CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .308708E+02
0    NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .573254E+03       .000000E+00  .209698E-03       .000000E+00
      2  .573342E+03       .000000E+00  .360765E-03       .000000E+00
      3  .573475E+03       .000000E+00  .463839E-03       .000000E+00
      4  .573630E+03       .000000E+00  .470925E-03       .000000E+00
      5  .573771E+03       .000000E+00  .334025E-03       .000000E+00
      6  .573848E+03       .000000E+00  .513880E-05       .000000E+00
      7  .573774E+03       .000000E+00 -.323751E-03       .000000E+00
      8  .573636E+03       .000000E+00 -.460657E-03       .000000E+00
      9  .573484E+03       .000000E+00 -.453574E-03       .000000E+00
     10  .573354E+03       .000000E+00 -.350499E-03       .000000E+00
     11  .573269E+03       .000000E+00 -.199433E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189067E+02  .000000E+00
      2  .141780E+05  .567218E+02  .000000E+00
      3  .368648E+05  .945259E+02  .000000E+00
      4  .708919E+05  .132325E+03  .000000E+00
      5  .116256E+06  .170115E+03  .000000E+00
      6  .116257E+06 -.170105E+03  .000000E+00
      7  .708936E+05 -.132318E+03  .000000E+00
      8  .368660E+05 -.945166E+02  .000000E+00
      9  .141787E+05 -.567219E+02  .000000E+00
     10  .283317E+04 -.189126E+02  .000000E+00
0    ITERATION NUMBER=  42
0    CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .308644E+02
0    NODE   DISPL.          REACTION       DISPL.          REACTION
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      1  .587253E+03      .000000E+00  .189932E-03      .000000E+00
      2  .587336E+03      .000000E+00  .344979E-03      .000000E+00
      3  .587464E+03      .000000E+00  .452033E-03      .000000E+00
      4  .587616E+03      .000000E+00  .463098E-03      .000000E+00
      5  .587756E+03      .000000E+00  .330175E-03      .000000E+00
      6  .587832E+03      .000000E+00  .526656E-05      .000000E+00
      7  .587759E+03      .000000E+00 -.319645E-03      .000000E+00
      8  .587622E+03      .000000E+00 -.452574E-03      .000000E+00
      9  .587474E+03      .000000E+00 -.441512E-03      .000000E+00
     10  .587348E+03      .000000E+00 -.334458E-03      .000000E+00
     11  .587268E+03      .000000E+00 -.179411E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189100E+02  .000000E+00
      2  .141780E+05  .567190E+02  .000000E+00
      3  .368648E+05  .945256E+02  .000000E+00
      4  .708919E+05  .132322E+03  .000000E+00
      5  .116256E+06  .170111E+03  .000000E+00
      6  .116257E+06 -.170104E+03  .000000E+00
      7  .708935E+05 -.132318E+03  .000000E+00
      8  .368660E+05 -.945187E+02  .000000E+00
      9  .141787E+05 -.567219E+02  .000000E+00
     10  .283317E+04 -.189065E+02  .000000E+00
0    ITERATION NUMBER=  43
0    CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .308650E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .601252E+03      .000000E+00  .170162E-03      .000000E+00
      2  .601329E+03      .000000E+00  .329191E-03      .000000E+00
      3  .601454E+03      .000000E+00  .440224E-03      .000000E+00
      4  .601603E+03      .000000E+00  .455267E-03      .000000E+00
      5  .601740E+03      .000000E+00  .326322E-03      .000000E+00
      6  .601817E+03      .000000E+00  .539072E-05      .000000E+00
      7  .601744E+03      .000000E+00 -.315544E-03      .000000E+00
      8  .601609E+03      .000000E+00 -.444495E-03      .000000E+00
      9  .601464E+03      .000000E+00 -.429455E-03      .000000E+00
     10  .601342E+03      .000000E+00 -.318422E-03      .000000E+00
     11  .601268E+03      .000000E+00 -.159393E-03      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04  .189069E+02  .000000E+00
      2  .141780E+05  .567161E+02  .000000E+00
      3  .368648E+05  .945190E+02  .000000E+00
      4  .708919E+05  .132314E+03  .000000E+00
      5  .116256E+06  .170108E+03  .000000E+00
      6  .116257E+06 -.170107E+03  .000000E+00
      7  .708936E+05 -.132322E+03  .000000E+00
      8  .368661E+05 -.945251E+02  .000000E+00
      9  .141787E+05 -.567257E+02  .000000E+00
     10  .283319E+04 -.189041E+02  .000000E+00
0    ITERATION NUMBER=  44
0    CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .308651E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .615251E+03      .000000E+00  .150394E-03      .000000E+00
      2  .615323E+03      .000000E+00  .313404E-03      .000000E+00
      3  .615443E+03      .000000E+00  .428416E-03      .000000E+00
      4  .615589E+03      .000000E+00  .447437E-03      .000000E+00
      5  .615725E+03      .000000E+00  .322470E-03      .000000E+00
      6  .615801E+03      .000000E+00  .551669E-05      .000000E+00
      7  .615728E+03      .000000E+00 -.311440E-03      .000000E+00
      8  .615596E+03      .000000E+00 -.436413E-03      .000000E+00
      9  .615453E+03      .000000E+00 -.417394E-03      .000000E+00
     10  .615336E+03      .000000E+00 -.302382E-03      .000000E+00
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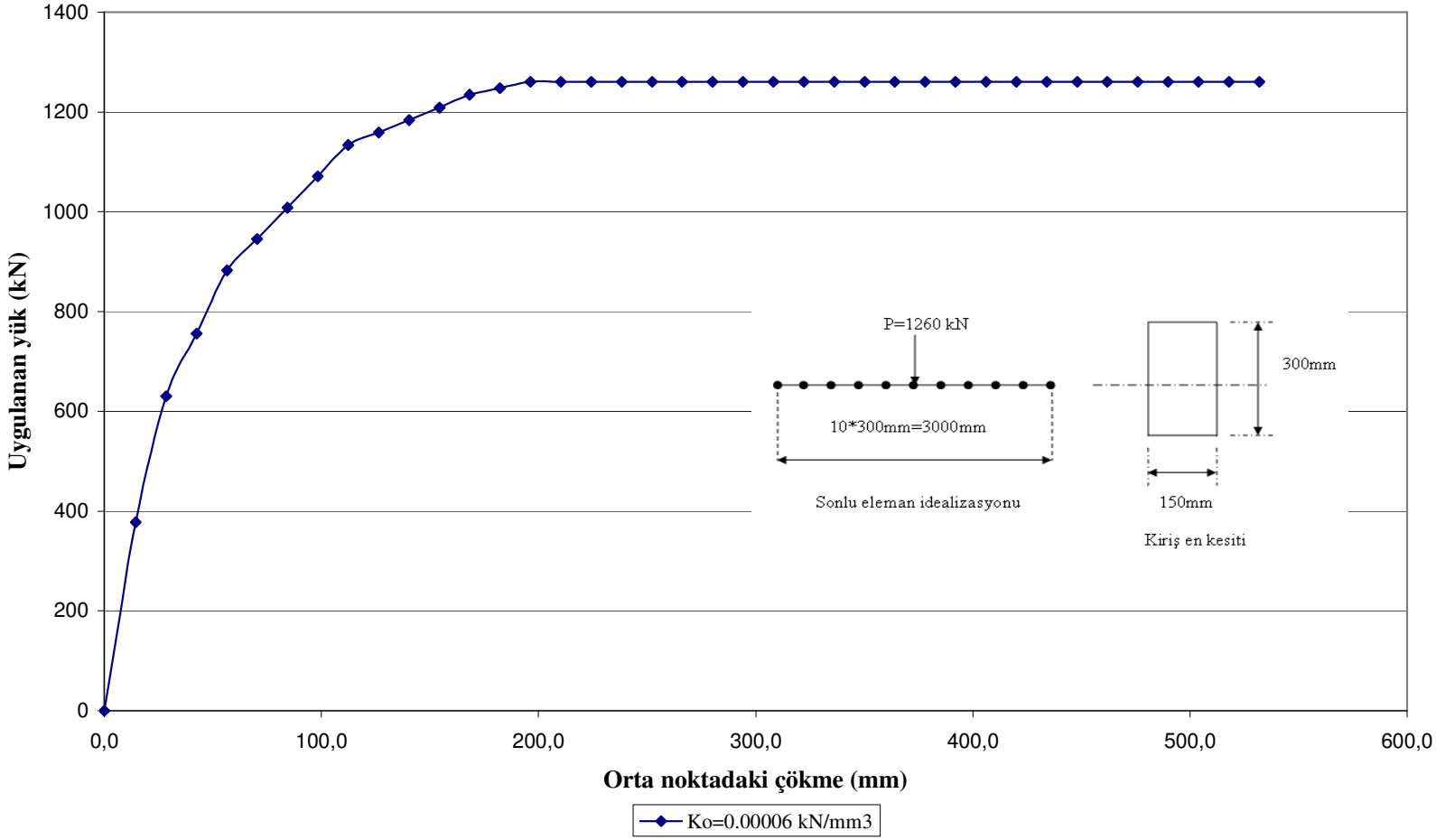
      11  .615267E+03       .000000E+00  -.139372E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
       1  .283211E+04  .189079E+02  .000000E+00
       2  .141780E+05  .567234E+02  .000000E+00
       3  .368648E+05  .945225E+02  .000000E+00
       4  .708919E+05  .132321E+03  .000000E+00
       5  .116256E+06  .170114E+03  .000000E+00
       6  .116257E+06 -.170109E+03  .000000E+00
       7  .708935E+05 -.132319E+03  .000000E+00
       8  .368660E+05 -.945246E+02  .000000E+00
       9  .141787E+05 -.567169E+02  .000000E+00
      10  .283315E+04 -.189139E+02  .000000E+00
0    ITERATION NUMBER=   45
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308863E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1  .629250E+03       .000000E+00  .130624E-03       .000000E+00
       2  .629317E+03       .000000E+00  .297614E-03       .000000E+00
       3  .629433E+03       .000000E+00  .416606E-03       .000000E+00
       4  .629576E+03       .000000E+00  .439606E-03       .000000E+00
       5  .629710E+03       .000000E+00  .318616E-03       .000000E+00
       6  .629785E+03       .000000E+00  .563994E-05       .000000E+00
       7  .629713E+03       .000000E+00 -.307340E-03       .000000E+00
       8  .629582E+03       .000000E+00 -.428335E-03       .000000E+00
       9  .629443E+03       .000000E+00 -.405338E-03       .000000E+00
      10  .629330E+03       .000000E+00 -.286347E-03       .000000E+00
      11  .629267E+03       .000000E+00 -.119357E-03       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
       1  .283211E+04  .189127E+02  .000000E+00
       2  .141780E+05  .567161E+02  .000000E+00
       3  .368648E+05  .945239E+02  .000000E+00
       4  .708919E+05  .132314E+03  .000000E+00
       5  .116256E+06  .170113E+03  .000000E+00
       6  .116257E+06 -.170111E+03  .000000E+00
       7  .708936E+05 -.132315E+03  .000000E+00
       8  .368661E+05 -.945224E+02  .000000E+00
       9  .141788E+05 -.567243E+02  .000000E+00
      10  .283320E+04 -.189208E+02  .000000E+00
0    ITERATION NUMBER=   46
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308686E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1  .643249E+03       .000000E+00  .110855E-03       .000000E+00
       2  .643310E+03       .000000E+00  .281826E-03       .000000E+00
       3  .643422E+03       .000000E+00  .404797E-03       .000000E+00
       4  .643562E+03       .000000E+00  .431775E-03       .000000E+00
       5  .643695E+03       .000000E+00  .314764E-03       .000000E+00
       6  .643769E+03       .000000E+00  .576447E-05       .000000E+00
       7  .643698E+03       .000000E+00 -.303238E-03       .000000E+00
       8  .643569E+03       .000000E+00 -.420256E-03       .000000E+00
       9  .643433E+03       .000000E+00 -.393280E-03       .000000E+00
      10  .643324E+03       .000000E+00 -.270309E-03       .000000E+00
      11  .643266E+03       .000000E+00 -.993378E-04       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
       1  .283211E+04  .189095E+02  .000000E+00
       2  .141780E+05  .567130E+02  .000000E+00
       3  .368648E+05  .945293E+02  .000000E+00
       4  .708919E+05  .132318E+03  .000000E+00
       5  .116256E+06  .170103E+03  .000000E+00
       6  .116257E+06 -.170109E+03  .000000E+00
       7  .708936E+05 -.132321E+03  .000000E+00
       8  .368661E+05 -.945304E+02  .000000E+00
```

```
      9  .141787E+05  -.567240E+02   .000000E+00
     10  .283320E+04  -.189085E+02   .000000E+00
0    ITERATION NUMBER=   47
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308645E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .657247E+03       .000000E+00   .910834E-04       .000000E+00
      2  .657304E+03       .000000E+00   .266035E-03       .000000E+00
      3  .657412E+03       .000000E+00   .392985E-03       .000000E+00
      4  .657549E+03       .000000E+00   .423942E-03       .000000E+00
      5  .657680E+03       .000000E+00   .310908E-03       .000000E+00
      6  .657754E+03       .000000E+00   .588672E-05       .000000E+00
      7  .657683E+03       .000000E+00  -.299138E-03       .000000E+00
      8  .657556E+03       .000000E+00  -.412178E-03       .000000E+00
      9  .657422E+03       .000000E+00  -.381224E-03       .000000E+00
     10  .657318E+03       .000000E+00  -.254273E-03       .000000E+00
     11  .657265E+03       .000000E+00  -.793214E-04       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189111E+02   .000000E+00
      2  .141780E+05   .567208E+02   .000000E+00
      3  .368648E+05   .945212E+02   .000000E+00
      4  .708919E+05   .132320E+03   .000000E+00
      5  .116256E+06   .170110E+03   .000000E+00
      6  .116257E+06  -.170109E+03   .000000E+00
      7  .708936E+05  -.132316E+03   .000000E+00
      8  .368661E+05  -.945219E+02   .000000E+00
      9  .141787E+05  -.567254E+02   .000000E+00
     10  .283320E+04  -.189099E+02   .000000E+00
0    ITERATION NUMBER=   48
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308797E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .671246E+03       .000000E+00   .713165E-04       .000000E+00
      2  .671298E+03       .000000E+00   .250249E-03       .000000E+00
      3  .671401E+03       .000000E+00   .381179E-03       .000000E+00
      4  .671536E+03       .000000E+00   .416114E-03       .000000E+00
      5  .671664E+03       .000000E+00   .307058E-03       .000000E+00
      6  .671738E+03       .000000E+00   .601424E-05       .000000E+00
      7  .671668E+03       .000000E+00  -.295033E-03       .000000E+00
      8  .671543E+03       .000000E+00  -.404095E-03       .000000E+00
      9  .671412E+03       .000000E+00  -.369162E-03       .000000E+00
     10  .671312E+03       .000000E+00  -.238232E-03       .000000E+00
     11  .671265E+03       .000000E+00  -.592990E-04       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189157E+02   .000000E+00
      2  .141780E+05   .567255E+02   .000000E+00
      3  .368648E+05   .945220E+02   .000000E+00
      4  .708919E+05   .132324E+03   .000000E+00
      5  .116256E+06   .170113E+03   .000000E+00
      6  .116257E+06  -.170101E+03   .000000E+00
      7  .708935E+05  -.132310E+03   .000000E+00
      8  .368660E+05  -.945244E+02   .000000E+00
      9  .141787E+05  -.567199E+02   .000000E+00
     10  .283319E+04  -.189107E+02   .000000E+00
0    ITERATION NUMBER=   49
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308843E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .685245E+03       .000000E+00   .515513E-04       .000000E+00
      2  .685291E+03       .000000E+00   .234465E-03       .000000E+00
      3  .685391E+03       .000000E+00   .369374E-03       .000000E+00
      4  .685522E+03       .000000E+00   .408287E-03       .000000E+00
      5  .685649E+03       .000000E+00   .303209E-03       .000000E+00
```

```
      6  .685722E+03      .000000E+00   .614260E-05      .000000E+00
      7  .685653E+03      .000000E+00  -.290927E-03      .000000E+00
      8  .685529E+03      .000000E+00  -.396011E-03      .000000E+00
      9  .685402E+03      .000000E+00  -.357101E-03      .000000E+00
     10  .685306E+03      .000000E+00  -.222190E-03      .000000E+00
     11  .685264E+03      .000000E+00  -.392770E-04      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189172E+02   .000000E+00
      2  .141780E+05   .567272E+02   .000000E+00
      3  .368648E+05   .945200E+02   .000000E+00
      4  .708919E+05   .132320E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170107E+03   .000000E+00
      7  .708936E+05  -.132317E+03   .000000E+00
      8  .368661E+05  -.945208E+02   .000000E+00
      9  .141787E+05  -.567199E+02   .000000E+00
     10  .283319E+04  -.189168E+02   .000000E+00
0   ITERATION NUMBER=   50
0   CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308792E+02
0   NODE    DISPL.          REACTION      DISPL.          REACTION
      1  .699244E+03      .000000E+00   .317822E-04      .000000E+00
      2  .699285E+03      .000000E+00   .218676E-03      .000000E+00
      3  .699380E+03      .000000E+00   .357565E-03      .000000E+00
      4  .699509E+03      .000000E+00   .400457E-03      .000000E+00
      5  .699634E+03      .000000E+00   .299356E-03      .000000E+00
      6  .699706E+03      .000000E+00   .626692E-05      .000000E+00
      7  .699638E+03      .000000E+00  -.286826E-03      .000000E+00
      8  .699516E+03      .000000E+00  -.387932E-03      .000000E+00
      9  .699392E+03      .000000E+00  -.345043E-03      .000000E+00
     10  .699300E+03      .000000E+00  -.206153E-03      .000000E+00
     11  .699264E+03      .000000E+00  -.192590E-04      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189016E+02   .000000E+00
      2  .141780E+05   .567179E+02   .000000E+00
      3  .368648E+05   .945255E+02   .000000E+00
      4  .708919E+05   .132312E+03   .000000E+00
      5  .116256E+06   .170104E+03   .000000E+00
      6  .116257E+06  -.170111E+03   .000000E+00
      7  .708936E+05  -.132316E+03   .000000E+00
      8  .368661E+05  -.945214E+02   .000000E+00
      9  .141787E+05  -.567304E+02   .000000E+00
     10  .283317E+04  -.189151E+02   .000000E+00
0   ITERATION NUMBER=   51
0   CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308708E+02
0   NODE    DISPL.          REACTION      DISPL.          REACTION
      1  .713243E+03      .000000E+00   .120107E-04      .000000E+00
      2  .713279E+03      .000000E+00   .202886E-03      .000000E+00
      3  .713370E+03      .000000E+00   .345753E-03      .000000E+00
      4  .713495E+03      .000000E+00   .392624E-03      .000000E+00
      5  .713619E+03      .000000E+00   .295501E-03      .000000E+00
      6  .713691E+03      .000000E+00   .638930E-05      .000000E+00
      7  .713622E+03      .000000E+00  -.282726E-03      .000000E+00
      8  .713503E+03      .000000E+00  -.379855E-03      .000000E+00
      9  .713381E+03      .000000E+00  -.332987E-03      .000000E+00
     10  .713294E+03      .000000E+00  -.190118E-03      .000000E+00
     11  .713263E+03      .000000E+00   .757291E-06      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283211E+04   .189153E+02   .000000E+00
      2  .141780E+05   .567256E+02   .000000E+00
      3  .368648E+05   .945171E+02   .000000E+00
```

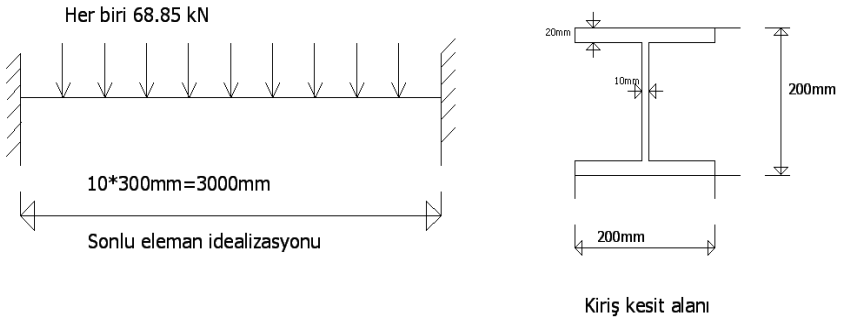
```
      4  .708919E+05   .132319E+03   .000000E+00
      5  .116256E+06   .170105E+03   .000000E+00
      6  .116257E+06  -.170105E+03   .000000E+00
      7  .708936E+05  -.132317E+03   .000000E+00
      8  .368661E+05  -.945253E+02   .000000E+00
      9  .141787E+05  -.567258E+02   .000000E+00
     10  .283320E+04  -.189104E+02   .000000E+00
0    ITERATION NUMBER=   52
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .308821E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .727242E+03       .000000E+00  -.775882E-05       .000000E+00
      2  .727272E+03       .000000E+00   .187097E-03       .000000E+00
      3  .727359E+03       .000000E+00   .333944E-03       .000000E+00
      4  .727482E+03       .000000E+00   .384793E-03       .000000E+00
      5  .727604E+03       .000000E+00   .291648E-03       .000000E+00
      6  .727675E+03       .000000E+00   .651357E-05       .000000E+00
      7  .727607E+03       .000000E+00  -.278624E-03       .000000E+00
      8  .727489E+03       .000000E+00  -.371775E-03       .000000E+00
      9  .727371E+03       .000000E+00  -.320929E-03       .000000E+00
     10  .727288E+03       .000000E+00  -.174080E-03       .000000E+00
     11  .727262E+03       .000000E+00   .207757E-04       .000000E+00
0 ELEMENT           STRESSES           PL.STRAIN
      1  .283211E+04   .189128E+02   .000000E+00
      2  .141780E+05   .567171E+02   .000000E+00
      3  .368648E+05   .945172E+02   .000000E+00
      4  .708919E+05   .132311E+03   .000000E+00
      5  .116256E+06   .170108E+03   .000000E+00
      6  .116257E+06  -.170109E+03   .000000E+00
      7  .708936E+05  -.132316E+03   .000000E+00
      8  .368661E+05  -.945206E+02   .000000E+00
      9  .141787E+05  -.567250E+02   .000000E+00
     10  .283320E+04  -.189096E+02   .000000E+00
0    ITERATION NUMBER=   53
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .308591E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .741241E+03       .000000E+00  -.275286E-04       .000000E+00
      2  .741266E+03       .000000E+00   .171308E-03       .000000E+00
      3  .741349E+03       .000000E+00   .322135E-03       .000000E+00
      4  .741468E+03       .000000E+00   .376962E-03       .000000E+00
      5  .741589E+03       .000000E+00   .287795E-03       .000000E+00
      6  .741659E+03       .000000E+00   .663765E-05       .000000E+00
      7  .741592E+03       .000000E+00  -.274523E-03       .000000E+00
      8  .741476E+03       .000000E+00  -.363696E-03       .000000E+00
      9  .741361E+03       .000000E+00  -.308871E-03       .000000E+00
     10  .741282E+03       .000000E+00  -.158043E-03       .000000E+00
     11  .741262E+03       .000000E+00   .407940E-04       .000000E+00
0 ELEMENT           STRESSES           PL.STRAIN
      1  .283211E+04   .189047E+02   .000000E+00
      2  .141780E+05   .567214E+02   .000000E+00
      3  .368648E+05   .945177E+02   .000000E+00
      4  .708919E+05   .132316E+03   .000000E+00
      5  .116256E+06   .170111E+03   .000000E+00
      6  .116257E+06  -.170107E+03   .000000E+00
      7  .708936E+05  -.132321E+03   .000000E+00
      8  .368661E+05  -.945279E+02   .000000E+00
      9  .141787E+05  -.567240E+02   .000000E+00
     10  .283320E+04  -.189087E+02   .000000E+00
```

0 ITERATION NUMBER= 54
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .308620E+02
0 NODE DISPL. REACTION DISPL. REACTION
1 .755240E+03 .000000E+00 -.472976E-04 .000000E+00
2 .755260E+03 .000000E+00 .155519E-03 .000000E+00
3 .755338E+03 .000000E+00 .310326E-03 .000000E+00
4 .755455E+03 .000000E+00 .369132E-03 .000000E+00
5 .755573E+03 .000000E+00 .283942E-03 .000000E+00
6 .755643E+03 .000000E+00 .676233E-05 .000000E+00
7 .755577E+03 .000000E+00 -.270420E-03 .000000E+00
8 .755463E+03 .000000E+00 -.355616E-03 .000000E+00
9 .755351E+03 .000000E+00 -.296813E-03 .000000E+00
10 .755276E+03 .000000E+00 -.142005E-03 .000000E+00
11 .755261E+03 .000000E+00 .608128E-04 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .283211E+04 .189075E+02 .000000E+00
2 .141780E+05 .567182E+02 .000000E+00
3 .368648E+05 .945292E+02 .000000E+00
4 .708919E+05 .132313E+03 .000000E+00
5 .116256E+06 .170107E+03 .000000E+00
6 .116257E+06 -.170106E+03 .000000E+00
7 .708936E+05 -.132315E+03 .000000E+00
8 .368661E+05 -.945240E+02 .000000E+00
9 .141787E+05 -.567240E+02 .000000E+00
10 .283320E+04 -.189087E+02 .000000E+00



Şekil 5.4: Elastik zemine oturan tekil yüklü tabakasız Timoshenko kirişi örneği

5.1.3 Uniform yayılı yüklü tabakasız Timoshenko kirişi örneği



Şekil 5.5: Uniform yayılı yük etkimesi hali

Kirişin malzeme özellikleri:

E (Elastisite modülü)=210 kN/mm^2

ν (Poisson oranı) = 0.3

σ_0 (Akma gerilmesi) = 0.25 kN/mm^2

H^I (Pekleşme parametresi) = 0.0

Kiriş geometrisi:

b= 150mm

t=300mm

l=3000mm

Bu problemin çözümü için kayma şekil değiştirmelerini dikkate alan rijitlik matrisi kullanılmıştır.

Probleme ait bilgilerin programa giriş listesi:

Buradaki idealleştirme Problem 5.1.1'deki gibidir.Yükleme durumu hariç diğer tüm veriler formatlı girişe uygundur.

```
11   10    2    1    4    2   14    2    2
       11.43808e10       516921.6        212000.         0.

