5.1.2.4 Drilled Shaft Modeling (Fully Coupled)

Programs M-STRUDL and COM624 can be used in an iterative approach to model a drilled shaft supported structure. The approach is to determine the approximate force magnitudes for the controlling loading and then use these forces to develop a better representation of the superstructure/shaft/soil problem. This allows a good approximation of soil stiffness non-linearity as well as the non-linearity of the shaft-soil interaction.

The following steps would be typical for drilled shaft modeling for design and checking:

1 Develop a full M-STRUDL model (superstructure with substructure) using shaft fixity at two shaft diameters below the groundline. Using the model, run the controlling load case--typically seismic loading will be the controlling case and the worst effect, either longitudinal or transverse, will be used for the next steps.

2 Develop COM624 models (shaft with soil) for each bent using the full shaft from its tip to its connection to the superstructure.

3 Using the top of shaft shear and moment results from the first M-STRUDL, load the COM624 models to develop a stiffness matrix for each shaft. This represents a condensing of the substructure/soil effect to the point of connection with the superstructure.

4 Develop a new M-STRUDL model using only the superstructure and supports represented by the COM624 developed substructure stiffness matrices. Run the same controlling load case.

5 Use the top of shaft shear and moment results from this latest M-STRUDL to again load the COM624 models to develop new substructure stiffness matrices.

6 Use the latest M-STRUDL model with the most recent substructure stiffness matrices and again run the same controlling load case.

7 Compare the results of this M-STRUDL with the previous M-STRUDL run for correlation. If the results do not correlate well, cycle through steps 5 and 6 to get better convergence . Results which change no more than 15% per cycle are normally sufficiently close and further cycling is not required.

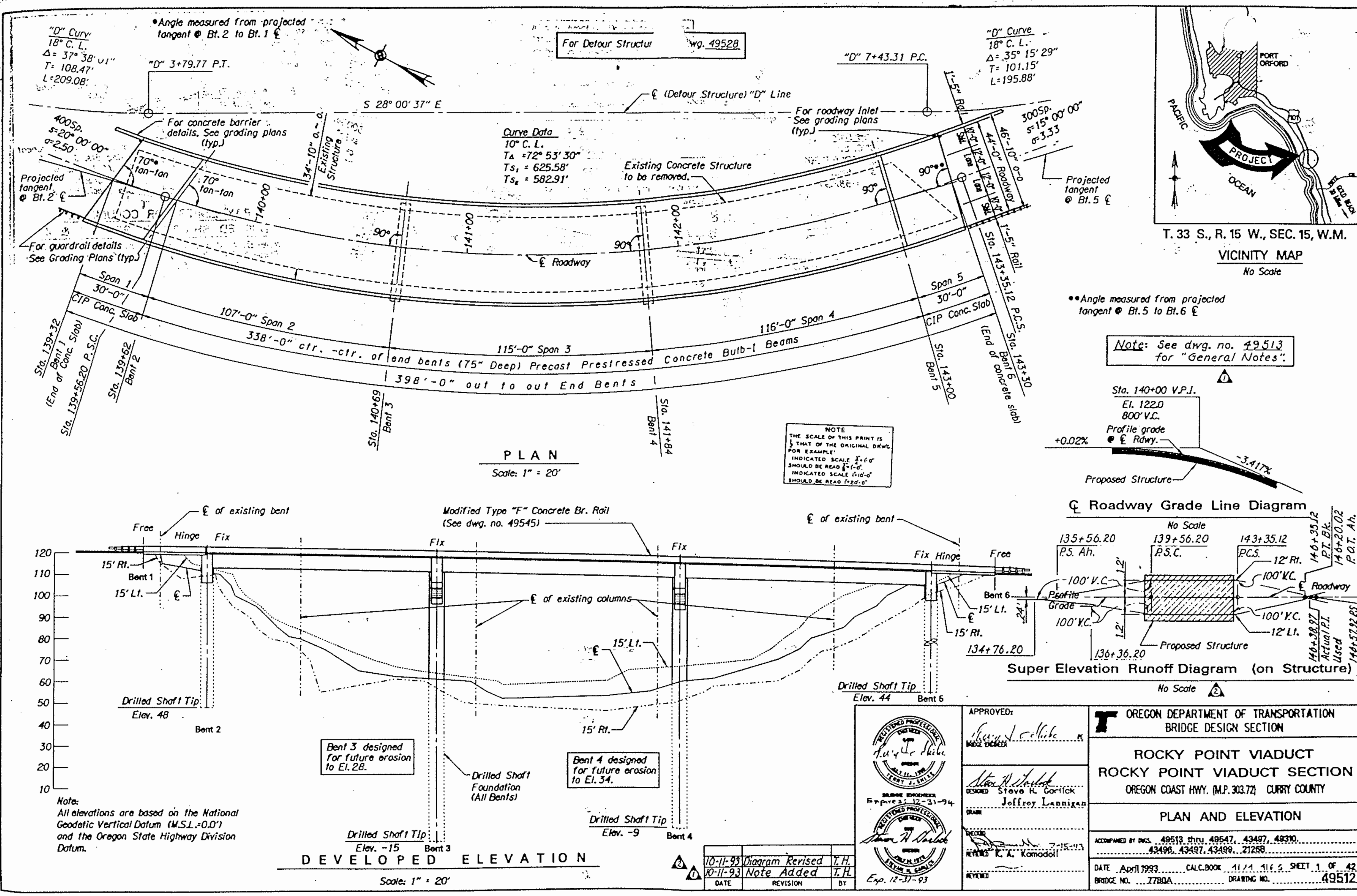
A sample problem using this approach is in Appendix Section A5.1.2.4.