  1    1    2    1
  2    2    3    1
  3    3    4    1
  4    4    5    1
  5    5    6    1
  6    6    7    1
  7    7    8    1
  8    8    9    1
  9    9   10    1
 10   10   11    1
      1           0.
      2         300.
      3         600.
      4         900.
      5        1200.
      6        1500.
      7        1800.
      8        2100.
      9        2400.
     10        2700.
     11        3000.
      1    1          0.    1          0.
     11    1          0.    1          0.
```

0.0E-3 (Elastik zemin değeri=0)

Eleman numarası	İlk D.N.'daki yük	İlk D.N'daki moment	Son D.N'daki yük	Son D.N'daki moment
1	68.85	0.	68.85	0.
2	68.85	0.	68.85	0.
3	68.85	0.	68.85	0.
4	68.85	0.	68.85	0.
5	68.85	0.	68.85	0.
6	68.85	0.	68.85	0.
7	68.85	0.	68.85	0.
8	68.85	0.	68.85	0.
9	68.85	0.	68.85	0.
10	68.85	0.	68.85	0.

100	2	0.30	0.5
100	2	0.20	0.5
100	2	0.10	0.5
100	2	0.10	0.5
100	2	0.05	0.5
100	2	0.05	0.5
100	2	0.05	0.5
100	2	0.05	0.5
100	2	0.02	0.5
100	2	0.02	0.5
100	2	0.02	0.5
100	2	0.02	0.5
100	2	0.01	0.5
100	2	0.01	0.5

Veri girişi sonrası alınan sonuçlar;

```
NPOIN=   11   NELEM=   10   NBOUN=    2   NMATS=    1
NPROP=    4   NNODE=    2   NINCS=   14   NALGO=    2
NDOFN=    2
0     MATERIAL PROPERTIES
        1   .1438080E+11   .5169216E+06   .2120000E+06   .0000000E+00
0   EL NODES MAT.
    1    1    2    1
    2    2    3    1
    3    3    4    1
    4    4    5    1
    5    5    6    1
    6    6    7    1
    7    7    8    1
    8    8    9    1
    9    9   10    1
   10   10   11    1
0     NODE     COORD.
        1        .00000
        2      300.00000
        3      600.00000
        4      900.00000
        5     1200.00000
        6     1500.00000
        7     1800.00000
        8     2100.00000
        9     2400.00000
       10     2700.00000
       11     3000.00000
0 RES.NODE  CODE   PRES.VALUES  CODE   PRES.VALUES
        1    1         .00000    1         .00000
       11    1         .00000    1         .00000
0  ELEMENT          NODAL LOADS
        1       68.85000         .00000       68.85000         .00000
        2       68.85000         .00000       68.85000         .00000
        3       68.85000         .00000       68.85000         .00000
        4       68.85000         .00000       68.85000         .00000
        5       68.85000         .00000       68.85000         .00000
        6       68.85000         .00000       68.85000         .00000
        7       68.85000         .00000       68.85000         .00000
        8       68.85000         .00000       68.85000         .00000
        9       68.85000         .00000       68.85000         .00000
       10       68.85000         .00000       68.85000         .00000
  ELASTIC SOIL COEFFICIENT=      .000000E+00
0     IINCS=    1   NITER=  100   NOUTP=    2   FACTO=   .300000E+00   TOLER=   .500000E+00
0     ITERATION NUMBER=    1
0     CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .114560E-03
0     NODE    DISPL.           REACTION       DISPL.           REACTION
        1   .000000E+00       -.206550E+03   .000000E+00       -.102242E+06
        2   .369650E+00        .000000E+00   .155120E-02        .000000E+00
        3   .101910E+01        .000000E+00   .206826E-02        .000000E+00
        4   .167690E+01        .000000E+00   .180973E-02        .000000E+00
        5   .214913E+01        .000000E+00   .103413E-02        .000000E+00
        6   .231947E+01        .000000E+00   .112103E-08        .000000E+00
        7   .214913E+01        .000000E+00  -.103413E-02        .000000E+00
        8   .167690E+01        .000000E+00  -.180973E-02        .000000E+00
        9   .101910E+01        .000000E+00  -.206826E-02        .000000E+00
       10   .369650E+00        .000000E+00  -.155120E-02        .000000E+00
```

```
     11  .000000E+00      -.206550E+03   .000000E+00       .102243E+06

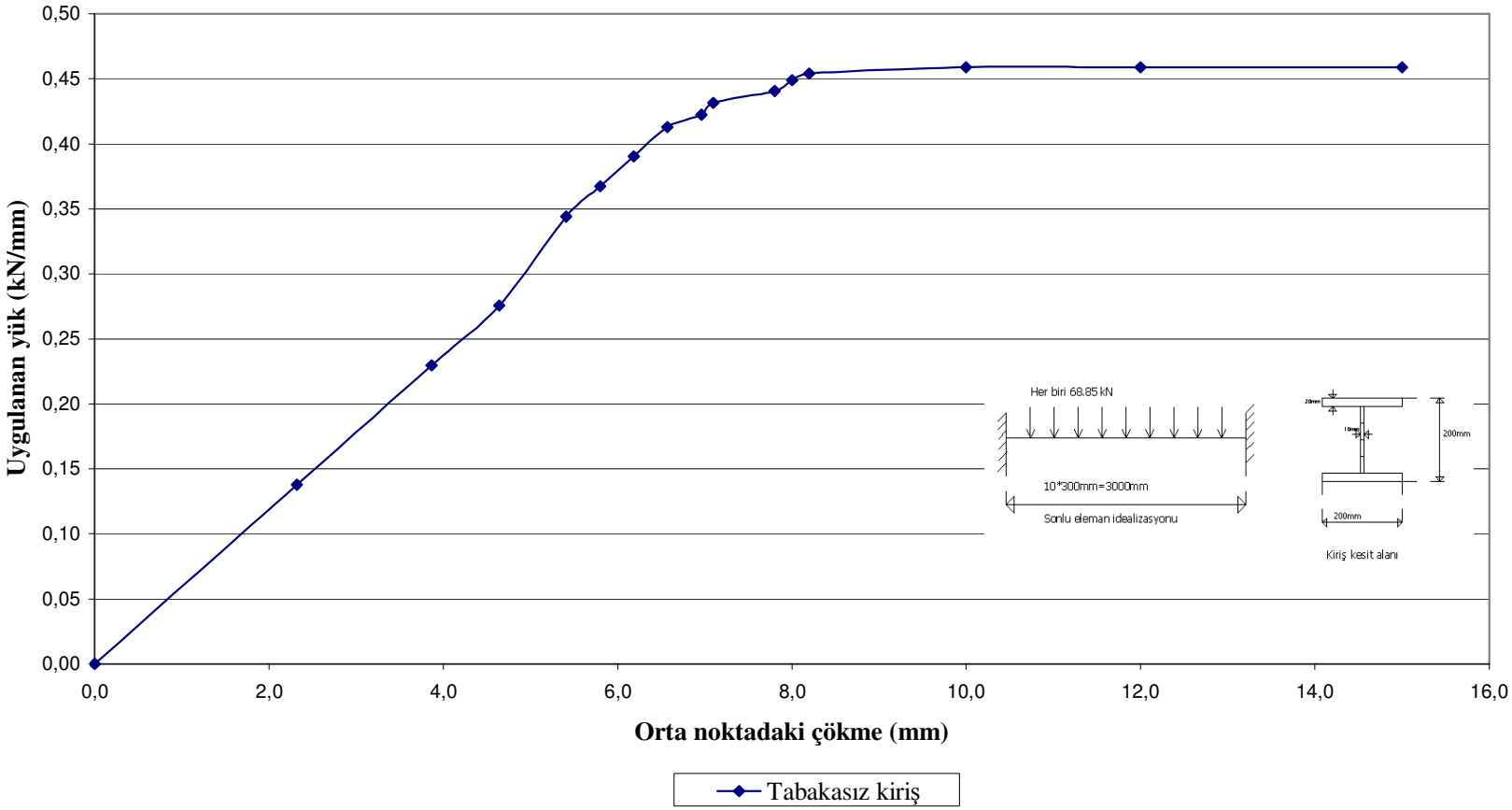
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.743582E+05   .185895E+03   .000000E+00
      2 -.247861E+05   .144585E+03   .000000E+00
      3  .123930E+05   .103275E+03   .000000E+00
      4  .371790E+05   .619652E+02   .000000E+00
      5  .495721E+05   .206549E+02   .000000E+00
      6  .495722E+05  -.206550E+02   .000000E+00
      7  .371791E+05  -.619651E+02   .000000E+00
      8  .123930E+05  -.103275E+03   .000000E+00
      9 -.247861E+05  -.144585E+03   .000000E+00
     10 -.743582E+05  -.185895E+03   .000000E+00
0   IINCS=   2  NITER= 100  NOUTP=   2  FACTO=   .200000E+00  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .380970E-04
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00      -.344250E+03   .000000E+00      -.170404E+06
      2  .616083E+00       .000000E+00   .258532E-02       .000000E+00
      3  .169850E+01       .000000E+00   .344710E-02       .000000E+00
      4  .279482E+01       .000000E+00   .301621E-02       .000000E+00
      5  .358188E+01       .000000E+00   .172355E-02       .000000E+00
      6  .386578E+01       .000000E+00   .741700E-09       .000000E+00
      7  .358188E+01       .000000E+00  -.172355E-02       .000000E+00
      8  .279482E+01       .000000E+00  -.301621E-02       .000000E+00
      9  .169850E+01       .000000E+00  -.344710E-02       .000000E+00
     10  .616083E+00       .000000E+00  -.258533E-02       .000000E+00
     11  .000000E+00      -.344250E+03   .000000E+00       .170404E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.123930E+06   .309825E+03   .000000E+00
      2 -.413101E+05   .240975E+03   .000000E+00
      3  .206549E+05   .172125E+03   .000000E+00
      4  .619650E+05   .103275E+03   .000000E+00
      5  .826200E+05   .344251E+02   .000000E+00
      6  .826201E+05  -.344249E+02   .000000E+00
      7  .619650E+05  -.103275E+03   .000000E+00
      8  .206550E+05  -.172125E+03   .000000E+00
      9 -.413101E+05  -.240975E+03   .000000E+00
     10 -.123930E+06  -.309825E+03   .000000E+00
0   IINCS=   3  NITER= 100  NOUTP=   2  FACTO=   .100000E+00  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .144935E-04
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00      -.413100E+03   .000000E+00      -.204485E+06
      2  .739300E+00       .000000E+00   .310239E-02       .000000E+00
      3  .203820E+01       .000000E+00   .413652E-02       .000000E+00
      4  .335379E+01       .000000E+00   .361945E-02       .000000E+00
      5  .429826E+01       .000000E+00   .206826E-02       .000000E+00
      6  .463893E+01       .000000E+00   .241158E-09       .000000E+00
      7  .429826E+01       .000000E+00  -.206826E-02       .000000E+00
      8  .335379E+01       .000000E+00  -.361945E-02       .000000E+00
      9  .203820E+01       .000000E+00  -.413652E-02       .000000E+00
     10  .739300E+00       .000000E+00  -.310239E-02       .000000E+00
     11  .000000E+00      -.413100E+03   .000000E+00       .204485E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.148716E+06   .371790E+03   .000000E+00
      2 -.495721E+05   .289170E+03   .000000E+00
      3  .247859E+05   .206550E+03   .000000E+00
      4  .743580E+05   .123930E+03   .000000E+00
      5  .991440E+05   .413101E+02   .000000E+00
```

```
      6  .991440E+05  -.413100E+02   .000000E+00
      7  .743580E+05  -.123930E+03   .000000E+00
      8  .247860E+05  -.206550E+03   .000000E+00
      9 -.495721E+05  -.289170E+03   .000000E+00
     10 -.148716E+06  -.371790E+03   .000000E+00
0   IINCS=  4  NITER= 100  NOUTP=  2  FACTO=  .100000E+00  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .147003E-04
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.481950E+03   .000000E+00      -.238565E+06
      2  .862516E+00       .000000E+00   .361945E-02       .000000E+00
      3  .237790E+01       .000000E+00   .482594E-02       .000000E+00
      4  .391275E+01       .000000E+00   .422270E-02       .000000E+00
      5  .501463E+01       .000000E+00   .241297E-02       .000000E+00
      6  .541209E+01       .000000E+00   .288634E-09       .000000E+00
      7  .501463E+01       .000000E+00  -.241297E-02       .000000E+00
      8  .391275E+01       .000000E+00  -.422270E-02       .000000E+00
      9  .237790E+01       .000000E+00  -.482594E-02       .000000E+00
     10  .862516E+00       .000000E+00  -.361945E-02       .000000E+00
     11  .000000E+00      -.481950E+03   .000000E+00       .238565E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.173502E+06   .433755E+03   .000000E+00
      2 -.578341E+05   .337365E+03   .000000E+00
      3  .289169E+05   .240975E+03   .000000E+00
      4  .867509E+05   .144585E+03   .000000E+00
      5  .115668E+06   .481951E+02   .000000E+00
      6  .115668E+06  -.481950E+02   .000000E+00
      7  .867510E+05  -.144585E+03   .000000E+00
      8  .289169E+05  -.240975E+03   .000000E+00
      9 -.578341E+05  -.337365E+03   .000000E+00
     10 -.173502E+06  -.433755E+03   .000000E+00
0   IINCS=  5  NITER= 100  NOUTP=  2  FACTO=  .500000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .871332E-05
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.516375E+03   .000000E+00      -.255606E+06
      2  .924124E+00       .000000E+00   .387798E-02       .000000E+00
      3  .254775E+01       .000000E+00   .517065E-02       .000000E+00
      4  .419223E+01       .000000E+00   .452432E-02       .000000E+00
      5  .537282E+01       .000000E+00   .258532E-02       .000000E+00
      6  .579867E+01       .000000E+00   .152198E-09       .000000E+00
      7  .537282E+01       .000000E+00  -.258532E-02       .000000E+00
      8  .419223E+01       .000000E+00  -.452432E-02       .000000E+00
      9  .254775E+01       .000000E+00  -.517065E-02       .000000E+00
     10  .924124E+00       .000000E+00  -.387798E-02       .000000E+00
     11  .000000E+00      -.516375E+03   .000000E+00       .255606E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.185895E+06   .464738E+03   .000000E+00
      2 -.619651E+05   .361463E+03   .000000E+00
      3  .309824E+05   .258188E+03   .000000E+00
      4  .929474E+05   .154913E+03   .000000E+00
      5  .123930E+06   .516376E+02   .000000E+00
      6  .123930E+06  -.516375E+02   .000000E+00
      7  .929475E+05  -.154913E+03   .000000E+00
      8  .309824E+05  -.258188E+03   .000000E+00
      9 -.619651E+05  -.361463E+03   .000000E+00
     10 -.185895E+06  -.464738E+03   .000000E+00
0   IINCS=  6  NITER= 100  NOUTP=  2  FACTO=  .500000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .612585E-05
```

```
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1   .000000E+00      -.550800E+03   .000000E+00      -.272646E+06
       2   .985733E+00       .000000E+00   .413652E-02       .000000E+00
       3   .271760E+01       .000000E+00   .551536E-02       .000000E+00
       4   .447171E+01       .000000E+00   .482594E-02       .000000E+00
       5   .573101E+01       .000000E+00   .275768E-02       .000000E+00
       6   .618524E+01       .000000E+00   .195499E-09       .000000E+00
       7   .573101E+01       .000000E+00  -.275768E-02       .000000E+00
       8   .447171E+01       .000000E+00  -.482594E-02       .000000E+00
       9   .271760E+01       .000000E+00  -.551536E-02       .000000E+00
      10   .985733E+00       .000000E+00  -.413652E-02       .000000E+00
      11   .000000E+00      -.550800E+03   .000000E+00       .272646E+06
0  ELEMENT          STRESSES          PL.STRAIN
       1  -.198288E+06   .495720E+03   .000000E+00
       2  -.660961E+05   .385560E+03   .000000E+00
       3   .330479E+05   .275400E+03   .000000E+00
       4   .991439E+05   .165240E+03   .000000E+00
       5   .132192E+06   .550800E+02   .000000E+00
       6   .132192E+06  -.550800E+02   .000000E+00
       7   .991439E+05  -.165240E+03   .000000E+00
       8   .330479E+05  -.275400E+03   .000000E+00
       9  -.660961E+05  -.385560E+03   .000000E+00
      10  -.198288E+06  -.495720E+03   .000000E+00
0    IINCS=   7  NITER= 100  NOUTP=   2  FACTO=   .500000E-01  TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .636509E-05
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1   .000000E+00      -.585225E+03   .000000E+00      -.289687E+06
       2   .104734E+01       .000000E+00   .439505E-02       .000000E+00
       3   .288745E+01       .000000E+00   .586007E-02       .000000E+00
       4   .475120E+01       .000000E+00   .512756E-02       .000000E+00
       5   .608920E+01       .000000E+00   .293003E-02       .000000E+00
       6   .657182E+01       .000000E+00  -.126934E-10       .000000E+00
       7   .608920E+01       .000000E+00  -.293003E-02       .000000E+00
       8   .475120E+01       .000000E+00  -.512756E-02       .000000E+00
       9   .288745E+01       .000000E+00  -.586007E-02       .000000E+00
      10   .104734E+01       .000000E+00  -.439505E-02       .000000E+00
      11   .000000E+00      -.585225E+03   .000000E+00       .289686E+06
0  ELEMENT          STRESSES          PL.STRAIN
       1  -.210681E+06   .526703E+03   .000000E+00
       2  -.702271E+05   .409658E+03   .000000E+00
       3   .351134E+05   .292613E+03   .000000E+00
       4   .105340E+06   .175568E+03   .000000E+00
       5   .140454E+06   .585225E+02   .000000E+00
       6   .140454E+06  -.585225E+02   .000000E+00
       7   .105340E+06  -.175567E+03   .000000E+00
       8   .351134E+05  -.292613E+03   .000000E+00
       9  -.702271E+05  -.409658E+03   .000000E+00
      10  -.210681E+06  -.526702E+03   .000000E+00
0    IINCS=   8  NITER= 100  NOUTP=   2  FACTO=   .500000E-01  TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .510589E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1   .000000E+00      -.619650E+03   .000000E+00      -.306727E+06
       2   .110895E+01       .000000E+00   .465358E-02       .000000E+00
       3   .305730E+01       .000000E+00   .620478E-02       .000000E+00
       4   .503068E+01       .000000E+00   .542918E-02       .000000E+00
       5   .644739E+01       .000000E+00   .310239E-02       .000000E+00
       6   .695840E+01       .000000E+00   .715151E-10       .000000E+00
       7   .644739E+01       .000000E+00  -.310239E-02       .000000E+00
```

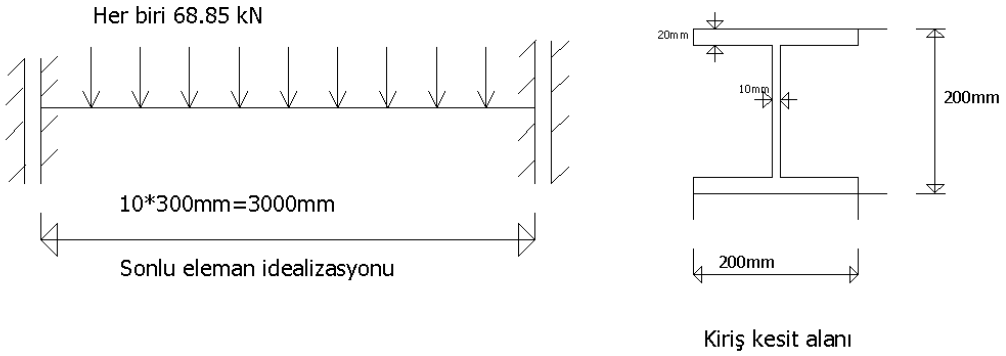
8 .503068E+01 .000000E+00 -.542918E-02 .000000E+00
9 .305730E+01 .000000E+00 -.620478E-02 .000000E+00
10 .110895E+01 .000000E+00 -.465358E-02 .000000E+00
11 .000000E+00 -.619650E+03 .000000E+00 .306727E+06

0 ELEMENT STRESSES PL.STRAIN
1 -.212000E+06 .557685E+03 -.770063E-06
2 -.743581E+05 .433755E+03 .000000E+00
3 .371789E+05 .309825E+03 .000000E+00
4 .111537E+06 .185895E+03 .000000E+00
5 .148716E+06 .619650E+02 .000000E+00
6 .148716E+06 -.619650E+02 .000000E+00
7 .111537E+06 -.185895E+03 .000000E+00
8 .371789E+05 -.309825E+03 .000000E+00
9 -.743581E+05 -.433755E+03 .000000E+00
10 -.212000E+06 -.557685E+03 -.770062E-06



Şekil 5.6: Uniform yayılı yüklü tabakasız Timoshenko kirişi örneği

5.1.4 Elastik zemine oturan uniform yayılı yüklü Timoshenko kirişi örneği



Şekil 5.7: Uniform yayılı yük etkimesi hali

Elastik zemin etkilerini daha iyi gözlemleyebilmek için ankastre mesnetler çökmeye serbest bırakılmıştır. Hesapta kayma şekil değiştirmelerini içeren sistem rijitlik matrisi kullanılmıştır.

Zemin yatak katsayısı 6000t/m^3'tür. Verilerde elastik zemin değeri 0.0E-3 yerine 12.0E-3 alınır.İlgili data satırlarındaki değişiklik aşağıda gösterilmiştir.

Düğüm nokta numarası	**Mesnetlenme durumu**	**Moment çökme değeri**	**Dönme değeri**	**Dışarıdan verilmiş dönme**
1(ilk)	**0**(serbest)	0.	1.	0.
11(son)	**0**(serbest)	0.	1.	0.

8	68.85	0.	68.85	0.
9	68.85	0.	68.85	0.
10	68.85	0.	68.85	0.

12.0E-3

100	2	0.30	0.5
100	2	0.20	0.5
100	2	0.01	0.5

Veri girişi sonrası alınan sonuçlar;

```
NPOIN=   11   NELEM=   10   NBOUN=    2   NMATS=    1

 NPROP=    4   NNODE=    2   NINCS=   14   NALGO=    2

 NDOFN=    2
0     MATERIAL PROPERTIES
        1   .1438080E+11   .5169216E+06   .2120000E+06   .1000000E+00
0   EL NODES MAT.
    1    1    2    1
    2    2    3    1
    3    3    4    1
    4    4    5    1
    5    5    6    1
    6    6    7    1
    7    7    8    1
    8    8    9    1
    9    9   10    1
   10   10   11    1
0     NODE     COORD.
        1        .00000
        2      300.00000
        3      600.00000
        4      900.00000
        5     1200.00000
        6     1500.00000
        7     1800.00000
        8     2100.00000
        9     2400.00000
       10     2700.00000
       11     3000.00000
0 RES.NODE  CODE   PRES.VALUES  CODE   PRES.VALUES
        1    0        .00000    1        .00000
       11    0        .00000    1        .00000
0  ELEMENT          NODAL LOADS
        1       68.85000        .00000       68.85000        .00000
        2       68.85000        .00000       68.85000        .00000
        3       68.85000        .00000       68.85000        .00000
        4       68.85000        .00000       68.85000        .00000
        5       68.85000        .00000       68.85000        .00000
        6       68.85000        .00000       68.85000        .00000
        7       68.85000        .00000       68.85000        .00000
        8       68.85000        .00000       68.85000        .00000
        9       68.85000        .00000       68.85000        .00000
       10       68.85000        .00000       68.85000        .00000
  ELASTIC SOIL COEFFICIENT=      .120000E-01
0     IINCS=    1   NITER=  100   NOUTP=    2   FACTO=   .300000E+00   TOLER=   .500000E+00
0     ITERATION NUMBER=    1
0     CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .870388E+01
0     NODE     DISPL.           REACTION        DISPL.           REACTION
        1   .114685E+02        .000000E+00   .000000E+00        .103197E+04
        2   .114685E+02        .000000E+00   .220105E-08        .000000E+00
        3   .114685E+02        .000000E+00  -.173750E-09        .000000E+00
        4   .114685E+02        .000000E+00  -.913881E-08        .000000E+00
        5   .114684E+02        .000000E+00  -.166174E-07        .000000E+00
        6   .114684E+02        .000000E+00  -.215181E-07        .000000E+00
        7   .114684E+02        .000000E+00  -.221003E-07        .000000E+00
```

```
      8  .114684E+02      .000000E+00  -.166932E-07      .000000E+00
      9  .114684E+02      .000000E+00  -.884009E-08      .000000E+00
     10  .114684E+02      .000000E+00  -.310441E-08      .000000E+00
     11  .114684E+02      .000000E+00   .000000E+00     -.103210E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .102706E+04  -.448227E-03   .000000E+00
      2  .102727E+04   .882149E-03   .000000E+00
      3  .102759E+04   .600815E-03   .000000E+00
      4  .102752E+04   .648499E-04   .000000E+00
      5  .102740E+04  -.381470E-05   .000000E+00
      6  .102719E+04  -.147724E-02   .000000E+00
      7  .102690E+04   .129700E-03   .000000E+00
      8  .102678E+04  -.127506E-02   .000000E+00
      9  .102688E+04  -.158310E-03   .000000E+00
     10  .102701E+04   .632286E-03   .000000E+00
0    ITERATION NUMBER=    2
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .437467E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .229369E+02      .000000E+00   .000000E+00      .205923E+04
      2  .229369E+02      .000000E+00   .157937E-09      .000000E+00
      3  .229369E+02      .000000E+00  -.411525E-08      .000000E+00
      4  .229369E+02      .000000E+00  -.146539E-07      .000000E+00
      5  .229369E+02      .000000E+00  -.231541E-07      .000000E+00
      6  .229369E+02      .000000E+00  -.285291E-07      .000000E+00
      7  .229369E+02      .000000E+00  -.291365E-07      .000000E+00
      8  .229369E+02      .000000E+00  -.226566E-07      .000000E+00
      9  .229369E+02      .000000E+00  -.135627E-07      .000000E+00
     10  .229369E+02      .000000E+00  -.557963E-08      .000000E+00
     11  .229369E+02      .000000E+00   .000000E+00     -.205912E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .205431E+04  -.324249E-04   .000000E+00
      2  .205453E+04  -.489235E-03   .000000E+00
      3  .205483E+04  -.629425E-04   .000000E+00
      4  .205473E+04  -.715256E-04   .000000E+00
      5  .205458E+04   .164986E-03   .000000E+00
      6  .205435E+04   .877380E-04   .000000E+00
      7  .205401E+04  -.110817E-02   .000000E+00
      8  .205388E+04  -.394821E-03   .000000E+00
      9  .205393E+04  -.128174E-02   .000000E+00
     10  .205405E+04   .113583E-02   .000000E+00
0    ITERATION NUMBER=    3
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .292046E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .344053E+02      .000000E+00   .000000E+00      .308642E+04
      2  .344053E+02      .000000E+00  -.514861E-09      .000000E+00
      3  .344053E+02      .000000E+00  -.535709E-08      .000000E+00
      4  .344053E+02      .000000E+00  -.162124E-07      .000000E+00
      5  .344053E+02      .000000E+00  -.248831E-07      .000000E+00
      6  .344053E+02      .000000E+00  -.302327E-07      .000000E+00
      7  .344053E+02      .000000E+00  -.305214E-07      .000000E+00
      8  .344053E+02      .000000E+00  -.238264E-07      .000000E+00
      9  .344053E+02      .000000E+00  -.140224E-07      .000000E+00
     10  .344053E+02      .000000E+00  -.587083E-08      .000000E+00
     11  .344053E+02      .000000E+00   .000000E+00     -.308627E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .308151E+04   .103951E-03   .000000E+00
      2  .308171E+04  -.991821E-04   .000000E+00
      3  .308200E+04   .507355E-03   .000000E+00
      4  .308190E+04   .597954E-03   .000000E+00
      5  .308174E+04   .864029E-03   .000000E+00
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      6  .308149E+04  -.577927E-03   .000000E+00
      7  .308116E+04  -.588417E-03   .000000E+00
      8  .308101E+04  -.135803E-02   .000000E+00
      9  .308109E+04   .165939E-03   .000000E+00
     10  .308120E+04  -.100136E-03   .000000E+00
0    ITERATION NUMBER=    4
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .219159E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .458738E+02       .000000E+00   .000000E+00       .411358E+04
      2  .458738E+02       .000000E+00  -.594657E-09       .000000E+00
      3  .458738E+02       .000000E+00  -.552959E-08       .000000E+00
      4  .458738E+02       .000000E+00  -.165555E-07       .000000E+00
      5  .458738E+02       .000000E+00  -.253204E-07       .000000E+00
      6  .458738E+02       .000000E+00  -.306714E-07       .000000E+00
      7  .458738E+02       .000000E+00  -.309786E-07       .000000E+00
      8  .458737E+02       .000000E+00  -.243348E-07       .000000E+00
      9  .458737E+02       .000000E+00  -.144840E-07       .000000E+00
     10  .458737E+02       .000000E+00  -.616495E-08       .000000E+00
     11  .458737E+02       .000000E+00   .000000E+00       -.411342E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .410867E+04   .120163E-03   .000000E+00
      2  .410888E+04   .124741E-02   .000000E+00
      3  .410917E+04   .612259E-03   .000000E+00
      4  .410906E+04  -.537872E-03   .000000E+00
      5  .410890E+04  -.251770E-03   .000000E+00
      6  .410865E+04  -.395775E-03   .000000E+00
      7  .410832E+04  -.391006E-03   .000000E+00
      8  .410817E+04  -.116062E-02   .000000E+00
      9  .410824E+04   .319481E-03   .000000E+00
     10  .410834E+04  -.400543E-04   .000000E+00
0    ITERATION NUMBER=    5
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .175385E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .573422E+02       .000000E+00   .000000E+00       .514075E+04
      2  .573422E+02       .000000E+00  -.785289E-09       .000000E+00
      3  .573422E+02       .000000E+00  -.590257E-08       .000000E+00
      4  .573422E+02       .000000E+00  -.170577E-07       .000000E+00
      5  .573422E+02       .000000E+00  -.259646E-07       .000000E+00
      6  .573422E+02       .000000E+00  -.313950E-07       .000000E+00
      7  .573422E+02       .000000E+00  -.316661E-07       .000000E+00
      8  .573422E+02       .000000E+00  -.248362E-07       .000000E+00
      9  .573422E+02       .000000E+00  -.149351E-07       .000000E+00
     10  .573422E+02       .000000E+00  -.645616E-08       .000000E+00
     11  .573422E+02       .000000E+00   .000000E+00       -.514057E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .513584E+04   .159264E-03   .000000E+00
      2  .513605E+04   .667572E-04   .000000E+00
      3  .513634E+04   .790596E-03   .000000E+00
      4  .513623E+04  -.304222E-03   .000000E+00
      5  .513606E+04   .267029E-04   .000000E+00
      6  .513581E+04  -.108719E-03   .000000E+00
      7  .513547E+04  -.149727E-03   .000000E+00
      8  .513532E+04  -.967026E-03   .000000E+00
      9  .513539E+04  -.824928E-03   .000000E+00
     10  .513549E+04   .190735E-04   .000000E+00
0    ITERATION NUMBER=    6
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .146183E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .688107E+02       .000000E+00   .000000E+00       .616793E+04
      2  .688107E+02       .000000E+00  -.109372E-08       .000000E+00
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      3  .688107E+02      .000000E+00  -.649106E-08      .000000E+00
      4  .688107E+02      .000000E+00  -.178776E-07      .000000E+00
      5  .688107E+02      .000000E+00  -.269558E-07      .000000E+00
      6  .688106E+02      .000000E+00  -.324418E-07      .000000E+00
      7  .688106E+02      .000000E+00  -.325471E-07      .000000E+00
      8  .688106E+02      .000000E+00  -.254232E-07      .000000E+00
      9  .688106E+02      .000000E+00  -.152425E-07      .000000E+00
     10  .688106E+02      .000000E+00  -.652691E-08      .000000E+00
     11  .688106E+02      .000000E+00   .000000E+00     -.616771E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .616301E+04   .222206E-03   .000000E+00
      2  .616322E+04   .154400E-02   .000000E+00
      3  .616351E+04   .107765E-02   .000000E+00
      4  .616340E+04   .648499E-04   .000000E+00
      5  .616322E+04   .441551E-03   .000000E+00
      6  .616296E+04  -.101089E-02   .000000E+00
      7  .616262E+04   .148773E-03   .000000E+00
      8  .616247E+04  -.784874E-03   .000000E+00
      9  .616254E+04   .546455E-03   .000000E+00
     10  .616264E+04   .333786E-04   .000000E+00
0    ITERATION NUMBER=    7
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .125317E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .802791E+02      .000000E+00   .000000E+00      .719507E+04
      2  .802791E+02      .000000E+00  -.698274E-09      .000000E+00
      3  .802791E+02      .000000E+00  -.572686E-08      .000000E+00
      4  .802791E+02      .000000E+00  -.168139E-07      .000000E+00
      5  .802791E+02      .000000E+00  -.256671E-07      .000000E+00
      6  .802791E+02      .000000E+00  -.311599E-07      .000000E+00
      7  .802791E+02      .000000E+00  -.314843E-07      .000000E+00
      8  .802791E+02      .000000E+00  -.247539E-07      .000000E+00
      9  .802791E+02      .000000E+00  -.149693E-07      .000000E+00
     10  .802791E+02      .000000E+00  -.638014E-08      .000000E+00
     11  .802791E+02      .000000E+00   .000000E+00     -.719489E+04
0 ELEMENT          STRESSES          PL.STRAIN
      1  .719015E+04   .141144E-03   .000000E+00
      2  .719036E+04   .130844E-02   .000000E+00
      3  .719065E+04   .705719E-03   .000000E+00
      4  .719054E+04  -.413895E-03   .000000E+00
      5  .719038E+04  -.820160E-04   .000000E+00
      6  .719013E+04  -.148869E-02   .000000E+00
      7  .718979E+04  -.149918E-02   .000000E+00
      8  .718965E+04  -.976563E-03   .000000E+00
      9  .718970E+04   .461578E-03   .000000E+00
     10  .718981E+04   .381470E-05   .000000E+00
0    ITERATION NUMBER=    8
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .109664E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .917475E+02      .000000E+00   .000000E+00      .822224E+04
      2  .917475E+02      .000000E+00  -.927704E-09      .000000E+00
      3  .917475E+02      .000000E+00  -.617686E-08      .000000E+00
      4  .917475E+02      .000000E+00  -.174216E-07      .000000E+00
      5  .917475E+02      .000000E+00  -.264433E-07      .000000E+00
      6  .917475E+02      .000000E+00  -.319107E-07      .000000E+00
      7  .917475E+02      .000000E+00  -.321646E-07      .000000E+00
      8  .917475E+02      .000000E+00  -.252451E-07      .000000E+00
      9  .917475E+02      .000000E+00  -.150635E-07      .000000E+00
     10  .917475E+02      .000000E+00  -.645382E-08      .000000E+00
     11  .917475E+02      .000000E+00   .000000E+00     -.822204E+04
0 ELEMENT          STRESSES          PL.STRAIN
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      1   .821732E+04   .187874E-03   .000000E+00
      2   .821753E+04   .152588E-03   .000000E+00
      3   .821782E+04   .920296E-03   .000000E+00
      4   .821771E+04  -.132561E-03   .000000E+00
      5   .821754E+04   .228882E-03   .000000E+00
      6   .821729E+04  -.119781E-02   .000000E+00
      7   .821695E+04   .343323E-04   .000000E+00
      8   .821679E+04  -.857353E-03   .000000E+00
      9   .821686E+04   .494957E-03   .000000E+00
     10   .821697E+04   .181198E-04   .000000E+00
0    ITERATION NUMBER=    9
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .974871E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1   .103216E+03       .000000E+00   .000000E+00       .924940E+04
      2   .103216E+03       .000000E+00  -.870899E-09       .000000E+00
      3   .103216E+03       .000000E+00  -.607351E-08       .000000E+00
      4   .103216E+03       .000000E+00  -.172885E-07       .000000E+00
      5   .103216E+03       .000000E+00  -.262949E-07       .000000E+00
      6   .103216E+03       .000000E+00  -.318646E-07       .000000E+00
      7   .103216E+03       .000000E+00  -.321572E-07       .000000E+00
      8   .103216E+03       .000000E+00  -.254216E-07       .000000E+00
      9   .103216E+03       .000000E+00  -.153709E-07       .000000E+00
     10   .103216E+03       .000000E+00  -.652458E-08       .000000E+00
     11   .103216E+03       .000000E+00   .000000E+00      -.924920E+04
0  ELEMENT          STRESSES          PL.STRAIN
      1   .924448E+04   .176430E-03   .000000E+00
      2   .924469E+04   .120163E-03   .000000E+00
      3   .924498E+04   .871658E-03   .000000E+00
      4   .924487E+04  -.189781E-03   .000000E+00
      5   .924471E+04   .189781E-03   .000000E+00
      6   .924445E+04  -.120831E-02   .000000E+00
      7   .924411E+04  -.122643E-02   .000000E+00
      8   .924395E+04  -.759125E-03   .000000E+00
      9   .924401E+04  -.721931E-03   .000000E+00
     10   .924412E+04   .324249E-04   .000000E+00
0    ITERATION NUMBER=   10
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .877441E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1   .114684E+03       .000000E+00   .000000E+00       .102766E+05
      2   .114684E+03       .000000E+00  -.108366E-08       .000000E+00
      3   .114684E+03       .000000E+00  -.646953E-08       .000000E+00
      4   .114684E+03       .000000E+00  -.177724E-07       .000000E+00
      5   .114684E+03       .000000E+00  -.267319E-07       .000000E+00
      6   .114684E+03       .000000E+00  -.321484E-07       .000000E+00
      7   .114684E+03       .000000E+00  -.323526E-07       .000000E+00
      8   .114684E+03       .000000E+00  -.255517E-07       .000000E+00
      9   .114684E+03       .000000E+00  -.156089E-07       .000000E+00
     10   .114684E+03       .000000E+00  -.681870E-08       .000000E+00
     11   .114684E+03       .000000E+00   .000000E+00      -.102764E+05
0  ELEMENT          STRESSES          PL.STRAIN
      1   .102717E+05   .219345E-03   .000000E+00
      2   .102719E+05   .153923E-02   .000000E+00
      3   .102721E+05   .105095E-02   .000000E+00
      4   .102720E+05  -.190735E-05   .000000E+00
      5   .102719E+05   .336647E-03   .000000E+00
      6   .102716E+05  -.111008E-02   .000000E+00
      7   .102713E+05   .135422E-03   .000000E+00
      8   .102711E+05  -.683784E-03   .000000E+00
      9   .102712E+05  -.614166E-03   .000000E+00
     10   .102713E+05   .925064E-04   .000000E+00
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0 ITERATION NUMBER= 11
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .797710E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .126153E+03 .000000E+00 .000000E+00 .113037E+05
2 .126153E+03 .000000E+00 -.748009E-09 .000000E+00
3 .126153E+03 .000000E+00 -.588695E-08 .000000E+00
4 .126153E+03 .000000E+00 -.170281E-07 .000000E+00
5 .126153E+03 .000000E+00 -.258914E-07 .000000E+00
6 .126153E+03 .000000E+00 -.313166E-07 .000000E+00
7 .126153E+03 .000000E+00 -.315826E-07 .000000E+00
8 .126153E+03 .000000E+00 -.246263E-07 .000000E+00
9 .126153E+03 .000000E+00 -.146113E-07 .000000E+00
10 .126153E+03 .000000E+00 -.623396E-08 .000000E+00
11 .126153E+03 .000000E+00 .000000E+00 -.113035E+05
0 ELEMENT STRESSES PL.STRAIN
1 .112988E+05 .151634E-03 .000000E+00
2 .112990E+05 .135231E-02 .000000E+00
3 .112993E+05 .781059E-03 .000000E+00
4 .112992E+05 -.325203E-03 .000000E+00
5 .112990E+05 -.381470E-05 .000000E+00
6 .112988E+05 -.143623E-02 .000000E+00
7 .112984E+05 -.150490E-02 .000000E+00
8 .112983E+05 -.107574E-02 .000000E+00
9 .112984E+05 .358582E-03 .000000E+00
10 .112985E+05 -.267029E-04 .000000E+00
0 ITERATION NUMBER= 12
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .731262E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .137621E+03 .000000E+00 .000000E+00 .123309E+05
2 .137621E+03 .000000E+00 -.102279E-08 .000000E+00
3 .137621E+03 .000000E+00 -.638731E-08 .000000E+00
4 .137621E+03 .000000E+00 -.177130E-07 .000000E+00
5 .137621E+03 .000000E+00 -.267759E-07 .000000E+00
6 .137621E+03 .000000E+00 -.323834E-07 .000000E+00
7 .137621E+03 .000000E+00 -.325367E-07 .000000E+00
8 .137621E+03 .000000E+00 -.255131E-07 .000000E+00
9 .137621E+03 .000000E+00 -.152966E-07 .000000E+00
10 .137621E+03 .000000E+00 -.652808E-08 .000000E+00
11 .137621E+03 .000000E+00 .000000E+00 -.123307E+05
0 ELEMENT STRESSES PL.STRAIN
1 .123260E+05 .207901E-03 .000000E+00
2 .123262E+05 .215530E-03 .000000E+00
3 .123265E+05 .102234E-02 .000000E+00
4 .123264E+05 -.572205E-05 .000000E+00
5 .123262E+05 .393867E-03 .000000E+00
6 .123259E+05 -.102520E-02 .000000E+00
7 .123256E+05 .164032E-03 .000000E+00
8 .123254E+05 -.756264E-03 .000000E+00
9 .123255E+05 .557899E-03 .000000E+00
10 .123256E+05 .333786E-04 .000000E+00
0 ITERATION NUMBER= 13
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .675031E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .149090E+03 .000000E+00 .000000E+00 .133580E+05
2 .149090E+03 .000000E+00 -.870586E-09 .000000E+00
3 .149090E+03 .000000E+00 -.611350E-08 .000000E+00
4 .149090E+03 .000000E+00 -.173597E-07 .000000E+00
5 .149090E+03 .000000E+00 -.264013E-07 .000000E+00
6 .149090E+03 .000000E+00 -.320260E-07 .000000E+00
7 .149090E+03 .000000E+00 -.324305E-07 .000000E+00

8 .149090E+03 .000000E+00 -.255469E-07 .000000E+00
9 .149090E+03 .000000E+00 -.153908E-07 .000000E+00
10 .149090E+03 .000000E+00 -.660176E-08 .000000E+00
11 .149090E+03 .000000E+00 .000000E+00 -.133578E+05
0 ELEMENT STRESSES PL.STRAIN
1 .133531E+05 .176430E-03 .000000E+00
2 .133533E+05 .142384E-02 .000000E+00
3 .133536E+05 -.400543E-03 .000000E+00
4 .133535E+05 -.153542E-03 .000000E+00
5 .133533E+05 .244141E-03 .000000E+00
6 .133531E+05 -.111961E-02 .000000E+00
7 .133527E+05 -.114536E-02 .000000E+00
8 .133526E+05 -.730515E-03 .000000E+00
9 .133527E+05 .591278E-03 .000000E+00
10 .133528E+05 .476837E-04 .000000E+00
0 ITERATION NUMBER= 14
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .626836E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .160558E+03 .000000E+00 .000000E+00 .143852E+05
2 .160558E+03 .000000E+00 -.109239E-08 .000000E+00
3 .160558E+03 .000000E+00 -.652875E-08 .000000E+00
4 .160558E+03 .000000E+00 -.179802E-07 .000000E+00
5 .160558E+03 .000000E+00 -.270461E-07 .000000E+00
6 .160558E+03 .000000E+00 -.324290E-07 .000000E+00
7 .160558E+03 .000000E+00 -.324558E-07 .000000E+00
8 .160558E+03 .000000E+00 -.254312E-07 .000000E+00
9 .160558E+03 .000000E+00 -.152614E-07 .000000E+00
10 .160558E+03 .000000E+00 -.667544E-08 .000000E+00
11 .160558E+03 .000000E+00 .000000E+00 -.143850E+05
0 ELEMENT STRESSES PL.STRAIN
1 .143803E+05 .221252E-03 .000000E+00
2 .143805E+05 .258446E-03 .000000E+00
3 .143808E+05 .110435E-02 .000000E+00
4 .143807E+05 -.119114E-02 .000000E+00
5 .143805E+05 -.837326E-03 .000000E+00
6 .143802E+05 -.103283E-02 .000000E+00
7 .143799E+05 .130653E-03 .000000E+00
8 .143797E+05 -.781059E-03 .000000E+00
9 .143798E+05 .580788E-03 .000000E+00
10 .143799E+05 .619888E-04 .000000E+00
0 ITERATION NUMBER= 15
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .585061E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .172027E+03 .000000E+00 .000000E+00 .154124E+05
2 .172027E+03 .000000E+00 -.843453E-09 .000000E+00
3 .172027E+03 .000000E+00 -.608078E-08 .000000E+00
4 .172027E+03 .000000E+00 -.173600E-07 .000000E+00
5 .172027E+03 .000000E+00 -.263798E-07 .000000E+00
6 .172027E+03 .000000E+00 -.318369E-07 .000000E+00
7 .172027E+03 .000000E+00 -.320212E-07 .000000E+00
8 .172027E+03 .000000E+00 -.249905E-07 .000000E+00
9 .172027E+03 .000000E+00 -.149882E-07 .000000E+00
10 .172027E+03 .000000E+00 -.652867E-08 .000000E+00
11 .172027E+03 .000000E+00 .000000E+00 -.154122E+05
0 ELEMENT STRESSES PL.STRAIN
1 .154074E+05 .170708E-03 .000000E+00
2 .154076E+05 .141144E-02 .000000E+00
3 .154079E+05 -.408173E-03 .000000E+00
4 .154078E+05 -.145340E-02 .000000E+00
5 .154077E+05 -.109386E-02 .000000E+00

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      6  .154074E+05  -.124168E-02   .000000E+00
      7  .154071E+05  -.134182E-02   .000000E+00
      8  .154069E+05  -.926971E-03   .000000E+00
      9  .154070E+05   .495911E-03   .000000E+00
     10  .154071E+05   .324249E-04   .000000E+00
0    ITERATION NUMBER=   16
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .548509E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .183495E+03       .000000E+00   .000000E+00       .164395E+05
      2  .183495E+03       .000000E+00  -.129151E-08       .000000E+00
      3  .183495E+03       .000000E+00  -.688677E-08       .000000E+00
      4  .183495E+03       .000000E+00  -.183775E-07       .000000E+00
      5  .183495E+03       .000000E+00  -.273839E-07       .000000E+00
      6  .183495E+03       .000000E+00  -.327344E-07       .000000E+00
      7  .183495E+03       .000000E+00  -.327385E-07       .000000E+00
      8  .183495E+03       .000000E+00  -.255351E-07       .000000E+00
      9  .183495E+03       .000000E+00  -.151622E-07       .000000E+00
     10  .183495E+03       .000000E+00  -.638190E-08       .000000E+00
     11  .183495E+03       .000000E+00   .000000E+00      -.164393E+05
0  ELEMENT          STRESSES          PL.STRAIN
      1  .164346E+05   .262260E-03   .000000E+00
      2  .164348E+05   .371933E-03   .000000E+00
      3  .164351E+05   .125790E-02   .000000E+00
      4  .164350E+05  -.104237E-02   .000000E+00
      5  .164348E+05   .588417E-03   .000000E+00
      6  .164346E+05  -.912666E-03   .000000E+00
      7  .164342E+05   .209808E-03   .000000E+00
      8  .164341E+05  -.781059E-03   .000000E+00
      9  .164341E+05   .500679E-03   .000000E+00
     10  .164342E+05   .286102E-05   .000000E+00
0    ITERATION NUMBER=   17
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .516253E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .194964E+03       .000000E+00   .000000E+00       .174667E+05
      2  .194964E+03       .000000E+00  -.803796E-09       .000000E+00
      3  .194964E+03       .000000E+00  -.604019E-08       .000000E+00
      4  .194964E+03       .000000E+00  -.173108E-07       .000000E+00
      5  .194964E+03       .000000E+00  -.263393E-07       .000000E+00
      6  .194964E+03       .000000E+00  -.317885E-07       .000000E+00
      7  .194963E+03       .000000E+00  -.319773E-07       .000000E+00
      8  .194963E+03       .000000E+00  -.249621E-07       .000000E+00
      9  .194963E+03       .000000E+00  -.150328E-07       .000000E+00
     10  .194963E+03       .000000E+00  -.645558E-08       .000000E+00
     11  .194963E+03       .000000E+00   .000000E+00      -.174665E+05
0  ELEMENT          STRESSES          PL.STRAIN
      1  .174618E+05   .163078E-03   .000000E+00
      2  .174620E+05   .100136E-03   .000000E+00
      3  .174623E+05  -.426292E-03   .000000E+00
      4  .174621E+05  -.147247E-02   .000000E+00
      5  .174620E+05   .183105E-03   .000000E+00
      6  .174617E+05  -.126076E-02   .000000E+00
      7  .174614E+05  -.135612E-02   .000000E+00
      8  .174612E+05  -.923157E-03   .000000E+00
      9  .174613E+05   .490189E-03   .000000E+00
     10  .174614E+05   .171661E-04   .000000E+00
0    ITERATION NUMBER=   18
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .487579E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .206432E+03       .000000E+00   .000000E+00       .184939E+05
      2  .206432E+03       .000000E+00  -.118948E-08       .000000E+00
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      3  .206432E+03      .000000E+00  -.678514E-08      .000000E+00
      4  .206432E+03      .000000E+00  -.183955E-07      .000000E+00
      5  .206432E+03      .000000E+00  -.276516E-07      .000000E+00
      6  .206432E+03      .000000E+00  -.332648E-07      .000000E+00
      7  .206432E+03      .000000E+00  -.335495E-07      .000000E+00
      8  .206432E+03      .000000E+00  -.264024E-07      .000000E+00
      9  .206432E+03      .000000E+00  -.158619E-07      .000000E+00
     10  .206432E+03      .000000E+00  -.697015E-08      .000000E+00
     11  .206432E+03      .000000E+00   .000000E+00     -.184936E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .184889E+05   .242233E-03   .000000E+00
      2  .184891E+05   .329971E-03   .000000E+00
      3  .184894E+05   .124073E-02   .000000E+00
      4  .184893E+05  -.985146E-03   .000000E+00
      5  .184891E+05  -.543594E-03   .000000E+00
      6  .184889E+05  -.639915E-03   .000000E+00
      7  .184885E+05  -.742912E-03   .000000E+00
      8  .184884E+05  -.460625E-03   .000000E+00
      9  .184884E+05   .763893E-03   .000000E+00
     10  .184885E+05   .121117E-03   .000000E+00
0   IINCS=   2  NITER= 100  NOUTP=   2  FACTO=   .200000E+00  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .743641E+00
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .225546E+03      .000000E+00   .000000E+00      .202090E+05
      2  .225546E+03      .000000E+00   .414710E-09      .000000E+00
      3  .225546E+03      .000000E+00  -.659645E-08      .000000E+00
      4  .225546E+03      .000000E+00  -.239561E-07      .000000E+00
      5  .225546E+03      .000000E+00  -.378516E-07      .000000E+00
      6  .225546E+03      .000000E+00  -.466150E-07      .000000E+00
      7  .225546E+03      .000000E+00  -.473447E-07      .000000E+00
      8  .225546E+03      .000000E+00  -.367590E-07      .000000E+00
      9  .225546E+03      .000000E+00  -.214978E-07      .000000E+00
     10  .225546E+03      .000000E+00  -.867546E-08      .000000E+00
     11  .225546E+03      .000000E+00   .000000E+00     -.202088E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .202008E+05  -.839233E-04   .000000E+00
      2  .202011E+05  -.343323E-04   .000000E+00
      3  .202016E+05  -.254631E-03   .000000E+00
      4  .202015E+05  -.295544E-02   .000000E+00
      5  .202012E+05   .166321E-02   .000000E+00
      6  .202008E+05  -.292778E-03   .000000E+00
      7  .202003E+05  -.100422E-02   .000000E+00
      8  .202001E+05  -.238514E-02   .000000E+00
      9  .202002E+05  -.330925E-03   .000000E+00
     10  .202004E+05   .468254E-03   .000000E+00
0   ITERATION NUMBER=   2
0   CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .685563E+00
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .244660E+03      .000000E+00   .000000E+00      .219210E+05
      2  .244660E+03      .000000E+00  -.873477E-09      .000000E+00
      3  .244660E+03      .000000E+00  -.898687E-08      .000000E+00
      4  .244660E+03      .000000E+00  -.271243E-07      .000000E+00
      5  .244660E+03      .000000E+00  -.414850E-07      .000000E+00
      6  .244660E+03      .000000E+00  -.503082E-07      .000000E+00
      7  .244660E+03      .000000E+00  -.509066E-07      .000000E+00
      8  .244660E+03      .000000E+00  -.399942E-07      .000000E+00
      9  .244660E+03      .000000E+00  -.237995E-07      .000000E+00
     10  .244660E+03      .000000E+00  -.996326E-08      .000000E+00
     11  .244660E+03      .000000E+00   .000000E+00     -.219207E+05
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0 ELEMENT STRESSES PL.STRAIN
1 .219128E+05 .179291E-03 .000000E+00
2 .219131E+05 .713348E-03 .000000E+00
3 .219136E+05 .878334E-03 .000000E+00
4 .219134E+05 -.157070E-02 .000000E+00
5 .219132E+05 .566483E-03 .000000E+00
6 .219128E+05 -.140476E-02 .000000E+00
7 .219122E+05 .380516E-03 .000000E+00
8 .219120E+05 -.125790E-02 .000000E+00
9 .219121E+05 .399590E-03 .000000E+00
10 .219123E+05 .729561E-03 .000000E+00
0 ITERATION NUMBER= 3
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .635902E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .263774E+03 .000000E+00 .000000E+00 .236330E+05
2 .263774E+03 .000000E+00 -.166870E-08 .000000E+00
3 .263774E+03 .000000E+00 -.105040E-07 .000000E+00
4 .263774E+03 .000000E+00 -.293152E-07 .000000E+00
5 .263774E+03 .000000E+00 -.443444E-07 .000000E+00
6 .263774E+03 .000000E+00 -.533195E-07 .000000E+00
7 .263774E+03 .000000E+00 -.537613E-07 .000000E+00
8 .263774E+03 .000000E+00 -.421584E-07 .000000E+00
9 .263774E+03 .000000E+00 -.253244E-07 .000000E+00
10 .263774E+03 .000000E+00 -.107985E-07 .000000E+00
11 .263774E+03 .000000E+00 .000000E+00 -.236326E+05
0 ELEMENT STRESSES PL.STRAIN
1 .236248E+05 .341415E-03 .000000E+00
2 .236251E+05 .118446E-02 .000000E+00
3 .236256E+05 .163364E-02 .000000E+00
4 .236254E+05 -.542641E-03 .000000E+00
5 .236251E+05 -.827789E-03 .000000E+00
6 .236247E+05 -.210762E-03 .000000E+00
7 .236241E+05 -.118732E-02 .000000E+00
8 .236239E+05 -.508308E-03 .000000E+00
9 .236240E+05 .880241E-03 .000000E+00
10 .236242E+05 .899315E-03 .000000E+00
0 ITERATION NUMBER= 4
0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .592952E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .282888E+03 .000000E+00 .000000E+00 .253449E+05
2 .282888E+03 .000000E+00 -.151777E-08 .000000E+00
3 .282888E+03 .000000E+00 -.102424E-07 .000000E+00
4 .282888E+03 .000000E+00 -.289695E-07 .000000E+00
5 .282888E+03 .000000E+00 -.438419E-07 .000000E+00
6 .282888E+03 .000000E+00 -.526548E-07 .000000E+00
7 .282888E+03 .000000E+00 -.530005E-07 .000000E+00
8 .282888E+03 .000000E+00 -.413792E-07 .000000E+00
9 .282888E+03 .000000E+00 -.249744E-07 .000000E+00
10 .282888E+03 .000000E+00 -.107636E-07 .000000E+00
11 .282888E+03 .000000E+00 .000000E+00 -.253445E+05
0 ELEMENT STRESSES PL.STRAIN
1 .253367E+05 .310898E-03 .000000E+00
2 .253370E+05 .110054E-02 .000000E+00
3 .253375E+05 .150967E-02 .000000E+00
4 .253373E+05 -.714302E-03 .000000E+00
5 .253370E+05 -.106430E-02 .000000E+00
6 .253366E+05 -.500679E-03 .000000E+00
7 .253360E+05 -.150013E-02 .000000E+00
8 .253358E+05 -.737190E-03 .000000E+00
9 .253359E+05 -.178814E-02 .000000E+00