A5.1.2.4 Drilled Shaft Modeling Sample Problem

The following 68 sheets demonstrate the use of M-STRUDL and COM624 in modeling a drilled shaft structure. This sample comes from a production job so it does not have extensive annotation. Only sheets pertaining to modeling have been included to reduce the paper volume.

Sheet	Description	
1	Plan and Elevation	
2	Foundation Data	
3-4	Analysis/Check Procedure	
5-8	Shaft/Soil Data	
9-29	M-STRUDL Model	(Step 1)
30-42	Shaft Stiffness Matrices (only bent 2 included)	(Steps 2 & 3)
43-50	New M-STRUDL Model (with support matrices)	(Step 4)
51-63	New Shaft Stiffness Matrices (only bent 2 included)	(Step 5)
64-68	Latest M-STRUDL Model (w/ most recent support matrices)	(Step 6)

Note that the change from step 4 to step 6 results ranges from 1% (bent 2 top of shaft moment, 30,100 K-FT to 29,700 K-FT) to 7% (bent 5 top of shaft shear, 2220 K to 2070 K).



•Angle measured from projected tangent @ Bt.2 to Bt.1 ℄
"D" Curve
18° C. L.
Δ= 37° 38' 01"
T= 108.47'
L=209.08'
"D" 3+79.77 P.T.
For Detour Structure dwg. 49528
"D" 7+43.31 P.C.
"D" Curve
18° C. L.
Δ= 35° 15' 29"
T= 101.15'
L=195.88'
S 28° 00' 37" E
℄ (Detour Structure) "D" Line
For concrete barrier details. See grading plans (typ.)
For roadway Inlet - See grading plans (typ.)
400Sp. s=20° 00' 00" a=2.50
300Sp. s=15° 00' 00" a=3.33
Projected tangent @ Bt.2 ℄
Projected tangent @ Bt.5 ℄
For guardrail details See Grading Plans (typ.)
Curve Data
10° C. L.
TΔ = 72° 53' 30"
Ts1 = 625.58'
Ts2 = 582.91'
Existing Concrete Structure to be removed.
34'-10" o.-o. Existing Structure
46'-10" o-o
44'-0" Roadway
1'-5" Rail
℄ Roadway
Span 1 30'-0"
CIP Conc. Slab
107'-0" Span 2
115'-0" Span 3
116'-0" Span 4
Span 5 30'-0"
338'-0" ctr.-ctr. of end bents (75" Deep) Precast Prestressed Concrete Bulb-I Beams
398'-0" out to out End Bents
Sta. 139+32 Bent 1 (End of Conc. Slab)
Sta. 139+56.20 P.S.C.
Sta. 139+62 Bent 2