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      10   .253361E+05   .891685E-03   .000000E+00
0    ITERATION NUMBER=    5
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .555434E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1   .302002E+03       .000000E+00   .000000E+00       .270568E+05
       2   .302002E+03       .000000E+00  -.120299E-08       .000000E+00
       3   .302002E+03       .000000E+00  -.965115E-08       .000000E+00
       4   .302002E+03       .000000E+00  -.282009E-07       .000000E+00
       5   .302002E+03       .000000E+00  -.430769E-07       .000000E+00
       6   .302002E+03       .000000E+00  -.519626E-07       .000000E+00
       7   .302002E+03       .000000E+00  -.525380E-07       .000000E+00
       8   .302002E+03       .000000E+00  -.413706E-07       .000000E+00
       9   .302002E+03       .000000E+00  -.250927E-07       .000000E+00
      10   .302002E+03       .000000E+00  -.107346E-07       .000000E+00
      11   .302002E+03       .000000E+00   .000000E+00      -.270565E+05
0  ELEMENT          STRESSES          PL.STRAIN
       1   .270486E+05   .246048E-03   .000000E+00
       2   .270489E+05   .915527E-03   .000000E+00
       3   .270494E+05   .123310E-02   .000000E+00
       4   .270493E+05  -.102711E-02   .000000E+00
       5   .270490E+05  -.136185E-02   .000000E+00
       6   .270486E+05  -.735283E-03   .000000E+00
       7   .270480E+05  -.159550E-02   .000000E+00
       8   .270478E+05  -.714302E-03   .000000E+00
       9   .270478E+05  -.176907E-02   .000000E+00
      10   .270480E+05   .885963E-03   .000000E+00
0    ITERATION NUMBER=    6
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .522384E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1   .321116E+03       .000000E+00   .000000E+00       .287687E+05
       2   .321116E+03       .000000E+00  -.137860E-08       .000000E+00
       3   .321116E+03       .000000E+00  -.996473E-08       .000000E+00
       4   .321116E+03       .000000E+00  -.286545E-07       .000000E+00
       5   .321116E+03       .000000E+00  -.435306E-07       .000000E+00
       6   .321116E+03       .000000E+00  -.522802E-07       .000000E+00
       7   .321116E+03       .000000E+00  -.524779E-07       .000000E+00
       8   .321116E+03       .000000E+00  -.405850E-07       .000000E+00
       9   .321116E+03       .000000E+00  -.240498E-07       .000000E+00
      10   .321116E+03       .000000E+00  -.102705E-07       .000000E+00
      11   .321116E+03       .000000E+00   .000000E+00      -.287684E+05
0  ELEMENT          STRESSES          PL.STRAIN
       1   .287605E+05   .282288E-03   .000000E+00
       2   .287609E+05   .101471E-02   .000000E+00
       3   .287614E+05   .138950E-02   .000000E+00
       4   .287612E+05  -.842094E-03   .000000E+00
       5   .287609E+05  -.120544E-02   .000000E+00
       6   .287605E+05  -.681877E-03   .000000E+00
       7   .287599E+05  -.176716E-02   .000000E+00
       8   .287597E+05  -.108624E-02   .000000E+00
       9   .287598E+05   .514030E-03   .000000E+00
      10   .287600E+05   .790596E-03   .000000E+00
0    ITERATION NUMBER=    7
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .493045E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1   .340230E+03       .000000E+00   .000000E+00       .304807E+05
       2   .340230E+03       .000000E+00  -.128259E-08       .000000E+00
       3   .340230E+03       .000000E+00  -.977270E-08       .000000E+00
       4   .340230E+03       .000000E+00  -.283333E-07       .000000E+00
       5   .340230E+03       .000000E+00  -.430625E-07       .000000E+00
       6   .340230E+03       .000000E+00  -.519967E-07       .000000E+00
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      7  .340230E+03      .000000E+00  -.522505E-07      .000000E+00
      8  .340230E+03      .000000E+00  -.405764E-07      .000000E+00
      9  .340230E+03      .000000E+00  -.241681E-07      .000000E+00
     10  .340230E+03      .000000E+00  -.102414E-07      .000000E+00
     11  .340230E+03      .000000E+00   .000000E+00      -.304804E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .304725E+05   .263214E-03   .000000E+00
      2  .304728E+05   .955582E-03   .000000E+00
      3  .304733E+05   .128460E-02   .000000E+00
      4  .304731E+05  -.100231E-02   .000000E+00
      5  .304728E+05  -.135803E-02   .000000E+00
      6  .304724E+05  -.784874E-03   .000000E+00
      7  .304718E+05  -.181484E-02   .000000E+00
      8  .304716E+05  -.106335E-02   .000000E+00
      9  .304717E+05   .533104E-03   .000000E+00
     10  .304719E+05   .784874E-03   .000000E+00
0    IINCS=   3  NITER=  100  NOUTP=   2  FACTO=   .100000E+00  TOLER=   .500000E+00
0    ITERATION NUMBER=   1
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .554298E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .363167E+03      .000000E+00   .000000E+00      .325366E+05
      2  .363167E+03      .000000E+00  -.720775E-09      .000000E+00
      3  .363167E+03      .000000E+00  -.101769E-07      .000000E+00
      4  .363167E+03      .000000E+00  -.318791E-07      .000000E+00
      5  .363167E+03      .000000E+00  -.492414E-07      .000000E+00
      6  .363167E+03      .000000E+00  -.598670E-07      .000000E+00
      7  .363167E+03      .000000E+00  -.604107E-07      .000000E+00
      8  .363167E+03      .000000E+00  -.470656E-07      .000000E+00
      9  .363167E+03      .000000E+00  -.280815E-07      .000000E+00
     10  .363167E+03      .000000E+00  -.121173E-07      .000000E+00
     11  .363167E+03      .000000E+00   .000000E+00      -.325363E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .325268E+05   .148773E-03   .000000E+00
      2  .325272E+05   .923157E-03   .000000E+00
      3  .325278E+05   .208759E-02   .000000E+00
      4  .325276E+05  -.161266E-02   .000000E+00
      5  .325272E+05  -.108719E-02   .000000E+00
      6  .325268E+05  -.109673E-03   .000000E+00
      7  .325261E+05  -.142193E-02   .000000E+00
      8  .325258E+05  -.153446E-02   .000000E+00
      9  .325260E+05  -.876427E-03   .000000E+00
     10  .325261E+05  -.142193E-02   .000000E+00
0    ITERATION NUMBER=   2
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .521346E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .386104E+03      .000000E+00   .000000E+00      .345910E+05
      2  .386104E+03      .000000E+00  -.186528E-08      .000000E+00
      3  .386104E+03      .000000E+00  -.124583E-07      .000000E+00
      4  .386104E+03      .000000E+00  -.352364E-07      .000000E+00
      5  .386104E+03      .000000E+00  -.535010E-07      .000000E+00
      6  .386104E+03      .000000E+00  -.647613E-07      .000000E+00
      7  .386104E+03      .000000E+00  -.657545E-07      .000000E+00
      8  .386104E+03      .000000E+00  -.522020E-07      .000000E+00
      9  .386104E+03      .000000E+00  -.320235E-07      .000000E+00
     10  .386104E+03      .000000E+00  -.140107E-07      .000000E+00
     11  .386104E+03      .000000E+00   .000000E+00      -.345905E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .345811E+05   .383377E-03   .000000E+00
      2  .345816E+05   .161934E-02   .000000E+00
      3  .345821E+05   .323391E-02   .000000E+00
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      4  .345819E+05  -.619888E-04   .000000E+00
      5  .345816E+05  -.181198E-02   .000000E+00
      6  .345811E+05  -.615120E-03   .000000E+00
      7  .345804E+05  -.187778E-02   .000000E+00
      8  .345801E+05  -.227642E-02   .000000E+00
      9  .345802E+05   .311852E-03   .000000E+00
     10  .345804E+05   .155354E-02   .000000E+00
0    ITERATION NUMBER=    3
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .492121E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .409041E+03       .000000E+00   .000000E+00       .366453E+05
      2  .409041E+03       .000000E+00  -.221239E-08       .000000E+00
      3  .409041E+03       .000000E+00  -.130926E-07       .000000E+00
      4  .409041E+03       .000000E+00  -.359375E-07       .000000E+00
      5  .409041E+03       .000000E+00  -.542992E-07       .000000E+00
      6  .409041E+03       .000000E+00  -.655587E-07       .000000E+00
      7  .409041E+03       .000000E+00  -.660397E-07       .000000E+00
      8  .409041E+03       .000000E+00  -.519210E-07       .000000E+00
      9  .409041E+03       .000000E+00  -.311476E-07       .000000E+00
     10  .409041E+03       .000000E+00  -.132646E-07       .000000E+00
     11  .409041E+03       .000000E+00   .000000E+00      -.366449E+05
0 ELEMENT           STRESSES           PL.STRAIN
      1  .366355E+05   .453949E-03   .000000E+00
      2  .366359E+05   .181961E-02   .000000E+00
      3  .366365E+05   .916481E-03   .000000E+00
      4  .366362E+05   .243187E-03   .000000E+00
      5  .366359E+05   .110245E-02   .000000E+00
      6  .366354E+05  -.298405E-02   .000000E+00
      7  .366347E+05  -.187588E-02   .000000E+00
      8  .366344E+05  -.251102E-02   .000000E+00
      9  .366345E+05  -.181198E-04   .000000E+00
     10  .366347E+05   .140095E-02   .000000E+00
0    IINCS=   4  NITER= 100  NOUTP=   2  FACTO=   .100000E+00  TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .538871E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .435801E+03       .000000E+00   .000000E+00       .390436E+05
      2  .435801E+03       .000000E+00  -.184406E-08       .000000E+00
      3  .435801E+03       .000000E+00  -.137758E-07       .000000E+00
      4  .435801E+03       .000000E+00  -.397242E-07       .000000E+00
      5  .435801E+03       .000000E+00  -.602523E-07       .000000E+00
      6  .435801E+03       .000000E+00  -.725305E-07       .000000E+00
      7  .435801E+03       .000000E+00  -.728637E-07       .000000E+00
      8  .435801E+03       .000000E+00  -.562906E-07       .000000E+00
      9  .435801E+03       .000000E+00  -.333569E-07       .000000E+00
     10  .435801E+03       .000000E+00  -.139941E-07       .000000E+00
     11  .435801E+03       .000000E+00   .000000E+00      -.390432E+05
0 ELEMENT           STRESSES           PL.STRAIN
      1  .390322E+05   .377655E-03   .000000E+00
      2  .390326E+05   .447273E-02   .000000E+00
      3  .390333E+05   .182629E-02   .000000E+00
      4  .390331E+05  -.295353E-02   .000000E+00
      5  .390327E+05   .114441E-02   .000000E+00
      6  .390321E+05  -.174522E-03   .000000E+00
      7  .390313E+05  -.218678E-02   .000000E+00
      8  .390310E+05  -.117016E-02   .000000E+00
      9  .390311E+05   .578880E-03   .000000E+00
     10  .390314E+05   .154972E-02   .000000E+00
0    ITERATION NUMBER=    2
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .507706E+00
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0 NODE DISPL. REACTION DISPL. REACTION
1 .462561E+03 .000000E+00 .000000E+00 .414404E+05
2 .462561E+03 .000000E+00 -.236147E-08 .000000E+00
3 .462561E+03 .000000E+00 -.148060E-07 .000000E+00
4 .462561E+03 .000000E+00 -.411989E-07 .000000E+00
5 .462560E+03 .000000E+00 -.621335E-07 .000000E+00
6 .462560E+03 .000000E+00 -.745650E-07 .000000E+00
7 .462560E+03 .000000E+00 -.754744E-07 .000000E+00
8 .462560E+03 .000000E+00 -.591813E-07 .000000E+00
9 .462560E+03 .000000E+00 -.354065E-07 .000000E+00
10 .462560E+03 .000000E+00 -.151646E-07 .000000E+00
11 .462560E+03 .000000E+00 .000000E+00 -.414399E+05
0 ELEMENT STRESSES PL.STRAIN
1 .414289E+05 .482559E-03 .000000E+00
2 .414294E+05 .219727E-02 .000000E+00
3 .414300E+05 .233555E-02 .000000E+00
4 .414298E+05 -.227070E-02 .000000E+00
5 .414294E+05 -.648499E-03 .000000E+00
6 .414288E+05 .771523E-03 .000000E+00
7 .414280E+05 -.106716E-02 .000000E+00
8 .414276E+05 -.275326E-02 .000000E+00
9 .414278E+05 .123310E-02 .000000E+00
10 .414280E+05 .178814E-02 .000000E+00
0 ITERATION NUMBER= 3
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .479972E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .489320E+03 .000000E+00 .000000E+00 .438371E+05
2 .489320E+03 .000000E+00 -.250487E-08 .000000E+00
3 .489320E+03 .000000E+00 -.149612E-07 .000000E+00
4 .489320E+03 .000000E+00 -.413326E-07 .000000E+00
5 .489320E+03 .000000E+00 -.624962E-07 .000000E+00
6 .489320E+03 .000000E+00 -.754608E-07 .000000E+00
7 .489320E+03 .000000E+00 -.758183E-07 .000000E+00
8 .489320E+03 .000000E+00 -.594756E-07 .000000E+00
9 .489320E+03 .000000E+00 -.355565E-07 .000000E+00
10 .489320E+03 .000000E+00 -.154533E-07 .000000E+00
11 .489320E+03 .000000E+00 .000000E+00 -.438366E+05
0 ELEMENT STRESSES PL.STRAIN
1 .438256E+05 .511169E-03 .000000E+00
2 .438261E+05 .225830E-02 .000000E+00
3 .438268E+05 .239468E-02 .000000E+00
4 .438265E+05 .420570E-03 .000000E+00
5 .438261E+05 -.392914E-03 .000000E+00
6 .438255E+05 -.415516E-02 .000000E+00
7 .438247E+05 -.937462E-03 .000000E+00
8 .438243E+05 -.266361E-02 .000000E+00
9 .438245E+05 .132275E-02 .000000E+00
10 .438247E+05 -.742912E-03 .000000E+00
0 IINCS= 5 NITER= 100 NOUTP= 2 FACTO= .500000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .485765E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .517991E+03 .000000E+00 .000000E+00 .464057E+05
2 .517991E+03 .000000E+00 -.150016E-08 .000000E+00
3 .517991E+03 .000000E+00 -.138032E-07 .000000E+00
4 .517991E+03 .000000E+00 -.412807E-07 .000000E+00
5 .517991E+03 .000000E+00 -.634064E-07 .000000E+00
6 .517991E+03 .000000E+00 -.767419E-07 .000000E+00
7 .517991E+03 .000000E+00 -.770674E-07 .000000E+00
8 .517991E+03 .000000E+00 -.599900E-07 .000000E+00

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      9  .517991E+03      .000000E+00  -.358032E-07      .000000E+00
     10  .517991E+03      .000000E+00  -.151864E-07      .000000E+00
     11  .517991E+03      .000000E+00   .000000E+00      -.464053E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .463935E+05  -.228119E-02   .000000E+00
      2  .463940E+05   .181770E-02   .000000E+00
      3  .463947E+05   .214863E-02   .000000E+00
      4  .463944E+05  -.199413E-02   .000000E+00
      5  .463940E+05   .534058E-04   .000000E+00
      6  .463934E+05  -.364017E-02   .000000E+00
      7  .463926E+05  -.578880E-03   .000000E+00
      8  .463922E+05  -.250912E-02   .000000E+00
      9  .463924E+05  -.127125E-02   .000000E+00
     10  .463926E+05  -.796318E-03   .000000E+00
0   IINCS=   6  NITER= 100  NOUTP=   2  FACTO=   .500000E-01  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .489264E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .548574E+03      .000000E+00   .000000E+00      .491457E+05
      2  .548574E+03      .000000E+00  -.173059E-08      .000000E+00
      3  .548574E+03      .000000E+00  -.149329E-07      .000000E+00
      4  .548574E+03      .000000E+00  -.442178E-07      .000000E+00
      5  .548574E+03      .000000E+00  -.677652E-07      .000000E+00
      6  .548574E+03      .000000E+00  -.818085E-07      .000000E+00
      7  .548574E+03      .000000E+00  -.822712E-07      .000000E+00
      8  .548574E+03      .000000E+00  -.643538E-07      .000000E+00
      9  .548574E+03      .000000E+00  -.384332E-07      .000000E+00
     10  .548574E+03      .000000E+00  -.165508E-07      .000000E+00
     11  .548574E+03      .000000E+00   .000000E+00      -.491452E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .491326E+05  -.223351E-02   .000000E+00
      2  .491331E+05   .209427E-02   .000000E+00
      3  .491339E+05   .386238E-03   .000000E+00
      4  .491336E+05  -.508308E-03   .000000E+00
      5  .491331E+05  -.617981E-03   .000000E+00
      6  .491325E+05   .104046E-02   .000000E+00
      7  .491316E+05   .136852E-02   .000000E+00
      8  .491312E+05  -.108433E-02   .000000E+00
      9  .491314E+05  -.456810E-03   .000000E+00
     10  .491317E+05  -.519753E-03   .000000E+00
0   IINCS=   7  NITER= 100  NOUTP=   2  FACTO=   .500000E-01  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .490776E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .581068E+03      .000000E+00   .000000E+00      .520568E+05
      2  .581068E+03      .000000E+00  -.248667E-08      .000000E+00
      3  .581068E+03      .000000E+00  -.170415E-07      .000000E+00
      4  .581068E+03      .000000E+00  -.484671E-07      .000000E+00
      5  .581068E+03      .000000E+00  -.733522E-07      .000000E+00
      6  .581068E+03      .000000E+00  -.879133E-07      .000000E+00
      7  .581068E+03      .000000E+00  -.876518E-07      .000000E+00
      8  .581068E+03      .000000E+00  -.682234E-07      .000000E+00
      9  .581068E+03      .000000E+00  -.405830E-07      .000000E+00
     10  .581068E+03      .000000E+00  -.173186E-07      .000000E+00
     11  .581068E+03      .000000E+00   .000000E+00      -.520563E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .520429E+05  -.207901E-02   .000000E+00
      2  .520435E+05   .267792E-02   .000000E+00
      3  .520443E+05   .168133E-02   .000000E+00
      4  .520440E+05   .149441E-02   .000000E+00
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      5  .520435E+05  .176239E-02  .000000E+00
      6  .520427E+05 -.179958E-02  .000000E+00
      7  .520418E+05  .325108E-02  .000000E+00
      8  .520414E+05  .142097E-03  .000000E+00
      9  .520416E+05  .136375E-03  .000000E+00
     10  .520419E+05 -.365257E-03  .000000E+00
0   IINCS=  8  NITER= 100  NOUTP=  2  FACTO=  .500000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .490591E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .615473E+03       .000000E+00  .000000E+00       .551391E+05
      2  .615473E+03       .000000E+00 -.200487E-08       .000000E+00
      3  .615473E+03       .000000E+00 -.169635E-07       .000000E+00
      4  .615473E+03       .000000E+00 -.503131E-07       .000000E+00
      5  .615473E+03       .000000E+00 -.767383E-07       .000000E+00
      6  .615473E+03       .000000E+00 -.926479E-07       .000000E+00
      7  .615473E+03       .000000E+00 -.930759E-07       .000000E+00
      8  .615473E+03       .000000E+00 -.728622E-07       .000000E+00
      9  .615473E+03       .000000E+00 -.433170E-07       .000000E+00
     10  .615473E+03       .000000E+00 -.183835E-07       .000000E+00
     11  .615473E+03       .000000E+00  .000000E+00      -.551386E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .551243E+05 -.217628E-02  .000000E+00
      2  .551250E+05  .256538E-02  .000000E+00
      3  .551258E+05  .204182E-02  .000000E+00
      4  .551255E+05 -.261974E-02  .000000E+00
      5  .551250E+05 -.176239E-02  .000000E+00
      6  .551243E+05  .267982E-03  .000000E+00
      7  .551233E+05  .121117E-03  .000000E+00
      8  .551228E+05 -.353527E-02  .000000E+00
      9  .551230E+05  .908852E-03  .000000E+00
     10  .551233E+05 -.149727E-03  .000000E+00
0   IINCS=  9  NITER= 100  NOUTP=  2  FACTO=  .200000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .474386E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .650643E+03       .000000E+00  .000000E+00       .582894E+05
      2  .650643E+03       .000000E+00 -.257591E-08       .000000E+00
      3  .650643E+03       .000000E+00 -.182812E-07       .000000E+00
      4  .650643E+03       .000000E+00 -.525195E-07       .000000E+00
      5  .650643E+03       .000000E+00 -.797100E-07       .000000E+00
      6  .650643E+03       .000000E+00 -.962541E-07       .000000E+00
      7  .650643E+03       .000000E+00 -.967163E-07       .000000E+00
      8  .650643E+03       .000000E+00 -.757692E-07       .000000E+00
      9  .650643E+03       .000000E+00 -.451718E-07       .000000E+00
     10  .650643E+03       .000000E+00 -.194118E-07       .000000E+00
     11  .650643E+03       .000000E+00  .000000E+00      -.582888E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .582743E+05 -.205994E-02  .000000E+00
      2  .582750E+05  .294876E-02  .000000E+00
      3  .582758E+05  .275898E-02  .000000E+00
      4  .582755E+05 -.156498E-02  .000000E+00
      5  .582750E+05 -.423431E-03  .000000E+00
      6  .582742E+05 -.343609E-02  .000000E+00
      7  .582732E+05  .145435E-02  .000000E+00
      8  .582727E+05 -.256634E-02  .000000E+00
      9  .582729E+05  .149632E-02  .000000E+00
     10  .582733E+05  .600815E-04  .000000E+00
0   IINCS= 10  NITER= 100  NOUTP=  2  FACTO=  .200000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
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0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .459337E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .686577E+03 .000000E+00 .000000E+00 .615082E+05
2 .686577E+03 .000000E+00 -.344739E-08 .000000E+00
3 .686577E+03 .000000E+00 -.203069E-07 .000000E+00
4 .686577E+03 .000000E+00 -.562686E-07 .000000E+00
5 .686577E+03 .000000E+00 -.849193E-07 .000000E+00
6 .686577E+03 .000000E+00 -.101814E-06 .000000E+00
7 .686577E+03 .000000E+00 -.102213E-06 .000000E+00
8 .686577E+03 .000000E+00 -.800679E-07 .000000E+00
9 .686577E+03 .000000E+00 -.478181E-07 .000000E+00
10 .686577E+03 .000000E+00 -.203801E-07 .000000E+00
11 .686577E+03 .000000E+00 .000000E+00 -.615075E+05
0 ELEMENT STRESSES PL.STRAIN
1 .614928E+05 .329971E-02 .000000E+00
2 .614934E+05 -.164032E-02 .000000E+00
3 .614944E+05 .393391E-02 .000000E+00
4 .614940E+05 -.491810E-02 .000000E+00
5 .614934E+05 -.341034E-02 .000000E+00
6 .614926E+05 -.118542E-02 .000000E+00
7 .614916E+05 -.173092E-02 .000000E+00
8 .614911E+05 -.115108E-02 .000000E+00
9 .614913E+05 .223255E-02 .000000E+00
10 .614916E+05 .543499E-02 .000000E+00
0 IINCS= 11 NITER= 100 NOUTP= 2 FACTO= .200000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .445344E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .723276E+03 .000000E+00 .000000E+00 .647954E+05
2 .723276E+03 .000000E+00 -.289005E-08 .000000E+00
3 .723276E+03 .000000E+00 -.195615E-07 .000000E+00
4 .723276E+03 .000000E+00 -.557359E-07 .000000E+00
5 .723276E+03 .000000E+00 -.843223E-07 .000000E+00
6 .723276E+03 .000000E+00 -.102013E-06 .000000E+00
7 .723276E+03 .000000E+00 -.103419E-06 .000000E+00
8 .723276E+03 .000000E+00 -.819256E-07 .000000E+00
9 .723276E+03 .000000E+00 -.496119E-07 .000000E+00
10 .723276E+03 .000000E+00 -.213003E-07 .000000E+00
11 .723276E+03 .000000E+00 .000000E+00 -.647947E+05
0 ELEMENT STRESSES PL.STRAIN
1 .647797E+05 .318909E-02 .000000E+00
2 .647803E+05 .327301E-02 .000000E+00
3 .647813E+05 .367451E-02 .000000E+00
4 .647809E+05 -.515079E-02 .000000E+00
5 .647804E+05 .168610E-02 .000000E+00
6 .647796E+05 -.899315E-03 .000000E+00
7 .647785E+05 -.110912E-02 .000000E+00
8 .647780E+05 -.558758E-02 .000000E+00
9 .647782E+05 -.239086E-02 .000000E+00
10 .647785E+05 .445366E-03 .000000E+00
0 IINCS= 12 NITER= 100 NOUTP= 2 FACTO= .200000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .432205E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .760740E+03 .000000E+00 .000000E+00 .681511E+05
2 .760740E+03 .000000E+00 -.271328E-08 .000000E+00
3 .760740E+03 .000000E+00 -.195176E-07 .000000E+00
4 .760740E+03 .000000E+00 -.561930E-07 .000000E+00
5 .760740E+03 .000000E+00 -.855829E-07 .000000E+00
6 .760740E+03 .000000E+00 -.103643E-06 .000000E+00

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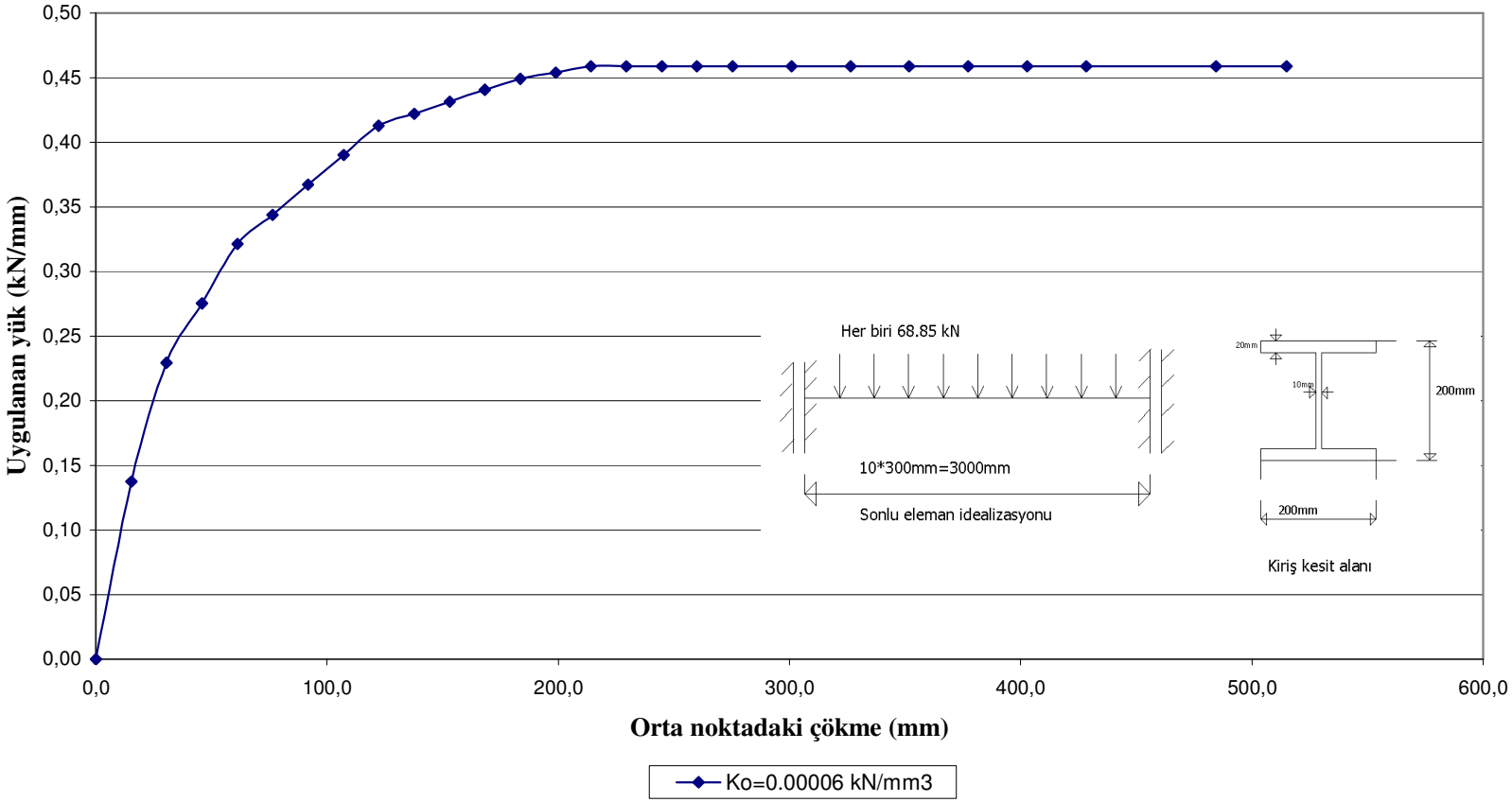
      7  .760740E+03      .000000E+00  -.105568E-06      .000000E+00
      8  .760740E+03      .000000E+00  -.841470E-07      .000000E+00
      9  .760740E+03      .000000E+00  -.513446E-07      .000000E+00
     10  .760740E+03      .000000E+00  -.221722E-07      .000000E+00
     11  .760740E+03      .000000E+00   .000000E+00      -.681504E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .681351E+05  -.202560E-02   .000000E+00
      2  .681357E+05   .322723E-02   .000000E+00
      3  .681367E+05   .375843E-02   .000000E+00
      4  .681363E+05   .376701E-03   .000000E+00
      5  .681358E+05  -.290298E-02   .000000E+00
      6  .681350E+05  -.128746E-03   .000000E+00
      7  .681339E+05  -.539684E-02   .000000E+00
      8  .681334E+05  -.478268E-02   .000000E+00
      9  .681335E+05  -.186062E-02   .000000E+00
     10  .681339E+05   .620842E-03   .000000E+00
0   IINCS=  13  NITER=  100  NOUTP=   2  FACTO=   .100000E-01  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .415953E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .798586E+03      .000000E+00   .000000E+00      .715409E+05
      2  .798586E+03      .000000E+00  -.324405E-08      .000000E+00
      3  .798586E+03      .000000E+00  -.206627E-07      .000000E+00
      4  .798586E+03      .000000E+00  -.582902E-07      .000000E+00
      5  .798586E+03      .000000E+00  -.882569E-07      .000000E+00
      6  .798586E+03      .000000E+00  -.106655E-06      .000000E+00
      7  .798586E+03      .000000E+00  -.107932E-06      .000000E+00
      8  .798586E+03      .000000E+00  -.850141E-07      .000000E+00
      9  .798586E+03      .000000E+00  -.514347E-07      .000000E+00
     10  .798586E+03      .000000E+00  -.225792E-07      .000000E+00
     11  .798586E+03      .000000E+00   .000000E+00      -.715402E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .715247E+05   .326157E-02   .000000E+00
      2  .715254E+05   .357056E-02   .000000E+00
      3  .715264E+05   .441837E-02   .000000E+00
      4  .715260E+05  -.383091E-02   .000000E+00
      5  .715254E+05  -.174332E-02   .000000E+00
      6  .715246E+05  -.421429E-02   .000000E+00
      7  .715234E+05  -.474072E-02   .000000E+00
      8  .715229E+05  -.458813E-02   .000000E+00
      9  .715232E+05   .342274E-02   .000000E+00
     10  .715235E+05   .704765E-03   .000000E+00
0   IINCS=  14  NITER=  100  NOUTP=   2  FACTO=   .100000E-01  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .400966E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .836814E+03      .000000E+00   .000000E+00      .749650E+05
      2  .836814E+03      .000000E+00  -.402446E-08      .000000E+00
      3  .836814E+03      .000000E+00  -.224762E-07      .000000E+00
      4  .836814E+03      .000000E+00  -.610799E-07      .000000E+00
      5  .836814E+03      .000000E+00  -.913456E-07      .000000E+00
      6  .836814E+03      .000000E+00  -.109725E-06      .000000E+00
      7  .836814E+03      .000000E+00  -.110184E-06      .000000E+00
      8  .836814E+03      .000000E+00  -.864822E-07      .000000E+00
      9  .836814E+03      .000000E+00  -.525237E-07      .000000E+00
     10  .836814E+03      .000000E+00  -.225094E-07      .000000E+00
     11  .836814E+03      .000000E+00   .000000E+00      -.749643E+05
0 ELEMENT          STRESSES          PL.STRAIN
      1  .749486E+05   .342178E-02   .000000E+00
      2  .749493E+05   .409698E-02   .000000E+00
```

3	.749503E+05	.176430E-03	.000000E+00
4	.749499E+05	-.263309E-02	.000000E+00
5	.749493E+05	-.488281E-03	.000000E+00
6	.749484E+05	-.313091E-02	.000000E+00
7	.749473E+05	.119495E-02	.000000E+00
8	.749468E+05	.111103E-02	.000000E+00
9	.749470E+05	-.154781E-02	.000000E+00
10	.749473E+05	.689507E-03	.000000E+00

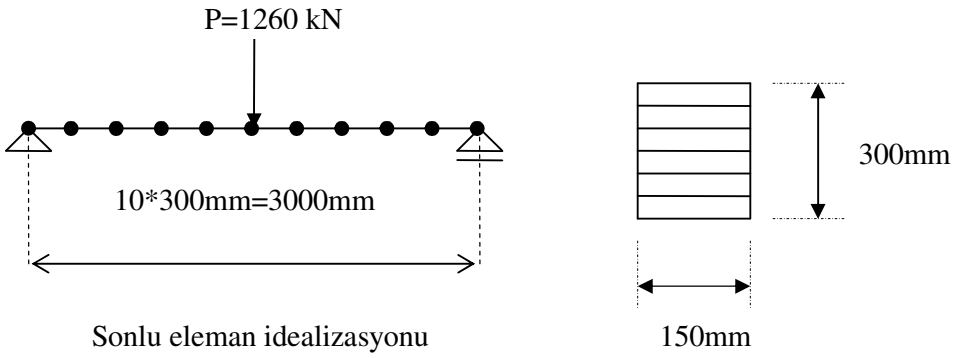


Şekil 5.8: Elastik zemine oturan uniform yayılı yüklü tabakasız Timoshenko kirişi örneği

5.2 Tabakalı Elastoplastik Timoshenko Kiriş Örnekleri

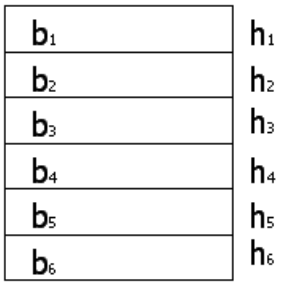
Tabakalı kiriş örneklerinde elastik zemin durumu ve kayma şekil değiştirmelerini içeren sistem rijitlik matrisi kullanılmamıştır.

5.2.1 Tekil yüklü tabakalı Timoshenko kirişi örneği



Şekil 5.9: Tabakalı Timoshenko kirişinde sabit tekil yük hali

Tabakasız kiriş örneklerindeki kiriş kesitin 6 tabakaya bölünerek hesap yapıldığı bu durumda, kiriş katmanları en üstteki tabakadan aşağıya doğru numaralandırılır.



Şekil 5.10: Tabakalı kirişte tabakalara ait boyutların simgesel gösterimi

Kirişin malzeme özellikleri;

E (Elastisite modülü)=210 kN/mm^2

ν (Poisson oranı) = 0.3

σ_0 (Akma gerilmesi) = 0.25 kN/mm^2

H^I (Pekleşme parametresi) = 0.0

Kirişin kesit özellikleri;

$b_1=b_2=b_3=b_4=b_5=b_6$= 150mm

$h_1=h_2=h_3=h_4=h_5=h_6$= 50mm

l=3000mm

Probleme ait bilgilerin programa giriş listesi;

Burada girilen verilerin açıklaması yapıldığı için formatlı girişteki düzen gözükmemektedir. Açıklamaların hemen altına formatlı veri giriş biçimi ilave edilmiştir.

11 10 2 1 **17**(NPROP) 2 14 2 2 **6**(Tabaka sayısı)

1

210. (E) **53.846** (G/1.5) **0.25** (σ_0) **0.** (H^1)

300.(h) 150.(b_1) 50.(h_1) 150.(b_2)

50.(h_2) 150.(b_3) 50.(h_3) 150.(b_4)

50.(h_4) 150.(b_5) 50.(h_5) 150.(b_6)

50.(h_6)

Diğer veriler Örnek 5.1.1'deki gibidir.

Veri girişi sonrası alınan sonuçlar;

NPOIN= 11 NELEM= 10 NBOUN= 2 NMATS= 1

NPROP= 17 NNODE= 2 NINCS= 14 NALGO= 2

NDOFN= 2 NLAYR= 6

```
0     MATERIAL PROPERTIES
        1
      210.00000       53.84600         .25000         .00000
      300.00000      150.00000       50.00000      150.00000
       50.00000      150.00000       50.00000      150.00000
       50.00000      150.00000       50.00000      150.00000
       50.00000
0   EL NODES MAT.
    1    1    2    1
    2    2    3    1
    3    3    4    1
    4    4    5    1
    5    5    6    1
    6    6    7    1
    7    7    8    1
    8    8    9    1
    9    9   10    1
   10   10   11    1
0     NODE     COORD.
        1         .00000
        2      300.00000
        3      600.00000
        4      900.00000
        5     1200.00000
        6     1500.00000
        7     1800.00000
        8     2100.00000
        9     2400.00000
       10     2700.00000
       11     3000.00000
0 RES.NODE  CODE   PRES.VALUES  CODE   PRES.VALUES
        1    1         .00000    0         .00000
       11    1         .00000    0         .00000
0  ELEMENT          NODAL LOADS
        1         .00000         .00000         .00000         .00000
        2         .00000         .00000         .00000         .00000
        3         .00000         .00000         .00000         .00000
        4         .00000         .00000         .00000         .00000
        5         .00000         .00000         .00000         .00000
        6      1260.00000         .00000         .00000         .00000
        7         .00000         .00000         .00000         .00000
        8         .00000         .00000         .00000         .00000
        9         .00000         .00000         .00000         .00000
       10         .00000         .00000         .00000         .00000
0     IINCS=    1   NITER=  100   NOUTP=    2   FACTO=   .300000E+00   TOLER=   .500000E+00
0     ITERATION NUMBER=    1
0     CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .368134E+01
0     NODE    DISPL.           REACTION        DISPL.           REACTION
        1   .000000E+00       -.189001E+03   .308648E-02       .000000E+00
        2   .930828E+00        .000000E+00   .296301E-02       .000000E+00
        3   .178758E+01        .000000E+00   .259262E-02       .000000E+00
        4   .249617E+01        .000000E+00   .197531E-02       .000000E+00
        5   .298253E+01        .000000E+00   .111109E-02       .000000E+00
        6   .317260E+01        .000000E+00  -.280374E-08       .000000E+00
        7   .298253E+01        .000000E+00  -.111110E-02       .000000E+00
        8   .249617E+01        .000000E+00  -.197531E-02       .000000E+00
        9   .178758E+01        .000000E+00  -.259262E-02       .000000E+00
       10   .930827E+00        .000000E+00  -.296301E-02       .000000E+00
       11   .000000E+00       -.189000E+03  -.308648E-02       .000000E+00
0  ELEMENT            STRESSES            PL.STRAIN
```

```
      1  .283585E+05  .189031E+03  .000000E+00
      2  .850746E+05  .189028E+03  .000000E+00
      3  .141789E+06  .189022E+03  .000000E+00
      4  .198499E+06  .189017E+03  .000000E+00
      5  .255205E+06  .189005E+03  .000000E+00
      6  .255205E+06 -.189006E+03  .000000E+00
      7  .198499E+06 -.189014E+03  .000000E+00
      8  .141788E+06 -.189022E+03  .000000E+00
      9  .850743E+05 -.189027E+03  .000000E+00
     10  .283583E+05 -.189030E+03  .000000E+00
0   ITERATION NUMBER=   2
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .114459E-01
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.189000E+03  .308571E-02       .000000E+00
      2  .930600E+00       .000000E+00  .296229E-02       .000000E+00
      3  .178714E+01       .000000E+00  .259200E-02       .000000E+00
      4  .249557E+01       .000000E+00  .197486E-02       .000000E+00
      5  .298183E+01       .000000E+00  .111086E-02       .000000E+00
      6  .317186E+01       .000000E+00 -.376121E-11       .000000E+00
      7  .298183E+01       .000000E+00 -.111086E-02       .000000E+00
      8  .249557E+01       .000000E+00 -.197486E-02       .000000E+00
      9  .178714E+01       .000000E+00 -.259200E-02       .000000E+00
     10  .930600E+00       .000000E+00 -.296229E-02       .000000E+00
     11  .000000E+00      -.189000E+03 -.308571E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .283500E+05  .189000E+03  .000000E+00
      2  .850500E+05  .189000E+03  .000000E+00
      3  .141750E+06  .189000E+03  .000000E+00
      4  .198450E+06  .189000E+03  .000000E+00
      5  .255150E+06  .189000E+03  .000000E+00
      6  .255150E+06 -.189000E+03  .000000E+00
      7  .198450E+06 -.189000E+03  .000000E+00
      8  .141750E+06 -.189000E+03  .000000E+00
      9  .850500E+05 -.189000E+03  .000000E+00
     10  .283500E+05 -.189000E+03  .000000E+00
0   IINCS=   2  NITER=  100  NOUTP=   2  FACTO=   .200000E+00  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .143241E+01
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.315001E+03  .514337E-02       .000000E+00
      2  .155115E+01       .000000E+00  .493763E-02       .000000E+00
      3  .297886E+01       .000000E+00  .432041E-02       .000000E+00
      4  .415969E+01       .000000E+00  .329173E-02       .000000E+00
      5  .497018E+01       .000000E+00  .185159E-02       .000000E+00
      6  .528692E+01       .000000E+00 -.175840E-08       .000000E+00
      7  .497018E+01       .000000E+00 -.185159E-02       .000000E+00
      8  .415968E+01       .000000E+00 -.329173E-02       .000000E+00
      9  .297886E+01       .000000E+00 -.432041E-02       .000000E+00
     10  .155115E+01       .000000E+00 -.493763E-02       .000000E+00
     11  .000000E+00      -.315000E+03 -.514336E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .472556E+05  .315021E+03  .000000E+00
      2  .141766E+06  .315019E+03  .000000E+00
      3  .236276E+06  .315015E+03  .000000E+00
      4  .330783E+06  .315011E+03  .000000E+00
      5  .425287E+06  .315003E+03  .000000E+00
      6  .425287E+06 -.315004E+03  .000000E+00
      7  .330782E+06 -.315011E+03  .000000E+00
      8  .236275E+06 -.315016E+03  .000000E+00
      9  .141766E+06 -.315019E+03  .000000E+00
```

```
      10  .472555E+05  -.315020E+03   .000000E+00
0    ITERATION NUMBER=    2
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .859152E-02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1  .000000E+00      -.315000E+03   .514286E-02       .000000E+00
       2  .155100E+01       .000000E+00   .493714E-02       .000000E+00
       3  .297857E+01       .000000E+00   .432000E-02       .000000E+00
       4  .415929E+01       .000000E+00   .329143E-02       .000000E+00
       5  .496971E+01       .000000E+00   .185143E-02       .000000E+00
       6  .528643E+01       .000000E+00   .489608E-11       .000000E+00
       7  .496971E+01       .000000E+00  -.185143E-02       .000000E+00
       8  .415929E+01       .000000E+00  -.329143E-02       .000000E+00
       9  .297857E+01       .000000E+00  -.432000E-02       .000000E+00
      10  .155100E+01       .000000E+00  -.493714E-02       .000000E+00
      11  .000000E+00      -.315000E+03  -.514286E-02       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
       1  .472500E+05   .315000E+03   .000000E+00
       2  .141750E+06   .315000E+03   .000000E+00
       3  .236250E+06   .315000E+03   .000000E+00
       4  .330750E+06   .315000E+03   .000000E+00
       5  .425250E+06   .315000E+03   .000000E+00
       6  .425250E+06  -.315000E+03   .000000E+00
       7  .330750E+06  -.315000E+03   .000000E+00
       8  .236250E+06  -.315000E+03   .000000E+00
       9  .141750E+06  -.315000E+03   .000000E+00
      10  .472500E+05  -.315000E+03   .000000E+00
0    IINCS=   3   NITER=  100   NOUTP=    2   FACTO=   .100000E+00   TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .597672E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1  .000000E+00      -.378000E+03   .617168E-02       .000000E+00
       2  .186128E+01       .000000E+00   .592481E-02       .000000E+00
       3  .357443E+01       .000000E+00   .518421E-02       .000000E+00
       4  .499134E+01       .000000E+00   .394987E-02       .000000E+00
       5  .596389E+01       .000000E+00   .222179E-02       .000000E+00
       6  .634396E+01       .000000E+00  -.924345E-09       .000000E+00
       7  .596389E+01       .000000E+00  -.222180E-02       .000000E+00
       8  .499134E+01       .000000E+00  -.394987E-02       .000000E+00
       9  .357443E+01       .000000E+00  -.518421E-02       .000000E+00
      10  .186128E+01       .000000E+00  -.592481E-02       .000000E+00
      11  .000000E+00      -.378000E+03  -.617168E-02       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
       1  .567028E+05   .378010E+03   .000000E+00
       2  .170108E+06   .378010E+03   .000000E+00
       3  .283513E+06   .378008E+03   .000000E+00
       4  .396917E+06   .378005E+03   .000000E+00
       5  .510318E+06   .378002E+03   .000000E+00
       6  .510318E+06  -.378003E+03   .000000E+00
       7  .396916E+06  -.378005E+03   .000000E+00
       8  .283513E+06  -.378008E+03   .000000E+00
       9  .170108E+06  -.378009E+03   .000000E+00
      10  .567027E+05  -.378010E+03   .000000E+00
0    ITERATION NUMBER=    2
0    CONVERGENCE CODE=   0   NORM OF RESIDUAL SUM RATIO=   .776480E-02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
       1  .000000E+00      -.378000E+03   .617143E-02       .000000E+00
       2  .186120E+01       .000000E+00   .592457E-02       .000000E+00
       3  .357429E+01       .000000E+00   .518400E-02       .000000E+00
       4  .499114E+01       .000000E+00   .394971E-02       .000000E+00
       5  .596366E+01       .000000E+00   .222171E-02       .000000E+00
```

```
      6  .634372E+01       .000000E+00  -.196708E-09       .000000E+00
      7  .596366E+01       .000000E+00  -.222171E-02       .000000E+00
      8  .499114E+01       .000000E+00  -.394971E-02       .000000E+00
      9  .357429E+01       .000000E+00  -.518400E-02       .000000E+00
     10  .186120E+01       .000000E+00  -.592457E-02       .000000E+00
     11  .000000E+00      -.378000E+03  -.617143E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .567000E+05   .378000E+03   .000000E+00
      2  .170100E+06   .378000E+03   .000000E+00
      3  .283500E+06   .378000E+03   .000000E+00
      4  .396900E+06   .378000E+03   .000000E+00
      5  .510300E+06   .378000E+03   .000000E+00
      6  .510300E+06  -.378000E+03   .000000E+00
      7  .396900E+06  -.378000E+03   .000000E+00
      8  .283500E+06  -.378000E+03   .000000E+00
      9  .170100E+06  -.378000E+03   .000000E+00
     10  .567000E+05  -.378000E+03   .000000E+00
0    IINCS=   4  NITER= 100  NOUTP=   2  FACTO=   .100000E+00  TOLER=   .500000E+00
0    ITERATION NUMBER=   1
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .515248E+00
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.441000E+03   .720026E-02       .000000E+00
      2  .217148E+01       .000000E+00   .691224E-02       .000000E+00
      3  .417015E+01       .000000E+00   .604821E-02       .000000E+00
      4  .582320E+01       .000000E+00   .460815E-02       .000000E+00
      5  .695784E+01       .000000E+00   .259208E-02       .000000E+00
      6  .740125E+01       .000000E+00  -.977916E-09       .000000E+00
      7  .695783E+01       .000000E+00  -.259208E-02       .000000E+00
      8  .582320E+01       .000000E+00  -.460815E-02       .000000E+00
      9  .417014E+01       .000000E+00  -.604821E-02       .000000E+00
     10  .217148E+01       .000000E+00  -.691224E-02       .000000E+00
     11  .000000E+00      -.441000E+03  -.720025E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .661528E+05   .441010E+03   .000000E+00
      2  .198458E+06   .441010E+03   .000000E+00
      3  .330763E+06   .441007E+03   .000000E+00
      4  .463066E+06   .441005E+03   .000000E+00
      5  .595368E+06   .441002E+03   .000000E+00
      6  .595368E+06  -.441002E+03   .000000E+00
      7  .463066E+06  -.441005E+03   .000000E+00
      8  .330763E+06  -.441008E+03   .000000E+00
      9  .198458E+06  -.441009E+03   .000000E+00
     10  .661528E+05  -.441010E+03   .000000E+00
0    ITERATION NUMBER=   2
0    CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .105389E-01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.441000E+03   .720000E-02       .000000E+00
      2  .217140E+01       .000000E+00   .691200E-02       .000000E+00
      3  .417000E+01       .000000E+00   .604800E-02       .000000E+00
      4  .582300E+01       .000000E+00   .460800E-02       .000000E+00
      5  .695760E+01       .000000E+00   .259200E-02       .000000E+00
      6  .740100E+01       .000000E+00  -.271079E-09       .000000E+00
      7  .695760E+01       .000000E+00  -.259200E-02       .000000E+00
      8  .582300E+01       .000000E+00  -.460800E-02       .000000E+00
      9  .417000E+01       .000000E+00  -.604800E-02       .000000E+00
     10  .217140E+01       .000000E+00  -.691200E-02       .000000E+00
     11  .000000E+00      -.441000E+03  -.720000E-02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .661500E+05   .441000E+03   .000000E+00
      2  .198450E+06   .441000E+03   .000000E+00
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      3  .330750E+06  .441000E+03  .000000E+00
      4  .463050E+06  .441000E+03  .000000E+00
      5  .595350E+06  .441000E+03  .000000E+00
      6  .595350E+06 -.441000E+03  .000000E+00
      7  .463050E+06 -.441000E+03  .000000E+00
      8  .330750E+06 -.441000E+03  .000000E+00
      9  .198450E+06 -.441000E+03  .000000E+00
     10  .661500E+05 -.441000E+03  .000000E+00
0   IINCS=  5  NITER= 100  NOUTP=  2  FACTO=  .500000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  0  NORM OF RESIDUAL SUM RATIO=  .238967E+00
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.472500E+03  .771441E-02       .000000E+00
      2  .232654E+01       .000000E+00  .740584E-02       .000000E+00
      3  .446793E+01       .000000E+00  .648010E-02       .000000E+00
      4  .623903E+01       .000000E+00  .493722E-02       .000000E+00
      5  .745469E+01       .000000E+00  .277718E-02       .000000E+00
      6  .792977E+01       .000000E+00 -.539610E-09       .000000E+00
      7  .745469E+01       .000000E+00 -.277718E-02       .000000E+00
      8  .623903E+01       .000000E+00 -.493722E-02       .000000E+00
      9  .446793E+01       .000000E+00 -.648010E-02       .000000E+00
     10  .232654E+01       .000000E+00 -.740583E-02       .000000E+00
     11  .000000E+00      -.472500E+03 -.771441E-02       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .708764E+05  .472505E+03  .000000E+00
      2  .212629E+06  .472505E+03  .000000E+00
      3  .354381E+06  .472504E+03  .000000E+00
      4  .496133E+06  .472503E+03  .000000E+00
      5  .637884E+06  .472501E+03  .000000E+00
      6  .637884E+06 -.472501E+03  .000000E+00
      7  .496133E+06 -.472503E+03  .000000E+00
      8  .354381E+06 -.472504E+03  .000000E+00
      9  .212629E+06 -.472505E+03  .000000E+00
     10  .708764E+05 -.472505E+03  .000000E+00
0   IINCS=  6  NITER= 100  NOUTP=  2  FACTO=  .500000E-01  TOLER=  .500000E+00
0   ITERATION NUMBER=  1
0   CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .197674E+04
0   NODE   DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.504000E+03  .822870E-02       .000000E+00
      2  .248164E+01       .000000E+00  .789955E-02       .000000E+00
      3  .476579E+01       .000000E+00  .691210E-02       .000000E+00
      4  .665496E+01       .000000E+00  .526636E-02       .000000E+00
      5  .795166E+01       .000000E+00  .296233E-02       .000000E+00
      6  .845841E+01       .000000E+00 -.615301E-09       .000000E+00
      7  .795166E+01       .000000E+00 -.296233E-02       .000000E+00
      8  .665496E+01       .000000E+00 -.526636E-02       .000000E+00
      9  .476579E+01       .000000E+00 -.691210E-02       .000000E+00
     10  .248164E+01       .000000E+00 -.789955E-02       .000000E+00
     11  .000000E+00      -.504000E+03 -.822870E-02       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .756014E+05  .504005E+03  .000000E+00
      2  .226804E+06  .504005E+03  .000000E+00
      3  .378006E+06  .504004E+03  .000000E+00
      4  .529208E+06  .504003E+03  .000000E+00
      5  .663153E+06  .504001E+03  .000000E+00
      6  .663153E+06 -.504001E+03  .000000E+00
      7  .529208E+06 -.504002E+03  .000000E+00
      8  .378006E+06 -.504004E+03  .000000E+00
      9  .226804E+06 -.504005E+03  .000000E+00
     10  .756014E+05 -.504005E+03  .000000E+00
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0 ITERATION NUMBER= 2
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .147266E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.504000E+03 .849157E-02 .000000E+00
2 .256050E+01 .000000E+00 .816243E-02 .000000E+00
3 .492351E+01 .000000E+00 .717499E-02 .000000E+00
4 .689155E+01 .000000E+00 .552926E-02 .000000E+00
5 .826712E+01 .000000E+00 .322524E-02 .000000E+00
6 .881331E+01 .000000E+00 -.148287E-09 .000000E+00
7 .826713E+01 .000000E+00 -.322524E-02 .000000E+00
8 .689155E+01 .000000E+00 -.552926E-02 .000000E+00
9 .492351E+01 .000000E+00 -.717499E-02 .000000E+00
10 .256050E+01 .000000E+00 -.816242E-02 .000000E+00
11 .000000E+00 -.504000E+03 -.849157E-02 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .756007E+05 .504003E+03 .000000E+00
2 .226802E+06 .504003E+03 .000000E+00
3 .378004E+06 .504003E+03 .000000E+00
4 .529205E+06 .504003E+03 .000000E+00
5 .680406E+06 .504001E+03 .000000E+00
6 .680406E+06 -.504001E+03 .000000E+00
7 .529205E+06 -.504003E+03 .000000E+00
8 .378004E+06 -.504003E+03 .000000E+00
9 .226802E+06 -.504003E+03 .000000E+00
10 .756007E+05 -.504003E+03 .000000E+00
0 IINCS= 7 NITER= 100 NOUTP= 2 FACTO= .500000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .458286E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.535500E+03 .946905E-02 .000000E+00
2 .285456E+01 .000000E+00 .911933E-02 .000000E+00
3 .549928E+01 .000000E+00 .807015E-02 .000000E+00
4 .772433E+01 .000000E+00 .632152E-02 .000000E+00
5 .931988E+01 .000000E+00 .387345E-02 .000000E+00
6 .996720E+01 .000000E+00 -.956933E-09 .000000E+00
7 .931988E+01 .000000E+00 -.387345E-02 .000000E+00
8 .772433E+01 .000000E+00 -.632152E-02 .000000E+00
9 .549928E+01 .000000E+00 -.807015E-02 .000000E+00
10 .285456E+01 .000000E+00 -.911933E-02 .000000E+00
11 .000000E+00 -.535500E+03 -.946905E-02 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .803277E+05 .535510E+03 .000000E+00
2 .240983E+06 .535509E+03 .000000E+00
3 .401638E+06 .535508E+03 .000000E+00
4 .562292E+06 .535507E+03 .000000E+00
5 .722945E+06 .535503E+03 .000000E+00
6 .722945E+06 -.535504E+03 .000000E+00
7 .562292E+06 -.535507E+03 .000000E+00
8 .401638E+06 -.535508E+03 .000000E+00
9 .240983E+06 -.535509E+03 .000000E+00
10 .803276E+05 -.535510E+03 .000000E+00
0 IINCS= 8 NITER= 100 NOUTP= 2 FACTO= .500000E-01 TOLER= .500000E+00
0 ITERATION NUMBER= 1
0 CONVERGENCE CODE= 0 NORM OF RESIDUAL SUM RATIO= .425359E+00
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.567000E+03 .104462E-01 .000000E+00
2 .314852E+01 .000000E+00 .100759E-01 .000000E+00
3 .607485E+01 .000000E+00 .896501E-02 .000000E+00
4 .855683E+01 .000000E+00 .711352E-02 .000000E+00
5 .103723E+02 .000000E+00 .452145E-02 .000000E+00

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      6  .111207E+02       .000000E+00  -.596281E-09       .000000E+00
      7  .103723E+02       .000000E+00  -.452145E-02       .000000E+00
      8  .855683E+01       .000000E+00  -.711352E-02       .000000E+00
      9  .607485E+01       .000000E+00  -.896501E-02       .000000E+00
     10  .314852E+01       .000000E+00  -.100759E-01       .000000E+00
     11  .000000E+00      -.567000E+03  -.104462E-01       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .850527E+05   .567010E+03   .000000E+00
      2  .255158E+06   .567009E+03   .000000E+00
      3  .425263E+06   .567008E+03   .000000E+00
      4  .595367E+06   .567008E+03   .000000E+00
      5  .765470E+06   .567002E+03   .000000E+00
      6  .765470E+06  -.567004E+03   .000000E+00
      7  .595367E+06  -.567007E+03   .000000E+00
      8  .425263E+06  -.567009E+03   .000000E+00
      9  .255158E+06  -.567009E+03   .000000E+00
     10  .850526E+05  -.567010E+03   .000000E+00
0   IINCS=   9  NITER= 100  NOUTP=   2  FACTO=   .200000E-01  TOLER=   .500000E+00
0   ITERATION NUMBER=   1
0   CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .109134E+03
0   NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.579600E+03   .108368E-01       .000000E+00
      2  .326601E+01       .000000E+00   .104582E-01       .000000E+00
      3  .630491E+01       .000000E+00   .932269E-02       .000000E+00
      4  .888959E+01       .000000E+00   .743009E-02       .000000E+00
      5  .107929E+02       .000000E+00   .478047E-02       .000000E+00
      6  .115818E+02       .000000E+00  -.115786E-08       .000000E+00
      7  .107929E+02       .000000E+00  -.478047E-02       .000000E+00
      8  .888959E+01       .000000E+00  -.743010E-02       .000000E+00
      9  .630491E+01       .000000E+00  -.932269E-02       .000000E+00
     10  .326601E+01       .000000E+00  -.104582E-01       .000000E+00
     11  .000000E+00      -.579600E+03  -.108368E-01       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .869411E+05   .579604E+03   .000000E+00
      2  .260823E+06   .579604E+03   .000000E+00
      3  .434705E+06   .579604E+03   .000000E+00
      4  .608587E+06   .579603E+03   .000000E+00
      5  .781372E+06   .579601E+03   .000000E+00
      6  .781372E+06  -.579601E+03   .000000E+00
      7  .608587E+06  -.579603E+03   .000000E+00
      8  .434705E+06  -.579603E+03   .000000E+00
      9  .260823E+06  -.579604E+03   .000000E+00
     10  .869411E+05  -.579604E+03   .000000E+00
0   ITERATION NUMBER=   2
0   CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=   .783295E-01
0   NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.579600E+03   .110031E-01       .000000E+00
      2  .331592E+01       .000000E+00   .106246E-01       .000000E+00
      3  .640474E+01       .000000E+00   .948907E-02       .000000E+00
      4  .903933E+01       .000000E+00   .759649E-02       .000000E+00
      5  .109926E+02       .000000E+00   .494687E-02       .000000E+00
      6  .118064E+02       .000000E+00  -.186900E-08       .000000E+00
      7  .109926E+02       .000000E+00  -.494687E-02       .000000E+00
      8  .903933E+01       .000000E+00  -.759649E-02       .000000E+00
      9  .640474E+01       .000000E+00  -.948907E-02       .000000E+00
     10  .331592E+01       .000000E+00  -.106246E-01       .000000E+00
     11  .000000E+00      -.579600E+03  -.110031E-01       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .869405E+05   .579602E+03   .000000E+00
      2  .260821E+06   .579602E+03   .000000E+00
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      3  .434702E+06   .579602E+03   .000000E+00
      4  .608583E+06   .579602E+03   .000000E+00
      5  .782464E+06   .579601E+03   .000000E+00
      6  .782464E+06  -.579601E+03   .000000E+00
      7  .608583E+06  -.579602E+03   .000000E+00
      8  .434702E+06  -.579602E+03   .000000E+00
      9  .260821E+06  -.579602E+03   .000000E+00
     10  .869404E+05  -.579602E+03   .000000E+00
0    IINCS=  10  NITER= 100  NOUTP=   2  FACTO=  .200000E-01  TOLER=  .500000E+00
0    ITERATION NUMBER=   1
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=  .125104E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.592201E+03   .137362E-01       .000000E+00
      2  .413617E+01       .000000E+00   .133494E-01       .000000E+00
      3  .804028E+01       .000000E+00   .121891E-01       .000000E+00
      4  .114803E+02       .000000E+00   .102552E-01       .000000E+00
      5  .142240E+02       .000000E+00   .754781E-02       .000000E+00
      6  .154295E+02       .000000E+00  -.264980E-07       .000000E+00
      7  .142240E+02       .000000E+00  -.754781E-02       .000000E+00
      8  .114803E+02       .000000E+00  -.102552E-01       .000000E+00
      9  .804028E+01       .000000E+00  -.121891E-01       .000000E+00
     10  .413617E+01       .000000E+00  -.133494E-01       .000000E+00
     11  .000000E+00      -.592200E+03  -.137362E-01       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .888376E+05   .592228E+03   .000000E+00
      2  .266513E+06   .592228E+03   .000000E+00
      3  .444188E+06   .592227E+03   .000000E+00
      4  .621862E+06   .592228E+03   .000000E+00
      5  .799533E+06   .592212E+03   .000000E+00
      6  .799532E+06  -.592214E+03   .000000E+00
      7  .621862E+06  -.592229E+03   .000000E+00
      8  .444187E+06  -.592226E+03   .000000E+00
      9  .266512E+06  -.592227E+03   .000000E+00
     10  .888373E+05  -.592227E+03   .000000E+00
0    ITERATION NUMBER=   2
0    CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .208280E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.592200E+03   .137261E-01       .000000E+00
      2  .413314E+01       .000000E+00   .133394E-01       .000000E+00
      3  .803424E+01       .000000E+00   .121791E-01       .000000E+00
      4  .114713E+02       .000000E+00   .102454E-01       .000000E+00
      5  .142121E+02       .000000E+00   .753824E-02       .000000E+00
      6  .154162E+02       .000000E+00   .256866E-08       .000000E+00
      7  .142121E+02       .000000E+00  -.753824E-02       .000000E+00
      8  .114713E+02       .000000E+00  -.102454E-01       .000000E+00
      9  .803424E+01       .000000E+00  -.121792E-01       .000000E+00
     10  .413314E+01       .000000E+00  -.133394E-01       .000000E+00
     11  .000000E+00      -.592200E+03  -.137261E-01       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .888300E+05   .592200E+03   .000000E+00
      2  .266490E+06   .592200E+03   .000000E+00
      3  .444150E+06   .592200E+03   .000000E+00
      4  .621810E+06   .592200E+03   .000000E+00
      5  .797327E+06   .592200E+03   .000000E+00
      6  .797340E+06  -.592200E+03   .000000E+00
      7  .621810E+06  -.592200E+03   .000000E+00
      8  .444150E+06  -.592200E+03   .000000E+00
      9  .266490E+06  -.592200E+03   .000000E+00
     10  .888300E+05  -.592200E+03   .000000E+00
0    ITERATION NUMBER=   3
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0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .208335E+03

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.592200E+03	.140530E-01	.000000E+00
2	.423122E+01	.000000E+00	.136663E-01	.000000E+00
3	.823038E+01	.000000E+00	.125060E-01	.000000E+00
4	.117655E+02	.000000E+00	.105723E-01	.000000E+00
5	.146044E+02	.000000E+00	.786507E-02	.000000E+00
6	.158573E+02	.000000E+00	-.922331E-06	.000000E+00
7	.146041E+02	.000000E+00	-.786487E-02	.000000E+00
8	.117653E+02	.000000E+00	-.105721E-01	.000000E+00
9	.823026E+01	.000000E+00	-.125058E-01	.000000E+00
10	.423115E+01	.000000E+00	-.136661E-01	.000000E+00
11	.000000E+00	-.592200E+03	-.140528E-01	.000000E+00