Sta. 140+69 Bent 3
Sta. 141+84 Bent 4
Sta. 143+00 Bent 5
Sta. 143+30 Bent 6 (End of concrete slab)
Sta. 143+35.12 P.C.S.
PLAN
Scale: 1" = 20'
NOTE
THE SCALE OF THIS PRINT IS ½ THAT OF THE ORIGINAL DRWG. FOR EXAMPLE: INDICATED SCALE 1"=10'-0" SHOULD BE READ 1"=20'-0"
T. 33 S., R. 15 W., SEC. 15, W.M.
VICINITY MAP
No Scale
PORT ORFORD
PACIFIC
OCEAN
PROJECT
GOLD BEACH
••Angle measured from projected tangent @ Bt.5 to Bt.6 ℄
Note: See dwg. no. 49513 for "General Notes".
Sta. 140+00 V.P.I.
El. 122.0
800' V.C.
Profile grade @ ℄ Rdwy.
+0.02%
-3.417%
Proposed Structure
℄ Roadway Grade Line Diagram
No Scale
135+56.20 P.S. Ah.
139+56.20 P.S.C.
143+35.12 P.C.S.
146+35.12 P.T. Bk.
146+20.02 P.O.T. Ah.
146+38.97 Actual P.I.
146+57.92 P.S. Used
134+76.20
136+36.20
100' V.C.
12' Rt.
12' Lt.
Profile Grade
Proposed Structure
Super Elevation Runoff Diagram (on Structure)
No Scale
℄ of existing bent
Modified Type "F" Concrete Br. Rail (See dwg. no. 49545)
Free
Hinge
Fix
15' Rt.
15' Lt.
Bent 1
℄ of existing columns
Drilled Shaft Tip Elev. 48
Bent 2
Bent 3 designed for future erosion to El. 28.
Drilled Shaft Foundation (All Bents)
Drilled Shaft Tip Elev. -15
Bent 3
Bent 4 designed for future erosion to El. 34.
Drilled Shaft Tip Elev. -9
Bent 4
Drilled Shaft Tip Elev. 44
Bent 5
Bent 6
120
110
100
90
80
70
60
50
40
30
20
10
Note:
All elevations are based on the National Geodetic Vertical Datum (M.S.L.=0.0') and the Oregon State Highway Division Datum.
DEVELOPED ELEVATION
Scale: 1" = 20'

DATE	REVISION	BY
10-11-93	Diagram Revised	T.H.
10-11-93	Note Added	T.H.

APPROVED:
BRIDGE ENGINEER
DESIGNED Steve H. Gorlick
Jeffrey Lannigan
DRAWN
CHECKED
REVIEWED K. A. Komodoll 7-15-93
REVIEWED

Expires: 12-31-94
Exp. 12-31-93

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

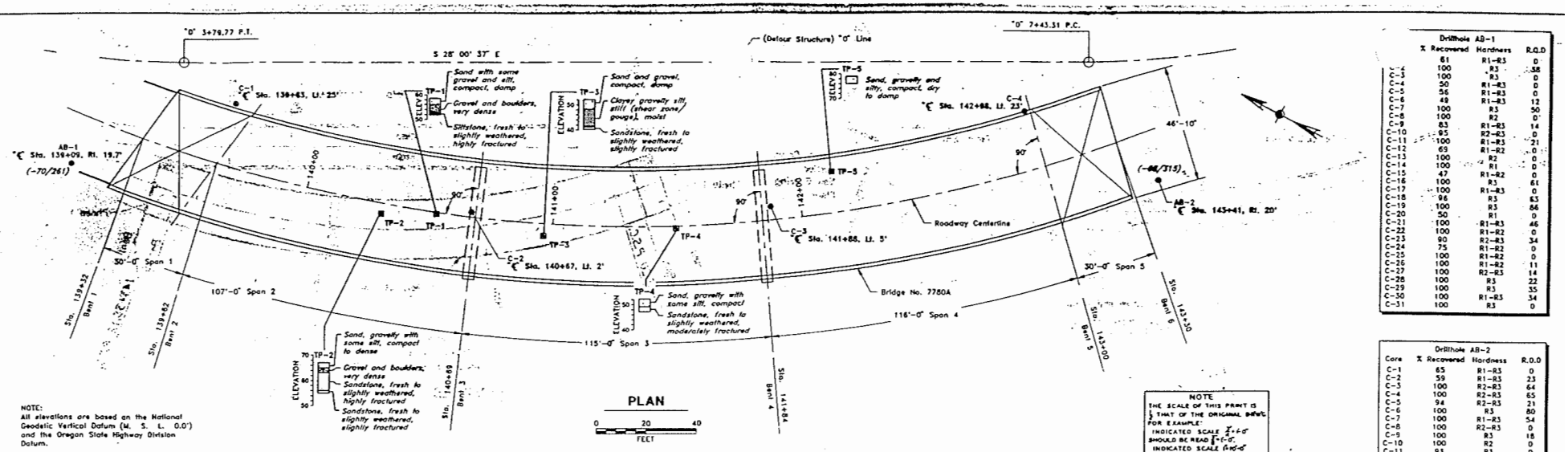
ROCKY POINT VIADUCT
ROCKY POINT VIADUCT SECTION
OREGON COAST HWY. (M.P. 303.72) CURRY COUNTY