0 ELEMENT	STRESSES	PL.STRAIN
1	.888309E+05	.592203E+03	.000000E+00
2	.266493E+06	.592203E+03	.000000E+00
3	.444155E+06	.592203E+03	.000000E+00
4	.621816E+06	.592203E+03	.000000E+00
5	.801621E+06	.592201E+03	.000000E+00
6	.801607E+06	-.592202E+03	.000000E+00
7	.621816E+06	-.592203E+03	.000000E+00
8	.444154E+06	-.592203E+03	.000000E+00
9	.266493E+06	-.592203E+03	.000000E+00
10	.888309E+05	-.592203E+03	.000000E+00

0 ITERATION NUMBER= 4

0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .713193E+04

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.592200E+03	.137249E-01	.000000E+00
2	.413279E+01	.000000E+00	.133382E-01	.000000E+00
3	.803354E+01	.000000E+00	.121780E-01	.000000E+00
4	.114702E+02	.000000E+00	.102443E-01	.000000E+00
5	.142107E+02	.000000E+00	.753712E-02	.000000E+00
6	.154146E+02	.000000E+00	.502786E-08	.000000E+00
7	.142107E+02	.000000E+00	-.753712E-02	.000000E+00
8	.114702E+02	.000000E+00	-.102443E-01	.000000E+00
9	.803354E+01	.000000E+00	-.121780E-01	.000000E+00
10	.413279E+01	.000000E+00	-.133382E-01	.000000E+00
11	.000000E+00	-.592200E+03	-.137249E-01	.000000E+00

0 ELEMENT	STRESSES	PL.STRAIN
1	.888291E+05	.592196E+03	.000000E+00
2	.266487E+06	.592197E+03	.000000E+00
3	.444145E+06	.592197E+03	.000000E+00
4	.621804E+06	.592197E+03	.000000E+00
5	.726081E+06	.592198E+03	.000000E+00
6	.726540E+06	-.592198E+03	.000000E+00
7	.621804E+06	-.592197E+03	.000000E+00
8	.444146E+06	-.592197E+03	.000000E+00
9	.266487E+06	-.592197E+03	.000000E+00
10	.888291E+05	-.592197E+03	.000000E+00

0 ITERATION NUMBER= 5

0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .429344E+04

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.592205E+03	.249185E-01	.000000E+00
2	.749085E+01	.000000E+00	.245316E-01	.000000E+00
3	.147496E+02	.000000E+00	.233710E-01	.000000E+00
4	.215440E+02	.000000E+00	.214366E-01	.000000E+00
5	.276421E+02	.000000E+00	.187284E-01	.000000E+00
6	.305200E+02	.000000E+00	-.316307E-04	.000000E+00
7	.276337E+02	.000000E+00	-.187214E-01	.000000E+00
8	.215377E+02	.000000E+00	-.214296E-01	.000000E+00

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      9  .147453E+02       .000000E+00  -.233639E-01       .000000E+00
     10  .748874E+01       .000000E+00  -.245246E-01       .000000E+00
     11  .000000E+00      -.592200E+03  -.249114E-01       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .888609E+05   .592317E+03   .000000E+00
      2  .266583E+06   .592317E+03   .000000E+00
      3  .444305E+06   .592310E+03   .000000E+00
      4  .622027E+06   .592312E+03   .000000E+00
      5  .843750E+06   .592255E+03   .000000E+00
      6  .843750E+06  -.592270E+03   .000000E+00
      7  .622024E+06  -.592308E+03   .000000E+00
      8  .444303E+06  -.592317E+03   .000000E+00
      9  .266581E+06  -.592308E+03   .000000E+00
     10  .888601E+05  -.592312E+03   .000000E+00
0    ITERATION NUMBER=    6
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .898786E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593061E+03   .187375E+01       .000000E+00
      2  .562139E+03       .000000E+00   .187334E+01       .000000E+00
      3  .112403E+04       .000000E+00   .187211E+01       .000000E+00
      4  .168543E+04       .000000E+00   .187007E+01       .000000E+00
      5  .224610E+04       .000000E+00   .186720E+01       .000000E+00
      6  .252372E+04       .000000E+00  -.168719E-01       .000000E+00
      7  .224160E+04       .000000E+00  -.186345E+01       .000000E+00
      8  .168206E+04       .000000E+00  -.186632E+01       .000000E+00
      9  .112178E+04       .000000E+00  -.186836E+01       .000000E+00
     10  .561014E+03       .000000E+00  -.186959E+01       .000000E+00
     11  .000000E+00      -.592758E+03  -.187000E+01       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .939812E+05   .611537E+03   .000000E+00
      2  .281916E+06   .611955E+03   .000000E+00
      3  .469851E+06   .611161E+03   .000000E+00
      4  .656689E+06   .611141E+03   .000000E+00
      5  .843750E+06   .601170E+03   .000000E+00
      6  .843750E+06  -.600514E+03   .000000E+00
      7  .656673E+06  -.611422E+03   .000000E+00
      8  .469849E+06  -.611741E+03   .000000E+00
      9  .281832E+06  -.610982E+03   .000000E+00
     10  .939256E+05  -.611289E+03   .000000E+00
0    ITERATION NUMBER=    7
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .942732E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.594414E+03   .357820E+01       .000000E+00
      2  .107347E+04       .000000E+00   .357779E+01       .000000E+00
      3  .214670E+04       .000000E+00   .357657E+01       .000000E+00
      4  .321944E+04       .000000E+00   .357453E+01       .000000E+00
      5  .429144E+04       .000000E+00   .357165E+01       .000000E+00
      6  .482696E+04       .000000E+00  -.205089E-02       .000000E+00
      7  .429090E+04       .000000E+00  -.357120E+01       .000000E+00
      8  .321903E+04       .000000E+00  -.357407E+01       .000000E+00
      9  .214643E+04       .000000E+00  -.357611E+01       .000000E+00
     10  .107334E+04       .000000E+00  -.357733E+01       .000000E+00
     11  .000000E+00      -.593303E+03  -.357774E+01       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937621E+05   .611518E+03   .000000E+00
      2  .281122E+06   .610536E+03   .000000E+00
      3  .468510E+06   .610801E+03   .000000E+00
      4  .657174E+06   .610687E+03   .000000E+00
      5  .843750E+06   .600417E+03   .000000E+00
      6  .843750E+06  -.601277E+03   .000000E+00
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      7  .656931E+06  -.610007E+03   .000000E+00
      8  .468233E+06  -.611123E+03   .000000E+00
      9  .280847E+06  -.610281E+03   .000000E+00
     10  .936518E+05  -.610331E+03   .000000E+00
0    ITERATION NUMBER=   8
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .940630E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593603E+03   .528265E+01       .000000E+00
      2  .158481E+04       .000000E+00   .528224E+01       .000000E+00
      3  .316937E+04       .000000E+00   .528102E+01       .000000E+00
      4  .475345E+04       .000000E+00   .527898E+01       .000000E+00
      5  .633679E+04       .000000E+00   .527611E+01       .000000E+00
      6  .713019E+04       .000000E+00   .127737E-01       .000000E+00
      7  .634019E+04       .000000E+00  -.527895E+01       .000000E+00
      8  .475600E+04       .000000E+00  -.528182E+01       .000000E+00
      9  .317108E+04       .000000E+00  -.528385E+01       .000000E+00
     10  .158566E+04       .000000E+00  -.528508E+01       .000000E+00
     11  .000000E+00      -.593303E+03  -.528549E+01       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .937621E+05   .610752E+03   .000000E+00
      2  .281122E+06   .610755E+03   .000000E+00
      3  .468537E+06   .611658E+03   .000000E+00
      4  .657147E+06   .610558E+03   .000000E+00
      5  .843750E+06   .601274E+03   .000000E+00
      6  .843750E+06  -.599763E+03   .000000E+00
      7  .656903E+06  -.610098E+03   .000000E+00
      8  .468233E+06  -.610372E+03   .000000E+00
      9  .280874E+06  -.611357E+03   .000000E+00
     10  .936244E+05  -.610421E+03   .000000E+00
0    ITERATION NUMBER=   9
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .947162E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593542E+03   .698710E+01       .000000E+00
      2  .209614E+04       .000000E+00   .698669E+01       .000000E+00
      3  .419204E+04       .000000E+00   .698547E+01       .000000E+00
      4  .628745E+04       .000000E+00   .698343E+01       .000000E+00
      5  .838213E+04       .000000E+00   .698056E+01       .000000E+00
      6  .943343E+04       .000000E+00   .276080E-01       .000000E+00
      7  .838949E+04       .000000E+00  -.698670E+01       .000000E+00
      8  .629297E+04       .000000E+00  -.698956E+01       .000000E+00
      9  .419572E+04       .000000E+00  -.699160E+01       .000000E+00
     10  .209798E+04       .000000E+00  -.699283E+01       .000000E+00
     11  .000000E+00      -.593303E+03  -.699323E+01       .000000E+00
0  ELEMENT          STRESSES          PL.STRAIN
      1  .936800E+05   .610665E+03   .000000E+00
      2  .281150E+06   .610873E+03   .000000E+00
      3  .468537E+06   .610687E+03   .000000E+00
      4  .657205E+06   .610310E+03   .000000E+00
      5  .843750E+06   .600223E+03   .000000E+00
      6  .843750E+06  -.600710E+03   .000000E+00
      7  .656946E+06  -.610955E+03   .000000E+00
      8  .468233E+06  -.610795E+03   .000000E+00
      9  .280874E+06  -.610302E+03   .000000E+00
     10  .936244E+05  -.610352E+03   .000000E+00
0    ITERATION NUMBER=  10
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .961740E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593975E+03   .869155E+01       .000000E+00
      2  .260748E+04       .000000E+00   .869114E+01       .000000E+00
      3  .521471E+04       .000000E+00   .868992E+01       .000000E+00
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      4  .782146E+04      .000000E+00   .868788E+01      .000000E+00
      5  .104275E+05      .000000E+00   .868501E+01      .000000E+00
      6  .117367E+05      .000000E+00   .424508E-01      .000000E+00
      7  .104388E+05      .000000E+00  -.869444E+01      .000000E+00
      8  .782995E+04      .000000E+00  -.869731E+01      .000000E+00
      9  .522037E+04      .000000E+00  -.869935E+01      .000000E+00
     10  .261031E+04      .000000E+00  -.870057E+01      .000000E+00
     11  .000000E+00      -.593303E+03  -.870098E+01      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937621E+05   .611010E+03   .000000E+00
      2  .281204E+06   .610953E+03   .000000E+00
      3  .468592E+06   .609867E+03   .000000E+00
      4  .657068E+06   .610042E+03   .000000E+00
      5  .843750E+06   .601287E+03   .000000E+00
      6  .843750E+06  -.599279E+03   .000000E+00
      7  .656892E+06  -.610512E+03   .000000E+00
      8  .468233E+06  -.609655E+03   .000000E+00
      9  .280874E+06  -.610641E+03   .000000E+00
     10  .936518E+05  -.610546E+03   .000000E+00
0    ITERATION NUMBER=   11
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .946988E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593858E+03   .103960E+02      .000000E+00
      2  .311881E+04       .000000E+00   .103956E+02      .000000E+00
      3  .623738E+04       .000000E+00   .103944E+02      .000000E+00
      4  .935546E+04       .000000E+00   .103923E+02      .000000E+00
      5  .124728E+05       .000000E+00   .103895E+02      .000000E+00
      6  .140399E+05       .000000E+00   .572994E-01      .000000E+00
      7  .124881E+05       .000000E+00  -.104022E+02      .000000E+00
      8  .936692E+04       .000000E+00  -.104051E+02      .000000E+00
      9  .624502E+04       .000000E+00  -.104071E+02      .000000E+00
     10  .312263E+04       .000000E+00  -.104083E+02      .000000E+00
     11  .000000E+00      -.593303E+03  -.104087E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937347E+05   .611058E+03   .000000E+00
      2  .281150E+06   .610568E+03   .000000E+00
      3  .468537E+06   .611122E+03   .000000E+00
      4  .657260E+06   .610277E+03   .000000E+00
      5  .843750E+06   .601372E+03   .000000E+00
      6  .843750E+06  -.601036E+03   .000000E+00
      7  .656970E+06  -.610521E+03   .000000E+00
      8  .468233E+06  -.609929E+03   .000000E+00
      9  .280874E+06  -.610421E+03   .000000E+00
     10  .936244E+05  -.610471E+03   .000000E+00
0    ITERATION NUMBER=   12
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .940865E+03
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593909E+03   .121005E+02      .000000E+00
      2  .363015E+04       .000000E+00   .121000E+02      .000000E+00
      3  .726006E+04       .000000E+00   .120988E+02      .000000E+00
      4  .108895E+05       .000000E+00   .120968E+02      .000000E+00
      5  .145182E+05       .000000E+00   .120939E+02      .000000E+00
      6  .163431E+05       .000000E+00   .721170E-01      .000000E+00
      7  .145374E+05       .000000E+00  -.121099E+02      .000000E+00
      8  .109039E+05       .000000E+00  -.121128E+02      .000000E+00
      9  .726967E+04       .000000E+00  -.121148E+02      .000000E+00
     10  .363496E+04       .000000E+00  -.121161E+02      .000000E+00
     11  .000000E+00      -.593303E+03  -.121165E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937074E+05   .611067E+03   .000000E+00
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      2  .281095E+06  .611131E+03  .000000E+00
      3  .468537E+06  .610410E+03  .000000E+00
      4  .656932E+06  .610789E+03  .000000E+00
      5  .843750E+06  .600913E+03  .000000E+00
      6  .843750E+06 -.601097E+03  .000000E+00
      7  .656833E+06 -.610681E+03  .000000E+00
      8  .468233E+06 -.609825E+03  .000000E+00
      9  .280874E+06 -.610810E+03  .000000E+00
     10  .936518E+05 -.610716E+03  .000000E+00
0    ITERATION NUMBER=  13
0    CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .969131E+03
0    NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00      -.593943E+03  .138049E+02      .000000E+00
      2  .414149E+04       .000000E+00  .138045E+02      .000000E+00
      3  .828273E+04       .000000E+00  .138033E+02      .000000E+00
      4  .124235E+05       .000000E+00  .138012E+02      .000000E+00
      5  .165635E+05       .000000E+00  .137984E+02      .000000E+00
      6  .186464E+05       .000000E+00  .869437E-01      .000000E+00
      7  .165867E+05       .000000E+00 -.138177E+02      .000000E+00
      8  .124409E+05       .000000E+00 -.138206E+02      .000000E+00
      9  .829432E+04       .000000E+00 -.138226E+02      .000000E+00
     10  .414728E+04       .000000E+00 -.138238E+02      .000000E+00
     11  .000000E+00      -.593303E+03 -.138242E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937347E+05  .611050E+03  .000000E+00
      2  .281122E+06  .610909E+03  .000000E+00
      3  .468592E+06  .610375E+03  .000000E+00
      4  .657409E+06  .609605E+03  .000000E+00
      5  .843750E+06  .601023E+03  .000000E+00
      6  .843750E+06 -.599180E+03  .000000E+00
      7  .657032E+06 -.609786E+03  .000000E+00
      8  .468233E+06 -.610010E+03  .000000E+00
      9  .280874E+06 -.610502E+03  .000000E+00
     10  .936244E+05 -.610552E+03  .000000E+00
0    ITERATION NUMBER=  14
0    CONVERGENCE CODE=  1  NORM OF RESIDUAL SUM RATIO=  .939722E+03
0    NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00      -.593979E+03  .155094E+02      .000000E+00
      2  .465282E+04       .000000E+00  .155089E+02      .000000E+00
      3  .930540E+04       .000000E+00  .155077E+02      .000000E+00
      4  .139575E+05       .000000E+00  .155057E+02      .000000E+00
      5  .186088E+05       .000000E+00  .155028E+02      .000000E+00
      6  .209496E+05       .000000E+00  .101773E+00      .000000E+00
      7  .186360E+05       .000000E+00 -.155254E+02      .000000E+00
      8  .139778E+05       .000000E+00 -.155283E+02      .000000E+00
      9  .931896E+04       .000000E+00 -.155303E+02      .000000E+00
     10  .465960E+04       .000000E+00 -.155316E+02      .000000E+00
     11  .000000E+00      -.593303E+03 -.155320E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937074E+05  .611133E+03  .000000E+00
      2  .281122E+06  .610848E+03  .000000E+00
      3  .468565E+06  .609923E+03  .000000E+00
      4  .656587E+06  .611084E+03  .000000E+00
      5  .843750E+06  .600853E+03  .000000E+00
      6  .843750E+06 -.600371E+03  .000000E+00
      7  .656676E+06 -.610643E+03  .000000E+00
      8  .468206E+06 -.610917E+03  .000000E+00
      9  .280847E+06 -.610712E+03  .000000E+00
     10  .936518E+05 -.610762E+03  .000000E+00
0    ITERATION NUMBER=  15
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0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .945441E+03

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.594327E+03	.172138E+02	.000000E+00
2	.516416E+04	.000000E+00	.172134E+02	.000000E+00
3	.103281E+05	.000000E+00	.172122E+02	.000000E+00
4	.154915E+05	.000000E+00	.172101E+02	.000000E+00
5	.206542E+05	.000000E+00	.172073E+02	.000000E+00
6	.232528E+05	.000000E+00	.116604E+00	.000000E+00
7	.206853E+05	.000000E+00	-.172332E+02	.000000E+00
8	.155148E+05	.000000E+00	-.172360E+02	.000000E+00
9	.103436E+05	.000000E+00	-.172381E+02	.000000E+00
10	.517193E+04	.000000E+00	-.172393E+02	.000000E+00
11	.000000E+00	-.593303E+03	-.172397E+02	.000000E+00

0 ELEMENT	STRESSES	PL.STRAIN
1	.937895E+05	.611381E+03	.000000E+00
2	.281150E+06	.610688E+03	.000000E+00
3	.468510E+06	.610604E+03	.000000E+00
4	.657753E+06	.611319E+03	.000000E+00
5	.843750E+06	.601806E+03	.000000E+00
6	.843750E+06	-.601775E+03	.000000E+00
7	.657189E+06	-.609528E+03	.000000E+00
8	.468233E+06	-.609821E+03	.000000E+00
9	.280874E+06	-.610806E+03	.000000E+00
10	.936518E+05	-.610712E+03	.000000E+00

0 ITERATION NUMBER= 16

0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .943476E+03

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.594268E+03	.189183E+02	.000000E+00
2	.567549E+04	.000000E+00	.189179E+02	.000000E+00
3	.113507E+05	.000000E+00	.189166E+02	.000000E+00
4	.170255E+05	.000000E+00	.189146E+02	.000000E+00
5	.226995E+05	.000000E+00	.189117E+02	.000000E+00
6	.255561E+05	.000000E+00	.131438E+00	.000000E+00
7	.227346E+05	.000000E+00	-.189409E+02	.000000E+00
8	.170518E+05	.000000E+00	-.189438E+02	.000000E+00
9	.113683E+05	.000000E+00	-.189458E+02	.000000E+00
10	.568425E+04	.000000E+00	-.189471E+02	.000000E+00
11	.000000E+00	-.593303E+03	-.189475E+02	.000000E+00

0 ELEMENT	STRESSES	PL.STRAIN
1	.937347E+05	.611454E+03	.000000E+00
2	.281095E+06	.610676E+03	.000000E+00
3	.468537E+06	.610695E+03	.000000E+00
4	.655754E+06	.610870E+03	.000000E+00
5	.843750E+06	.601573E+03	.000000E+00
6	.843750E+06	-.601673E+03	.000000E+00
7	.656258E+06	-.609971E+03	.000000E+00
8	.468233E+06	-.610245E+03	.000000E+00
9	.280874E+06	-.610737E+03	.000000E+00
10	.936244E+05	-.610787E+03	.000000E+00

0 ITERATION NUMBER= 17

0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .974977E+03

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.593894E+03	.206227E+02	.000000E+00
2	.618683E+04	.000000E+00	.206223E+02	.000000E+00
3	.123734E+05	.000000E+00	.206211E+02	.000000E+00
4	.185595E+05	.000000E+00	.206190E+02	.000000E+00
5	.247449E+05	.000000E+00	.206161E+02	.000000E+00
6	.278593E+05	.000000E+00	.146275E+00	.000000E+00
7	.247839E+05	.000000E+00	-.206487E+02	.000000E+00
8	.185888E+05	.000000E+00	-.206515E+02	.000000E+00

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      9  .123929E+05       .000000E+00  -.206536E+02       .000000E+00
     10  .619658E+04       .000000E+00  -.206548E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.206552E+02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937621E+05   .611040E+03   .000000E+00
      2  .281122E+06   .611044E+03   .000000E+00
      3  .468537E+06   .610714E+03   .000000E+00
      4  .658614E+06   .610206E+03   .000000E+00
      5  .843750E+06   .600594E+03   .000000E+00
      6  .843750E+06  -.599236E+03   .000000E+00
      7  .657596E+06  -.610306E+03   .000000E+00
      8  .468233E+06  -.609991E+03   .000000E+00
      9  .280874E+06  -.610483E+03   .000000E+00
     10  .936518E+05  -.610388E+03   .000000E+00
0    ITERATION NUMBER=   18
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .102228E+04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593683E+03   .223272E+02       .000000E+00
      2  .669816E+04       .000000E+00   .223268E+02       .000000E+00
      3  .133961E+05       .000000E+00   .223255E+02       .000000E+00
      4  .200935E+05       .000000E+00   .223235E+02       .000000E+00
      5  .267902E+05       .000000E+00   .223206E+02       .000000E+00
      6  .301625E+05       .000000E+00   .161103E+00       .000000E+00
      7  .268332E+05       .000000E+00  -.223564E+02       .000000E+00
      8  .201257E+05       .000000E+00  -.223593E+02       .000000E+00
      9  .134176E+05       .000000E+00  -.223613E+02       .000000E+00
     10  .670890E+04       .000000E+00  -.223626E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.223630E+02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .936800E+05   .610730E+03   .000000E+00
      2  .281177E+06   .611083E+03   .000000E+00
      3  .468537E+06   .611288E+03   .000000E+00
      4  .653575E+06   .609840E+03   .000000E+00
      5  .843750E+06   .600900E+03   .000000E+00
      6  .843750E+06  -.600738E+03   .000000E+00
      7  .655268E+06  -.608771E+03   .000000E+00
      8  .468233E+06  -.609887E+03   .000000E+00
      9  .280874E+06  -.611365E+03   .000000E+00
     10  .936244E+05  -.610429E+03   .000000E+00
0    ITERATION NUMBER=   19
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .102590E+04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593985E+03   .240316E+02       .000000E+00
      2  .720950E+04       .000000E+00   .240312E+02       .000000E+00
      3  .144188E+05       .000000E+00   .240300E+02       .000000E+00
      4  .216275E+05       .000000E+00   .240280E+02       .000000E+00
      5  .288356E+05       .000000E+00   .240250E+02       .000000E+00
      6  .324658E+05       .000000E+00   .175940E+00       .000000E+00
      7  .288825E+05       .000000E+00  -.240642E+02       .000000E+00
      8  .216627E+05       .000000E+00  -.240670E+02       .000000E+00
      9  .144422E+05       .000000E+00  -.240691E+02       .000000E+00
     10  .722123E+04       .000000E+00  -.240703E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.240707E+02       .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937347E+05   .611177E+03   .000000E+00
      2  .281122E+06   .610543E+03   .000000E+00
      3  .468592E+06   .610995E+03   .000000E+00
      4  .660773E+06   .609720E+03   .000000E+00
      5  .843750E+06   .600342E+03   .000000E+00
      6  .843750E+06  -.602392E+03   .000000E+00
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      7  .658597E+06  -.610506E+03   .000000E+00
      8  .468206E+06  -.611568E+03   .000000E+00
      9  .280847E+06  -.610377E+03   .000000E+00
     10  .936518E+05  -.610427E+03   .000000E+00
0    ITERATION NUMBER=   20
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .132725E+04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593742E+03   .257361E+02       .000000E+00
      2  .772083E+04       .000000E+00   .257357E+02       .000000E+00
      3  .154414E+05       .000000E+00   .257344E+02       .000000E+00
      4  .231615E+05       .000000E+00   .257324E+02       .000000E+00
      5  .308809E+05       .000000E+00   .257295E+02       .000000E+00
      6  .347690E+05       .000000E+00   .190770E+00       .000000E+00
      7  .309318E+05       .000000E+00  -.257719E+02       .000000E+00
      8  .231997E+05       .000000E+00  -.257748E+02       .000000E+00
      9  .154669E+05       .000000E+00  -.257768E+02       .000000E+00
     10  .773355E+04       .000000E+00  -.257780E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.257785E+02       .000000E+00
0 ELEMENT           STRESSES           PL.STRAIN
      1  .937074E+05   .610848E+03   .000000E+00
      2  .281122E+06   .611055E+03   .000000E+00
      3  .468565E+06   .610870E+03   .000000E+00
      4  .648150E+06   .610901E+03   .000000E+00
      5  .843750E+06   .600838E+03   .000000E+00
      6  .843750E+06  -.601692E+03   .000000E+00
      7  .652765E+06  -.609637E+03   .000000E+00
      8  .468206E+06  -.610898E+03   .000000E+00
      9  .280847E+06  -.610200E+03   .000000E+00
     10  .936518E+05  -.610250E+03   .000000E+00
0    ITERATION NUMBER=   21
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .138270E+04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.594054E+03   .274405E+02       .000000E+00
      2  .823218E+04       .000000E+00   .274401E+02       .000000E+00
      3  .164641E+05       .000000E+00   .274389E+02       .000000E+00
      4  .246956E+05       .000000E+00   .274369E+02       .000000E+00
      5  .329262E+05       .000000E+00   .274339E+02       .000000E+00
      6  .370722E+05       .000000E+00   .205636E+00       .000000E+00
      7  .329811E+05       .000000E+00  -.274796E+02       .000000E+00
      8  .247367E+05       .000000E+00  -.274825E+02       .000000E+00
      9  .164915E+05       .000000E+00  -.274846E+02       .000000E+00
     10  .824588E+04       .000000E+00  -.274858E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.274862E+02       .000000E+00
0 ELEMENT           STRESSES           PL.STRAIN
      1  .937621E+05   .611171E+03   .000000E+00
      2  .281204E+06   .610622E+03   .000000E+00
      3  .468565E+06   .610131E+03   .000000E+00
      4  .666202E+06   .610348E+03   .000000E+00
      5  .843750E+06   .599732E+03   .000000E+00
      6  .843750E+06  -.600335E+03   .000000E+00
      7  .661093E+06  -.610076E+03   .000000E+00
      8  .468233E+06  -.610276E+03   .000000E+00
      9  .280874E+06  -.610768E+03   .000000E+00
     10  .936518E+05  -.610673E+03   .000000E+00
0    ITERATION NUMBER=   22
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .257394E+04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593926E+03   .291450E+02       .000000E+00
      2  .874350E+04       .000000E+00   .291446E+02       .000000E+00
      3  .174868E+05       .000000E+00   .291433E+02       .000000E+00
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      4  .262295E+05      .000000E+00  .291413E+02      .000000E+00
      5  .349716E+05      .000000E+00  .291384E+02      .000000E+00
      6  .393755E+05      .000000E+00  .220430E+00      .000000E+00
      7  .350304E+05      .000000E+00 -.291874E+02      .000000E+00
      8  .262736E+05      .000000E+00 -.291903E+02      .000000E+00
      9  .175162E+05      .000000E+00 -.291923E+02      .000000E+00
     10  .875820E+04      .000000E+00 -.291935E+02      .000000E+00
     11  .000000E+00      -.593303E+03 -.291939E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .936800E+05  .611008E+03  .000000E+00
      2  .281150E+06  .611215E+03  .000000E+00
      3  .468537E+06  .610537E+03  .000000E+00
      4  .634632E+06  .609726E+03  .000000E+00
      5  .843750E+06  .600396E+03  .000000E+00
      6  .843750E+06 -.600143E+03  .000000E+00
      7  .646526E+06 -.609499E+03  .000000E+00
      8  .468206E+06 -.611745E+03  .000000E+00
      9  .280847E+06 -.610554E+03  .000000E+00
     10  .936518E+05 -.610604E+03  .000000E+00
0   ITERATION NUMBER=  23
0   CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .262991E+04
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00      -.594224E+03  .308495E+02      .000000E+00
      2  .925486E+04      .000000E+00  .308491E+02      .000000E+00
      3  .185095E+05      .000000E+00  .308479E+02      .000000E+00
      4  .277636E+05      .000000E+00  .308458E+02      .000000E+00
      5  .370169E+05      .000000E+00  .308426E+02      .000000E+00
      6  .416787E+05      .000000E+00  .235343E+00      .000000E+00
      7  .370797E+05      .000000E+00 -.308950E+02      .000000E+00
      8  .278106E+05      .000000E+00 -.308981E+02      .000000E+00
      9  .185408E+05      .000000E+00 -.309001E+02      .000000E+00
     10  .927054E+04      .000000E+00 -.309013E+02      .000000E+00
     11  .000000E+00      -.593303E+03 -.309017E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937347E+05  .611254E+03  .000000E+00
      2  .281150E+06  .610272E+03  .000000E+00
      3  .468565E+06  .610477E+03  .000000E+00
      4  .679720E+06  .610818E+03  .000000E+00
      5  .843750E+06  .600044E+03  .000000E+00
      6  .843750E+06 -.600261E+03  .000000E+00
      7  .667335E+06 -.609079E+03  .000000E+00
      8  .468206E+06 -.610512E+03  .000000E+00
      9  .280847E+06 -.610308E+03  .000000E+00
     10  .936518E+05 -.610358E+03  .000000E+00
0   ITERATION NUMBER=  24
0   CONVERGENCE CODE= 999  NORM OF RESIDUAL SUM RATIO=  .609336E+04
0   NODE   DISPL.          REACTION      DISPL.          REACTION
      1  .000000E+00      -.593804E+03  .325539E+02      .000000E+00
      2  .976618E+04      .000000E+00  .325535E+02      .000000E+00
      3  .195321E+05      .000000E+00  .325522E+02      .000000E+00
      4  .292975E+05      .000000E+00  .325502E+02      .000000E+00
      5  .390623E+05      .000000E+00  .325473E+02      .000000E+00
      6  .439819E+05      .000000E+00  .250097E+00      .000000E+00
      7  .391289E+05      .000000E+00 -.326029E+02      .000000E+00
      8  .293476E+05      .000000E+00 -.326058E+02      .000000E+00
      9  .195655E+05      .000000E+00 -.326078E+02      .000000E+00
     10  .978285E+04      .000000E+00 -.326090E+02      .000000E+00
     11  .000000E+00      -.593303E+03 -.326094E+02      .000000E+00
0 ELEMENT          STRESSES          PL.STRAIN
      1  .937347E+05  .610911E+03  .000000E+00
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      2  .281232E+06   .610855E+03   .000000E+00
      3  .468565E+06   .610508E+03   .000000E+00
      4  .600781E+06   .610046E+03   .000000E+00
      5  .843750E+06   .600602E+03   .000000E+00
      6  .843750E+06  -.600784E+03   .000000E+00
      7  .630919E+06  -.609191E+03   .000000E+00
      8  .468233E+06  -.610306E+03   .000000E+00
      9  .280874E+06  -.610306E+03   .000000E+00
     10  .936518E+05  -.610211E+03   .000000E+00
0    ITERATION NUMBER=   25
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .614989E+04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593953E+03   .342585E+02       .000000E+00
      2  .102776E+05       .000000E+00   .342581E+02       .000000E+00
      3  .205549E+05       .000000E+00   .342568E+02       .000000E+00
      4  .308317E+05       .000000E+00   .342548E+02       .000000E+00
      5  .411077E+05       .000000E+00   .342511E+02       .000000E+00
      6  .462852E+05       .000000E+00   .265129E+00       .000000E+00
      7  .411783E+05       .000000E+00  -.343104E+02       .000000E+00
      8  .308846E+05       .000000E+00  -.343136E+02       .000000E+00
      9  .205902E+05       .000000E+00  -.343157E+02       .000000E+00
     10  .102952E+05       .000000E+00  -.343169E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.343173E+02       .000000E+00
0  ELEMENT           STRESSES           PL.STRAIN
      1  .937347E+05   .611062E+03   .000000E+00
      2  .281122E+06   .610428E+03   .000000E+00
      3  .468537E+06   .610591E+03   .000000E+00
      4  .713571E+06   .610627E+03   .000000E+00
      5  .843750E+06   .600072E+03   .000000E+00
      6  .843750E+06  -.601472E+03   .000000E+00
      7  .682943E+06  -.610687E+03   .000000E+00
      8  .468206E+06  -.611887E+03   .000000E+00
      9  .280874E+06  -.610552E+03   .000000E+00
     10  .936518E+05  -.610458E+03   .000000E+00
0    ITERATION NUMBER=   26
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .151202E+05
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.593921E+03   .359628E+02       .000000E+00
      2  .107888E+05       .000000E+00   .359624E+02       .000000E+00
      3  .215774E+05       .000000E+00   .359611E+02       .000000E+00
      4  .323656E+05       .000000E+00   .359591E+02       .000000E+00
      5  .431529E+05       .000000E+00   .359562E+02       .000000E+00
      6  .485884E+05       .000000E+00   .279762E+00       .000000E+00
      7  .432275E+05       .000000E+00  -.360184E+02       .000000E+00
      8  .324215E+05       .000000E+00  -.360213E+02       .000000E+00
      9  .216148E+05       .000000E+00  -.360233E+02       .000000E+00
     10  .108075E+05       .000000E+00  -.360245E+02       .000000E+00
     11  .000000E+00      -.593303E+03  -.360249E+02       .000000E+00
0  ELEMENT           STRESSES           PL.STRAIN
      1  .937074E+05   .610952E+03   .000000E+00
      2  .281095E+06   .611015E+03   .000000E+00
      3  .468565E+06   .610439E+03   .000000E+00
      4  .516182E+06   .610121E+03   .000000E+00
      5  .843750E+06   .601307E+03   .000000E+00
      6  .843750E+06  -.599866E+03   .000000E+00
      7  .591901E+06  -.610515E+03   .000000E+00
      8  .468206E+06  -.610790E+03   .000000E+00
      9  .280874E+06  -.610441E+03   .000000E+00
     10  .936244E+05  -.610490E+03   .000000E+00
0    ITERATION NUMBER=   27
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0 CONVERGENCE CODE= 1 NORM OF RESIDUAL SUM RATIO= .138565E+05

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.593958E+03	.376676E+02	.000000E+00
2	.113003E+05	.000000E+00	.376672E+02	.000000E+00
3	.226004E+05	.000000E+00	.376660E+02	.000000E+00
4	.338999E+05	.000000E+00	.376639E+02	.000000E+00
5	.451984E+05	.000000E+00	.376589E+02	.000000E+00
6	.508916E+05	.000000E+00	.295085E+00	.000000E+00
7	.452770E+05	.000000E+00	-.377254E+02	.000000E+00
8	.339587E+05	.000000E+00	-.377293E+02	.000000E+00
9	.226395E+05	.000000E+00	-.377313E+02	.000000E+00
10	.113199E+05	.000000E+00	-.377325E+02	.000000E+00
11	.000000E+00	-.593303E+03	-.377329E+02	.000000E+00

0 ELEMENT	STRESSES	PL.STRAIN
1	.937621E+05	.611129E+03	.000000E+00
2	.281150E+06	.610784E+03	.000000E+00
3	.468510E+06	.609961E+03	.000000E+00
4	.782944E+06	.610223E+03	.000000E+00
5	.843750E+06	.600096E+03	.000000E+00
6	.843750E+06	-.599014E+03	.000000E+00
7	.721964E+06	-.609142E+03	.000000E+00
8	.468233E+06	-.610530E+03	.000000E+00
9	.280874E+06	-.610529E+03	.000000E+00
10	.936244E+05	-.610579E+03	.000000E+00

0 ITERATION NUMBER= 28

0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .413846E+06

0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.594795E+03	.394675E+02	.000000E+00
2	.118403E+05	.000000E+00	.394671E+02	.000000E+00
3	.236803E+05	.000000E+00	.394659E+02	.000000E+00
4	.355198E+05	.000000E+00	.394638E+02	.000000E+00
5	.473611E+05	.000000E+00	.394778E+02	.000000E+00
6	.533101E+05	.000000E+00	.181620E+00	.000000E+00
7	.474115E+05	.000000E+00	-.395051E+02	.000000E+00
8	.355595E+05	.000000E+00	-.395079E+02	.000000E+00
9	.237067E+05	.000000E+00	-.395100E+02	.000000E+00
10	.118535E+05	.000000E+00	-.395112E+02	.000000E+00
11	.000000E+00	-.591781E+03	-.395116E+02	.000000E+00

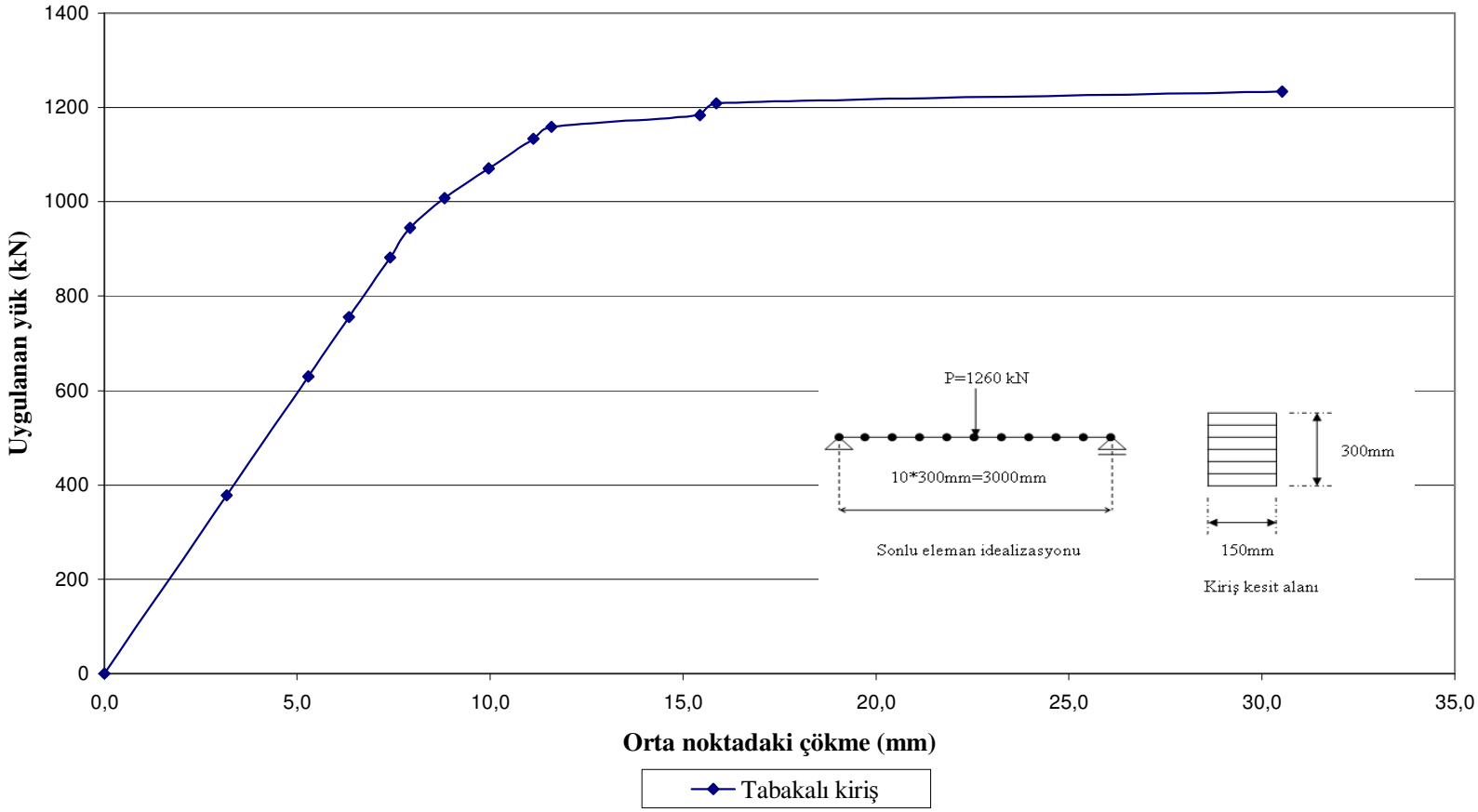
0 ELEMENT	STRESSES	PL.STRAIN
1	.941455E+05	.612897E+03	.000000E+00
2	.282190E+06	.612174E+03	.000000E+00
3	.470399E+06	.612509E+03	.000000E+00
4	-.358639E+07	.612491E+03	.000000E+00
5	.843750E+06	.600335E+03	.000000E+00
6	.843750E+06	-.601601E+03	.000000E+00
7	.493744E+06	-.609903E+03	.000000E+00
8	.468206E+06	-.609411E+03	.000000E+00
9	.280847E+06	-.609206E+03	.000000E+00
10	.935970E+05	-.609545E+03	.000000E+00

0 ITERATION NUMBER= 29

0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .136702E+08

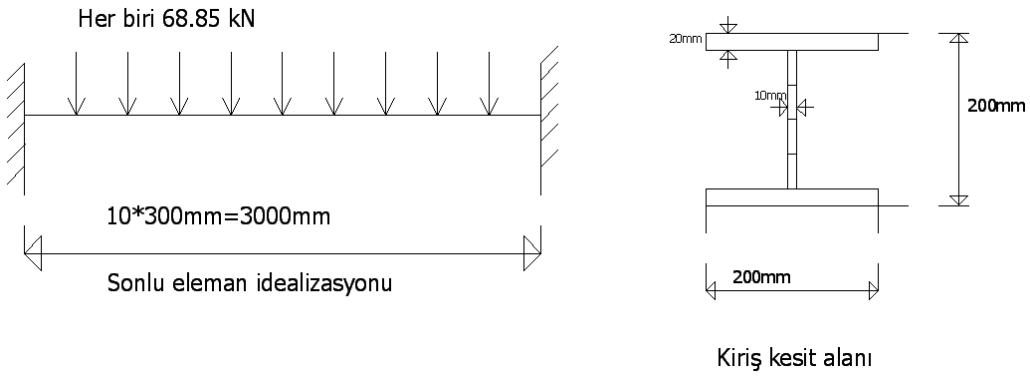
0 NODE	DISPL.	REACTION	DISPL.	REACTION
1	.000000E+00	-.594413E+03	.413696E+02	.000000E+00
2	.124109E+05	.000000E+00	.413692E+02	.000000E+00
3	.248216E+05	.000000E+00	.413680E+02	.000000E+00
4	.372317E+05	.000000E+00	.413659E+02	.000000E+00
5	.495466E+05	.000000E+00	.407330E+02	.000000E+00
6	.557106E+05	.000000E+00	.359782E+00	.000000E+00
7	.495694E+05	.000000E+00	-.413011E+02	.000000E+00
8	.371782E+05	.000000E+00	-.413064E+02	.000000E+00

9 .247858E+05 .000000E+00 -.413085E+02 .000000E+00
10 .123930E+05 .000000E+00 -.413097E+02 .000000E+00
11 .000000E+00 -.591804E+03 -.413101E+02 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .943645E+05 .613621E+03 .000000E+00
2 .283094E+06 .612904E+03 .000000E+00
3 .471823E+06 .613684E+03 .000000E+00
4 .140948E+09 .609455E+03 .000000E+00
5 .843750E+06 .599533E+03 .000000E+00
6 .843750E+06 -.599496E+03 .000000E+00
7 .785143E+06 -.611887E+03 .000000E+00
8 .468480E+06 -.609892E+03 .000000E+00
9 .281038E+06 -.609697E+03 .000000E+00
10 .936518E+05 -.609722E+03 .000000E+00
0 ITERATION NUMBER= 30
0 CONVERGENCE CODE= 999 NORM OF RESIDUAL SUM RATIO= .103968E+12
0 NODE DISPL. REACTION DISPL. REACTION
1 .000000E+00 -.207091E+05 .128723E+05 .000000E+00
2 .386169E+07 .000000E+00 .128721E+05 .000000E+00
3 .772328E+07 .000000E+00 .128717E+05 .000000E+00
4 .115847E+08 .000000E+00 .128708E+05 .000000E+00
5 .392777E+07 .000000E+00 -.639166E+05 .000000E+00
6 -.782481E+06 .000000E+00 .325150E+05 .000000E+00
7 .364067E+07 .000000E+00 -.302748E+04 .000000E+00
8 .273135E+07 .000000E+00 -.303465E+04 .000000E+00
9 .182093E+07 .000000E+00 -.303480E+04 .000000E+00
10 .910474E+06 .000000E+00 -.303489E+04 .000000E+00
11 .000000E+00 .842968E+04 -.303492E+04 .000000E+00
0 ELEMENT STRESSES PL.STRAIN
1 .843749E+06 .149673E+06 -.677470E-01
2 .843750E+06 .147007E+06 -.401720E-01
3 .843753E+06 .149752E+06 -.125970E-01
4 .140948E+09 -.235703E+06 .125970E-01
5 -.164605E+14 -.145952E+06 .401720E-01
6 .843750E+06 .159207E+06 .677470E-01
7 .843749E+06 -.211275E+05 -.206029E+00
8 .843750E+06 -.222574E+05 -.123141E+00
9 .843750E+06 -.223716E+05 -.402534E-01
10 .843750E+06 -.218629E+05 .402534E-01



Şekil 5.11: Tekil yüklü tabakalı kiriş örneği

5.2.2 Uniform yayılı yüklü tabakalı Timoshenko kirişi örneği



Şekil 5.12: Tabakalı Timoshenko kirişinde uniform yayılı yük hali.

Şekil 5.12'te görüldüğü gibi kiriş kesitinde 10mm kalınlığındaki kısım 4'e bölünmüştür.

Probleme ait bilgilerin programa giriş listesi;

```
11   10    2    1   17    2   14    2    2    6
     1
      210.        53.846        0.25          0.
      200.         200.         20.          10.
       40.         10.          40.          10.
       40.         10.          40.          10.
       40.
 1    1    2    1
 2    2    3    1
 3    3    4    1
 4    4    5    1
 5    5    6    1
 6    6    7    1
 7    7    8    1
```

```
 8    8    9    1
 9    9   10    1
10   10   11    1
     1          0.
     2        300.
     3        600.
     4        900.
     5       1200.
     6       1500.
     7       1800.
     8       2100.
     9       2400.
    10       2700.
    11       3000.
     1    1          0.    1          0.
    11    1          0.    1          0.
     1        68.85          0.        68.85          0.
     2        68.85          0.        68.85          0.
     3        68.85          0.        68.85          0.
     4        68.85          0.        68.85          0.
     5        68.85          0.        68.85          0.
     6        68.85          0.        68.85          0.
     7        68.85          0.        68.85          0.
     8        68.85          0.        68.85          0.
     9        68.85          0.        68.85          0.
    10        68.85          0.        68.85          0.
100    2          0.30          0.5
100    2          0.20          0.5
100    2          0.10          0.5
100    2          0.10          0.5
100    2          0.05          0.5
100    2          0.05          0.5
100    2          0.05          0.5
100    2          0.05          0.5
```

100	2	0.02	0.5
100	2	0.02	0.5
100	2	0.02	0.5
100	2	0.02	0.5
100	2	0.01	0.5
100	2	0.01	0.5

Veri girişi sonrası alınan sonuçlar;

```
NPOIN=   11   NELEM=   10   NBOUN=    2   NMATS=    1

 NPROP=   17   NNODE=    2   NINCS=   14   NALGO=    2

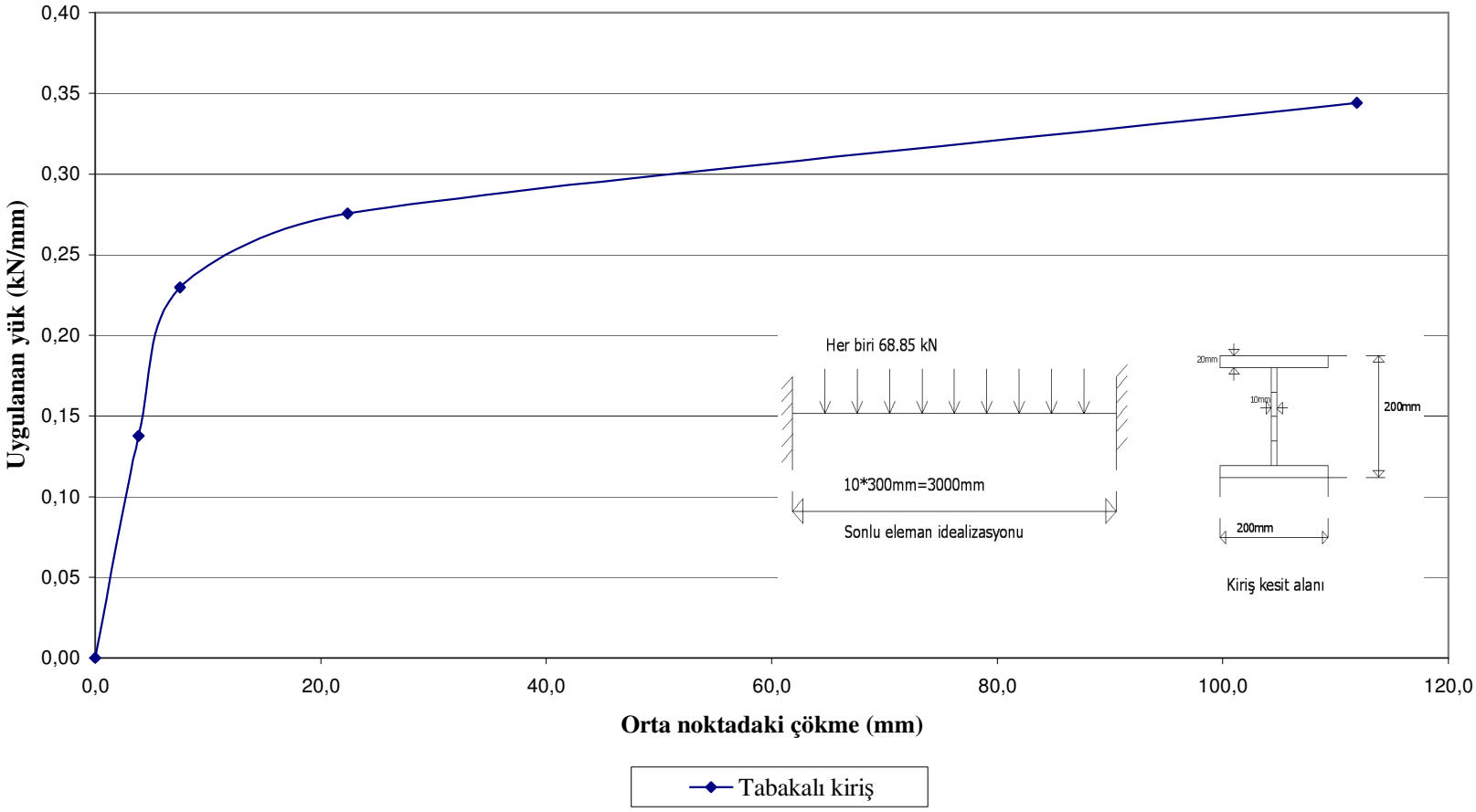
 NDOFN=    2   NLAYR=    6
0     MATERIAL PROPERTIES
        1
     210.00000       53.84600        .25000        .00000
     200.00000      200.00000      20.00000      10.00000
      40.00000      10.00000      40.00000      10.00000
      40.00000      10.00000      40.00000      10.00000
      40.00000
0   EL NODES MAT.
   1    1    2    1
   2    2    3    1
   3    3    4    1
   4    4    5    1
   5    5    6    1
   6    6    7    1
   7    7    8    1
   8    8    9    1
   9    9   10    1
  10   10   11    1
0     NODE     COORD.
        1        .00000
        2      300.00000
        3      600.00000
        4      900.00000
        5     1200.00000
        6     1500.00000
        7     1800.00000
        8     2100.00000
        9     2400.00000
       10     2700.00000
       11     3000.00000
0 RES.NODE  CODE   PRES.VALUES  CODE   PRES.VALUES
        1    1        .00000    1        .00000
       11    1        .00000    1        .00000
0  ELEMENT         NODAL LOADS
        1       68.85000        .00000       68.85000        .00000
        2       68.85000        .00000       68.85000        .00000
        3       68.85000        .00000       68.85000        .00000
        4       68.85000        .00000       68.85000        .00000
        5       68.85000        .00000       68.85000        .00000
        6       68.85000        .00000       68.85000        .00000
```

```
      7     68.85000      .00000     68.85000      .00000
      8     68.85000      .00000     68.85000      .00000
      9     68.85000      .00000     68.85000      .00000
     10     68.85000      .00000     68.85000      .00000
0    IINCS=   1  NITER= 100  NOUTP=   2  FACTO=  .300000E+00  TOLER=  .500000E+00
0    ITERATION NUMBER=   1
0    CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=  .961086E-04
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.206550E+03   .000000E+00      -.102242E+06
      2  .574987E+00       .000000E+00   .268247E-02       .000000E+00
      3  .164811E+01       .000000E+00   .357662E-02       .000000E+00
      4  .274993E+01       .000000E+00   .312954E-02       .000000E+00
      5  .354515E+01       .000000E+00   .178831E-02       .000000E+00
      6  .383257E+01       .000000E+00   .872816E-09       .000000E+00
      7  .354515E+01       .000000E+00  -.178831E-02       .000000E+00
      8  .274993E+01       .000000E+00  -.312954E-02       .000000E+00
      9  .164811E+01       .000000E+00  -.357662E-02       .000000E+00
     10  .574987E+00       .000000E+00  -.268247E-02       .000000E+00
     11  .000000E+00      -.206550E+03   .000000E+00       .102242E+06
0  ELEMENT          STRESSES          PL.STRAIN
      1 -.743579E+05   .185895E+03   .000000E+00
      2 -.247860E+05   .144585E+03   .000000E+00
      3  .123930E+05   .103275E+03   .000000E+00
      4  .371790E+05   .619650E+02   .000000E+00
      5  .495720E+05   .206554E+02   .000000E+00
      6  .495720E+05  -.206548E+02   .000000E+00
      7  .371790E+05  -.619649E+02   .000000E+00
      8  .123930E+05  -.103275E+03   .000000E+00
      9 -.247860E+05  -.144585E+03   .000000E+00
     10 -.743580E+05  -.185895E+03   .000000E+00
0    IINCS=   2  NITER= 100  NOUTP=   2  FACTO=  .200000E+00  TOLER=  .500000E+00
0    ITERATION NUMBER=   1
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=  .115487E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.344250E+03   .000000E+00      -.170404E+06
      2  .958312E+00       .000000E+00   .447078E-02       .000000E+00
      3  .274685E+01       .000000E+00   .596104E-02       .000000E+00
      4  .458322E+01       .000000E+00   .521591E-02       .000000E+00
      5  .590858E+01       .000000E+00   .298052E-02       .000000E+00
      6  .638763E+01       .000000E+00   .657992E-09       .000000E+00
      7  .590858E+01       .000000E+00  -.298052E-02       .000000E+00
      8  .458322E+01       .000000E+00  -.521591E-02       .000000E+00
      9  .274685E+01       .000000E+00  -.596104E-02       .000000E+00
     10  .958312E+00       .000000E+00  -.447078E-02       .000000E+00
     11  .000000E+00      -.344250E+03   .000000E+00       .170404E+06
0  ELEMENT          STRESSES          PL.STRAIN
      1 -.110015E+06   .309825E+03   .150757E-03
      2 -.413100E+05   .240975E+03   .000000E+00
      3  .206550E+05   .172125E+03   .000000E+00
      4  .619650E+05   .103275E+03   .000000E+00
      5  .826200E+05   .344252E+02   .000000E+00
      6  .826200E+05  -.344249E+02  -.299783E-03
      7  .619650E+05  -.103275E+03   .000000E+00
      8  .206550E+05  -.172125E+03   .000000E+00
      9 -.413100E+05  -.240975E+03   .000000E+00
     10 -.110015E+06  -.309825E+03   .000000E+00
0    ITERATION NUMBER=   2
0    CONVERGENCE CODE=   0  NORM OF RESIDUAL SUM RATIO=  .640159E-01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.344250E+03   .000000E+00      -.159888E+06
```

```
      2  .118594E+01       .000000E+00   .598828E-02       .000000E+00
      3  .337282E+01       .000000E+00   .709916E-02       .000000E+00
      4  .549372E+01       .000000E+00   .597466E-02       .000000E+00
      5  .698980E+01       .000000E+00   .335989E-02       .000000E+00
      6  .752575E+01       .000000E+00   .495058E-10       .000000E+00
      7  .698980E+01       .000000E+00  -.335989E-02       .000000E+00
      8  .549372E+01       .000000E+00  -.597466E-02       .000000E+00
      9  .337282E+01       .000000E+00  -.709916E-02       .000000E+00
     10  .118594E+01       .000000E+00  -.598828E-02       .000000E+00
     11  .000000E+00      -.344250E+03   .000000E+00       .159888E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.113341E+06   .309825E+03   .606007E-03
      2 -.307938E+05   .240975E+03   .717924E-05
      3  .311713E+05   .172125E+03   .000000E+00
      4  .724813E+05   .103275E+03   .000000E+00
      5  .931363E+05   .344250E+02  -.717924E-05
      6  .931363E+05  -.344251E+02  -.805616E-03
      7  .724813E+05  -.103275E+03   .000000E+00
      8  .311713E+05  -.172125E+03   .000000E+00
      9 -.307937E+05  -.240975E+03   .000000E+00
     10 -.113341E+06  -.309825E+03   .000000E+00
0    IINCS=   3  NITER= 100  NOUTP=   2  FACTO=   .100000E+00  TOLER=   .500000E+00
0    ITERATION NUMBER=    1
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .128120E+02
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.413100E+03   .000000E+00      -.170082E+06
      2  .189461E+01       .000000E+00   .103292E-01       .000000E+00
      3  .534397E+01       .000000E+00   .108764E-01       .000000E+00
      4  .847841E+01       .000000E+00   .874121E-02       .000000E+00
      5  .106273E+02       .000000E+00   .481768E-02       .000000E+00
      6  .113883E+02       .000000E+00   .162957E-08       .000000E+00
      7  .106273E+02       .000000E+00  -.481768E-02       .000000E+00
      8  .847841E+01       .000000E+00  -.874121E-02       .000000E+00
      9  .534397E+01       .000000E+00  -.108764E-01       .000000E+00
     10  .189461E+01       .000000E+00  -.103292E-01       .000000E+00
     11  .000000E+00      -.413100E+03   .000000E+00       .170082E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.114314E+06   .371790E+03   .190828E-02
      2 -.151698E+05   .289170E+03   .875358E-03
      3  .591882E+05   .206550E+03   .000000E+00
      4  .107774E+06   .123930E+03   .000000E+00
      5  .110792E+06   .413098E+02  -.875358E-03
      6  .110792E+06  -.413099E+02  -.225258E-02
      7  .107774E+06  -.123930E+03   .000000E+00
      8  .591882E+05  -.206550E+03   .000000E+00
      9 -.151697E+05  -.289170E+03   .000000E+00
     10 -.114314E+06  -.371790E+03   .000000E+00
0    ITERATION NUMBER=    2
0    CONVERGENCE CODE=   1  NORM OF RESIDUAL SUM RATIO=   .944435E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.413100E+03   .000000E+00      -.172113E+06
      2  .325417E+01       .000000E+00   .193929E-01       .000000E+00
      3  .943362E+01       .000000E+00   .200134E-01       .000000E+00
      4  .153201E+02       .000000E+00   .179514E-01       .000000E+00
      5  .202384E+02       .000000E+00   .140697E-01       .000000E+00
      6  .223872E+02       .000000E+00  -.720083E-07       .000000E+00
      7  .202384E+02       .000000E+00  -.140697E-01       .000000E+00
      8  .153201E+02       .000000E+00  -.179514E-01       .000000E+00
      9  .943361E+01       .000000E+00  -.200133E-01       .000000E+00
     10  .325416E+01       .000000E+00  -.193929E-01       .000000E+00
```

```
      11  .000000E+00      -.413100E+03   .000000E+00       .172112E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.116000E+06   .371790E+03   .462739E-02
      2 -.171999E+05   .289170E+03   .268810E-02
      3  .571582E+05   .206550E+03   .102382E-03
      4  .106613E+06   .123930E+03  -.102382E-03
      5  .115152E+06   .413103E+02  -.268810E-02
      6  .115152E+06  -.413103E+02  -.527382E-02
      7  .106613E+06  -.123930E+03   .000000E+00
      8  .571580E+05  -.206550E+03   .000000E+00
      9 -.172000E+05  -.289170E+03   .000000E+00
     10 -.116000E+06  -.371790E+03   .000000E+00
0    ITERATION NUMBER=    3
0    CONVERGENCE CODE=   1   NORM OF RESIDUAL SUM RATIO=   .926178E+01
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.413097E+03   .000000E+00      -.171768E+06
      2  .144469E+02       .000000E+00   .940113E-01       .000000E+00
      3  .430100E+02       .000000E+00   .946194E-01       .000000E+00
      4  .712765E+02       .000000E+00   .925451E-01       .000000E+00
      5  .985701E+02       .000000E+00   .886451E-01       .000000E+00
      6  .111905E+03       .000000E+00   .132569E-05       .000000E+00
      7  .985705E+02       .000000E+00  -.886454E-01       .000000E+00
      8  .712768E+02       .000000E+00  -.925454E-01       .000000E+00
      9  .430102E+02       .000000E+00  -.946197E-01       .000000E+00
     10  .144470E+02       .000000E+00  -.940116E-01       .000000E+00
     11  .000000E+00      -.413098E+03   .000000E+00       .171768E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.116000E+06   .371786E+03   .270129E-01
      2 -.168573E+05   .289164E+03   .176118E-01
      3  .574994E+05   .206550E+03   .507694E-02
      4  .107122E+06   .123933E+03  -.507694E-02
      5  .116000E+06   .413106E+02  -.176118E-01
      6  .116000E+06  -.413081E+02  -.301466E-01
      7  .107123E+06  -.123932E+03   .000000E+00
      8  .575000E+05  -.206549E+03   .000000E+00
      9 -.168567E+05  -.289171E+03   .000000E+00
     10 -.116000E+06  -.371788E+03   .000000E+00
0    ITERATION NUMBER=    4
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .135229E+09
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.479563E+03   .000000E+00      -.174186E+06
      2  .813898E+06       .000000E+00   .542599E+04       .000000E+00
      3  .244169E+07       .000000E+00   .542599E+04       .000000E+00
      4  .406949E+07       .000000E+00   .542599E+04       .000000E+00
      5  .569729E+07       .000000E+00   .542599E+04       .000000E+00
      6  .484165E+07       .000000E+00  -.111303E+05       .000000E+00
      7  .277560E+07       .000000E+00  -.264342E+04       .000000E+00
      8  .198257E+07       .000000E+00  -.264342E+04       .000000E+00
      9  .118954E+07       .000000E+00  -.264342E+04       .000000E+00
     10  .396514E+06       .000000E+00  -.264342E+04       .000000E+00
     11  .000000E+00      -.426317E+03   .000000E+00       .173751E+06
0 ELEMENT          STRESSES          PL.STRAIN
      1 -.116000E+06   .382303E+03   .162779E+04
      2 -.439276E+05   .152445E+03   .108520E+04
      3  .335876E+04   .135036E+03   .361731E+03
      4  .259107E+05   .609809E+03  -.361731E+03
      5  .116000E+06  -.217403E+03  -.108520E+04
      6 -.235257E+12   .380937E+02  -.180866E+04
      7  .800531E+05   .137936E+03   .000000E+00
      8  .507325E+05  -.141871E+03   .000000E+00
```

```
      9 -.168567E+05  -.263931E+03   .000000E+00
     10 -.116000E+06  -.359167E+03   .000000E+00
0    ITERATION NUMBER=    5
0    CONVERGENCE CODE= 999   NORM OF RESIDUAL SUM RATIO=   .424689E+12
0    NODE    DISPL.          REACTION       DISPL.          REACTION
      1  .000000E+00      -.567864E+08   .000000E+00       .877179E+09
      2  .107387E+13       .000000E+00   .715914E+10       .000000E+00
      3  .322161E+13       .000000E+00   .715914E+10       .000000E+00
      4  .536936E+13       .000000E+00   .715914E+10       .000000E+00
      5  .751710E+13       .000000E+00   .715914E+10       .000000E+00
      6  .160584E+14       .000000E+00   .497826E+11       .000000E+00
      7  .205850E+14       .000000E+00  -.196048E+11       .000000E+00
      8  .147036E+14       .000000E+00  -.196048E+11       .000000E+00
      9  .882215E+13       .000000E+00  -.196048E+11       .000000E+00
     10  .294072E+13       .000000E+00  -.196048E+11       .000000E+00
     11  .000000E+00      -.426317E+03   .000000E+00       .173751E+06
0 ELEMENT           STRESSES           PL.STRAIN
      1 -.116000E+06   .231585E+08   .214774E+10
      2  .115948E+06  -.153284E+09   .143183E+10
      3 -.115843E+06   .463163E+08   .477276E+09
      4 -.114581E+06   .280103E+09  -.477276E+09
      5 -.108605E+19  -.242609E+09  -.143183E+10
      6  .192342E+19  -.463162E+09  -.238638E+10
      7 -.110382E+06  -.529326E+08  -.153598E+03
      8 -.111785E+06   .688126E+09  -.102398E+03
      9 -.168567E+05  -.255842E+09  -.341320E+02
     10 -.116000E+06   .295541E+09   .341320E+02
```