PLAN AND ELEVATION

ACCOMPANIED BY DWGS. 49513 thru 49547, 43497, 49310, 43496, 43497, 43499, 21268

DATE April 1993 CALC.BOOK 4144, 4145 SHEET 1 OF 42
BRIDGE NO. 7780A DRAWING NO. 49512

br225ai /usr/br/projects/91403/ji17780a.dgn [VIEW=D5] [PGRID=05] 15-JUL-1993



PLAN

0 20 40
FEET

NOTE:
All elevations are based on the National Geodetic Vertical Datum (M. S. L. 0.0') and the Oregon State Highway Division Datum.

NOTE
THE SCALE OF THIS PRINT IS ½ THAT OF THE ORIGINAL DRAWING.
FOR EXAMPLE:
INDICATED SCALE 1"=10'-0" SHOULD BE READ 1"=5'-0"
INDICATED SCALE 1"=40'-0" SHOULD BE READ 1"=20'-0"

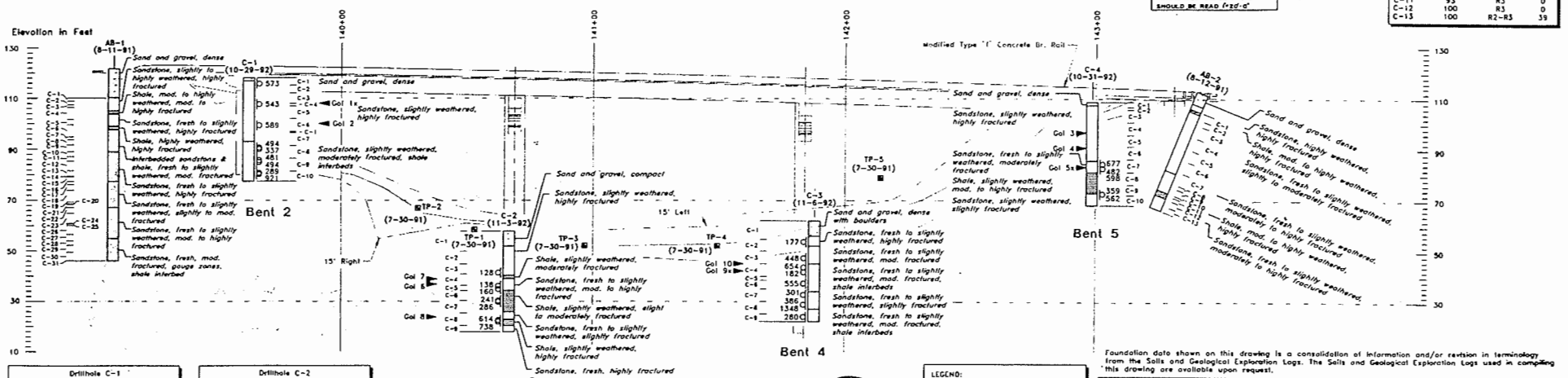
Drillhole AB-1

Core	% Recovered	Hardness	R.Q.D
C-1	61	R1-R3	0
C-2	100	R3	58
C-3	100	R3	0
C-4	50	R1-R3	0
C-5	56	R1-R3	0
C-6	49	R1-R3	12
C-7	100	R3	50
C-8	100	R2	0
C-9	83	R1-R3	14
C-10	95	R2-R3	0
C-11	100	R1-R3	21
C-12	69	R1-R2	0
C-13	100	R2	0
C-14	100	R1	0
C-15	47	R1-R2	0
C-16	100	R3	61
C-17	100	R1-R3	0
C-18	96	R3	83
C-19	100	R3	66
C-20	50	R1	0
C-21	100	R1-R3	46
C-22	100	R1-R2	0
C-23	90	R2-R3	34
C-24	75	R1-R2	0
C-25	100	R1-R2	0
C-26	100	R1-R2	11
C-27	100	R2-R3	14
C-28	100	R3	22
C-29	100	R3	35
C-30	100	R1-R3	54
C-31	100	R3	0