Şekil 5.13: Uniform yayılı yüklü tabakalı Timoshenko kirişi örneği

6. SONUÇ ve ÖNERİLER

Bu çalışmada Timoshenko kirişinin sonlu elemanlar yöntemi ile elastoplastik analizi yapılmıştır. Bu amaçla daha önce Fortran dilinde kodlanmış olan kapsamlı bir sonlu eleman programı Windows altında tekrar yazılarak derlenmiştir.

Kullanılan yazılımda iki serbestlikli çubuk eleman (Hughes elemanı) kullanılarak yapılan yaklaşıma karşılık tezde kayma şekil değiştirmesini dikkate alan kiriş sonlu eleman rijitlik matrisi kullanılmıştır. Kirişin elastik zemine oturma hali de incelenmiştir. Bu amaçla tek parametreli zemine (Winkler zemini) ait rijitlik matrisi kayma şekil değiştirmesini de içeren matrise eklenmiştir. Mevcut program bu şekilde değiştirilmiştir.

Aynı yazılım kullanılarak en kesitin tabakalı olması haline karşı gelen hal de incelenmiştir. Tabakalı halde, enkesit yükseklik boyunca yeteri sayıda tabakaya ayrılmakta her tabakanın orta noktasında oluşan eğilme momenti plastikleşme momentine eriştiğinde o tabakanın plastikleştiği varsayılmaktadır. En dış tabakadan içe doğru tüm tabakalar plastikleştiğinde kesit tümüyle plastikleşmiş olmaktadır. Tabaka sayısı arttıkça sonuçların daha da iyileştiği açıktır.

Malzemenin ideal elastoplastik olduğu varsayılmıştır. Aynı yazılımda pekleşme de dikkate alınabilmektedir.

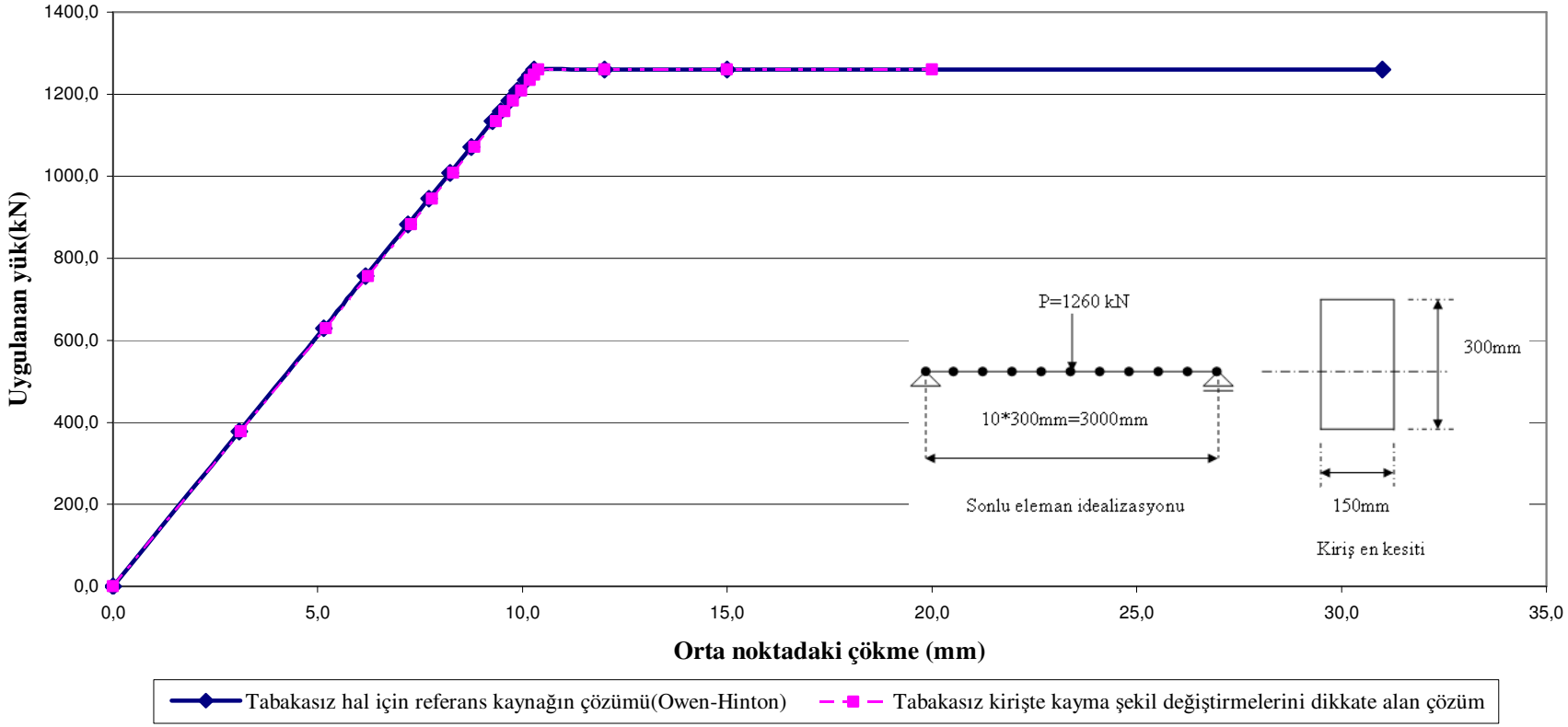
Derlenen yazılım tekil yük etkisindeki basit kiriş ve yayılı yük etkisindeki ankastre kiriş örnekleri tabakasız ve tabakalı haller için kullanılmış, sonuçlar çıktı ve diyagramlar halinde karşılaştırılmalı olarak sunulmuştur. Basit kiriş örneğinde dikdörtgen kesit, yayılı yük halinde ise (I) kesit alınmıştır. Basit kiriş örneğinde 3

farklı elastik zemin için yapılan uygulamalar, verilen örnek için, değerlerin çok fazla fark etmediğini göstermektedir.

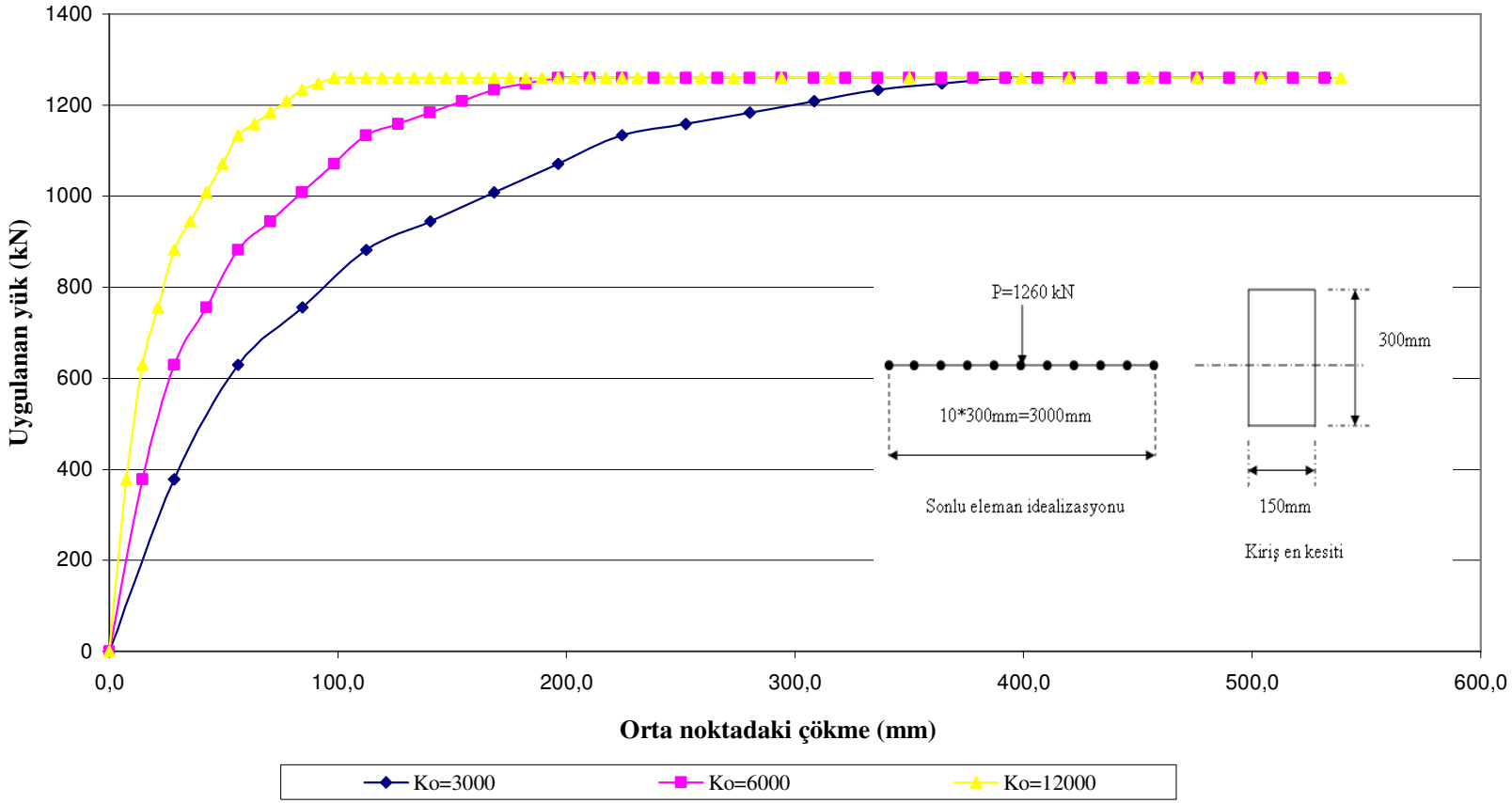
Tabakalı halde yük yer değiştirme diyagramının keskin köşeler yerine, tabaka tabaka plastikleşme olduğu için, beklendiği üzere yumuşak eğriler şeklinde oluştuğu görülmektedir. Bu halde diyagram tabakasız hale çok yakın, ama onun biraz altında seyretmektedir.

Bu geliştirilmiş yazılım sayesinde Timoshenko kirişinin elastik zemine oturma halini de kapsayacak şekilde elastoplastik analizi yapılabilmektedir. Tez kapsamı içerisinde iyileştirilmiş yazılıma ait program listesi ve giriş bilgileri ayrıntılı olarak açıklanmış ve araştırmacıların programı kolayca kullanımı sağlanmıştır. Sayısal hesaplardan elde edilen sonuçlar kaynaklardakiler ile örtüşmektedir. Toplu sonuçlar (Şekil6.1-6.5) de diyagramları ile karşılaştırmalı olarak verilmiştir.

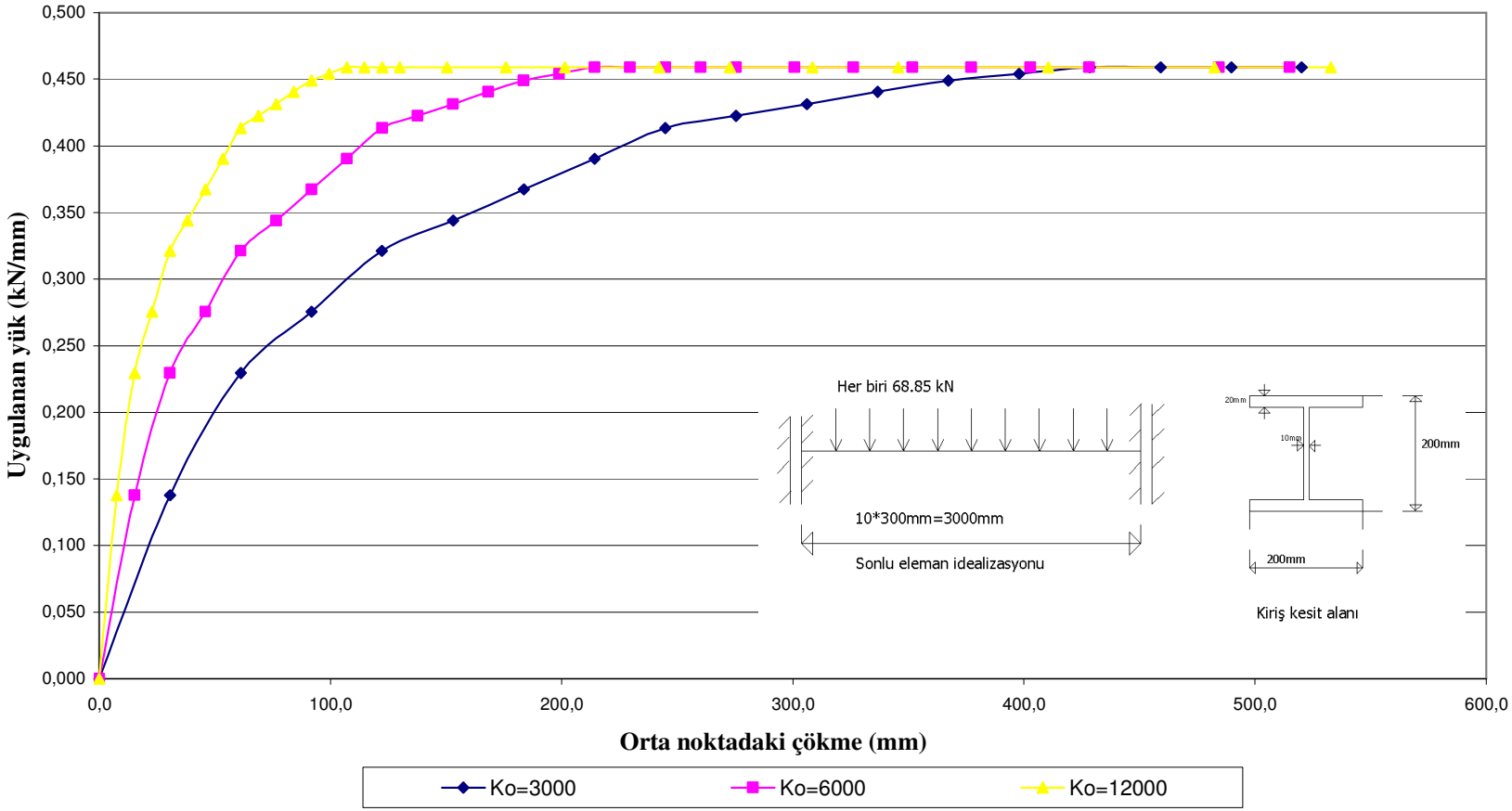
İleri bir adım olarak aynı yol izlenerek iki parametreli zeminler için de analiz yapılabilir.



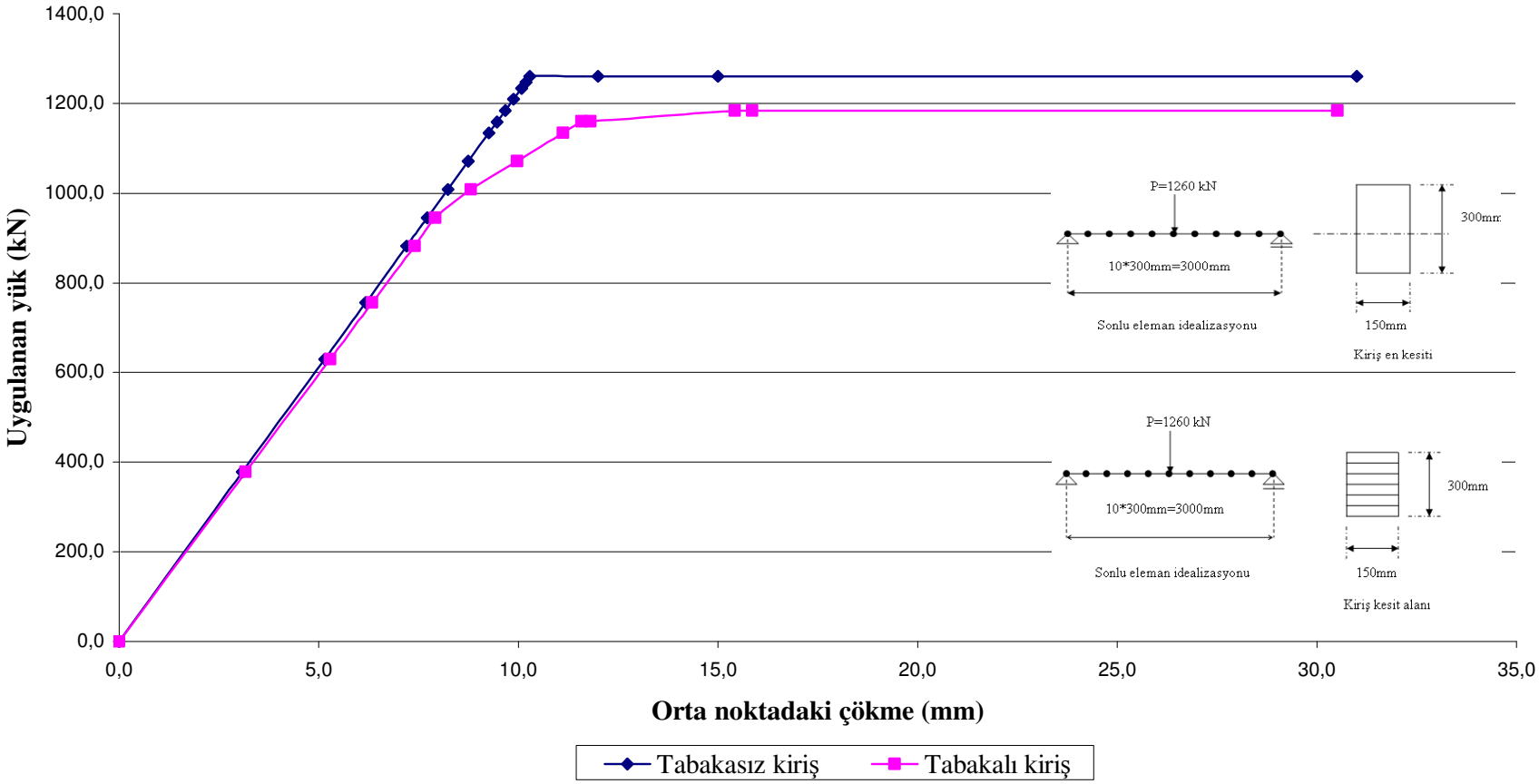
Şekil 6.1: Tabakasız Kirişte Tekil Yük Hali İçin Referans Kaynak Çözümü ile Kayma Şekil Değiştirmesini Dikkate Alan Çözümün Karşılaştırılması



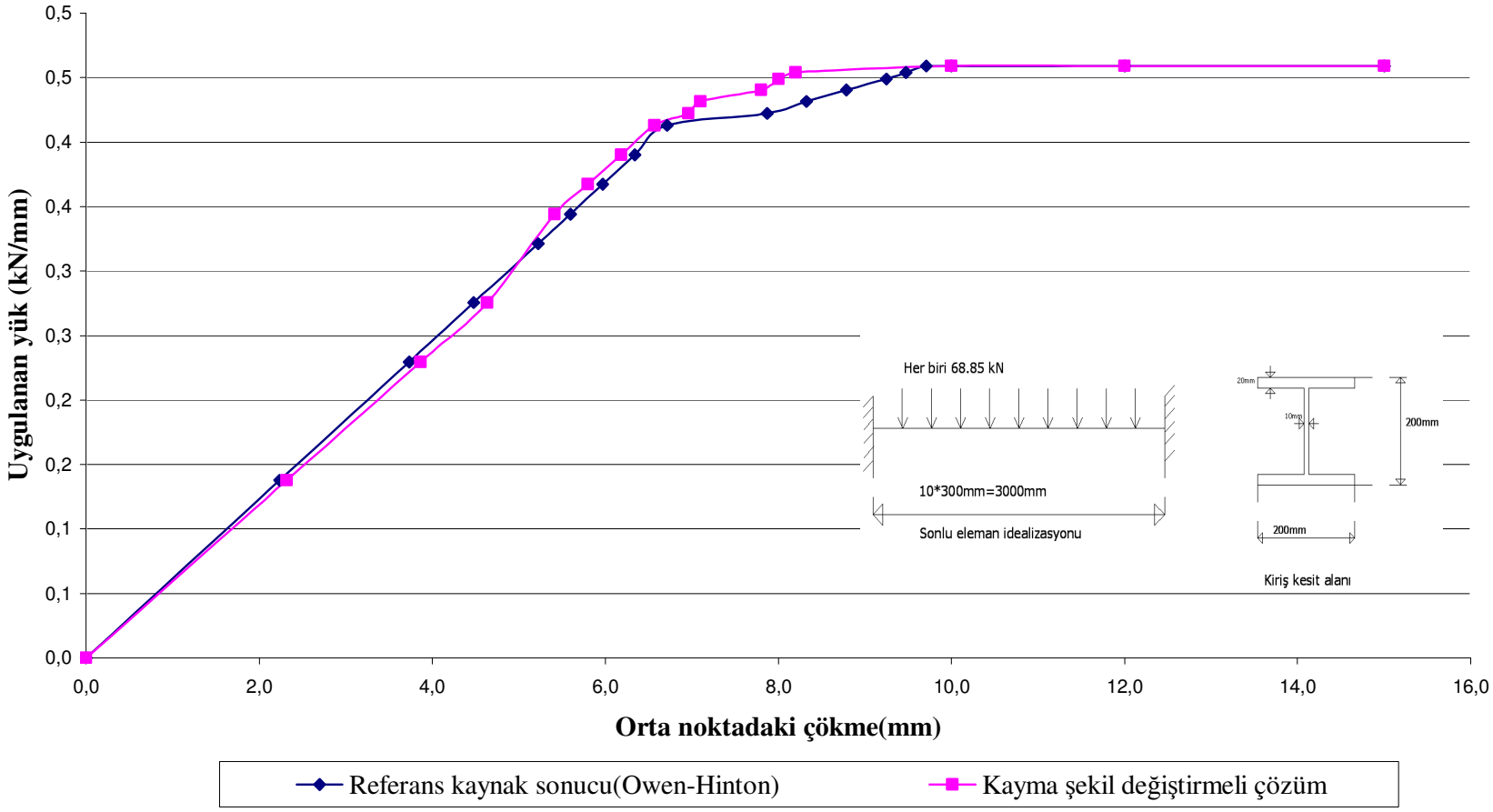
Şekil 6.2: Tabakasız kirişte tekil yük halinde 3 farklı zemin durumu için karşılaştırma



Şekil 6.3: Tabakasız kirişte yayılı yük halinde 3 farklı zemin durumunda karşılaştırma



Şekil 6.4: Tekil Yük Hali İçin Tabakasız Kirişle Tabakalı Kirişin Karşılaştırılması



Şekil 6.5: Tabakasız Kirişe Yayılı Yük Etkimesi Hali İçin Karşılaştırma

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