Drillhole AB-2

Core	% Recovered	Hardness	R.Q.D
C-1	65	R1-R3	0
C-2	59	R1-R3	23
C-3	100	R2-R3	64
C-4	100	R2-R3	65
C-5	94	R2-R3	21
C-6	100	R3	80
C-7	100	R1-R3	54
C-8	100	R2-R3	0
C-9	100	R3	18
C-10	100	R2	0
C-11	93	R3	0
C-12	100	R3	0
C-13	100	R2-R3	39

Elevation in Feet



Drillhole C-1

Core	% Recovered	Hardness	R.Q.D
C-1	67	R3	0
C-2	67	R3	0
C-3	75	R3	0
C-4	100	R3	0
C-5	80	R3	14
C-6	70	R3	18
C-7	100	R3	0
C-8	80	R3	0
C-9	32	R3	12
C-10	100	R3	40
C-11	48	R3	16

Drillhole C-2

Core	% Recovered	Hardness	R.Q.D
C-1	25	R2-R3	0
C-2	20	R3	0
C-3	50	R3	0
C-4	96	R2-R3	37
C-5	75	R3	15
C-6	50	R2	0
C-7	100	R3	100
C-8	94	R3	58
C-9	88	R2	36

LEGEND OF MATERIALS:
Sand and gravel
Sandstone
Conglomerate
Cobbles and boulders
Shale/Mudstone/Siltstone

FOUNDATION DATA

0 20 40
FEET
(VERTICAL = HORIZONTAL)

Drillhole C-3

Core	% Recovered	Hardness	R.Q.D
C-1	7	R2	0
C-2	93	R2	0
C-3	100	R2-R3	46
C-4	90	R3	40
C-5	100	R3	60
C-6	83	R3	26
C-7	92	R3	30
C-8	70	R2-R3	54
C-9	80	R2	0

Drillhole C-4

Core	% Recovered	Hardness	R.Q.D
C-1	25	R3	0
C-2	40	R3	0
C-3	50	R3	18
C-4	46	R3	0
C-5	31	R3	0
C-6	50	R2	0
C-7	99	R2-R3	36
C-8	48	R2	0
C-9	100	R3	100
C-10	100	R3	100

LEGEND:
- AB-1 — Test Hole Location and Designation
- (70/261) — Dip/Direction
- TP-1 — Test Pit Location and Designation
- 150 — Point Load Strength (psi)
- Col-1 — Pressuremeter Test by Golder Associates Inc.
- C-1 — Core Sample
- R.Q.D. — Rock Quality Designation

Foundation data shown on this drawing is a consolidation of information and/or revision in terminology from the Soils and Geological Exploration Logs. The Soils and Geological Exploration Logs used in compiling this drawing are available upon request.

DATE	REVISION	BY
6/16/93	Response to comments	JSS

APPROVED:
BRIDGE ENGINEER PE
DESIGNED D. Holmer
DRAWN
REVIEWED
REVIEWED

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

ROCKY POINT VIADUCT

OREGON COAST HWY. ONY. 101, M.P. 303.72) CURRY COUNTY

FOUNDATION DATA

ACCOMPANIED BY DWGS.

DATE June 1993 CALC BOOK –
SHEET 3 OF 42
BRIDGE NO. 7780A
DRAWING NO. 49514

200000

BRIDGE SECTION
Oregon State Highway Division

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-15-93 Bridge No. 7780A

Drilled Shaft Check (DS-__)

By insp. vertical capacity is controlled by D+L (Gr.1), and lateral capacity is controlled by D+EQ (Gr.7).

Do a seismic analysis.

Check the vertical capacity as a part of the seismic model development.

Seismic Analysis Procedure

Run M-STRUDL w/ col. fixity @ 2 x dia. into rock. (Dynamic run)

W/ results @ col. tops as input, run COM624 to develop support stiffn. matrix (condense col. & soil down to stiffn. matrix).

Rerun M-STRUDL w/ cols. out & stiffn. matrix in.

Use support force output of last M-STRUDL to develop new support stiffn. matrices.

Cycle as reqd. to close.

Do similar for more rock gone (long shafts, erosion/foiled rock).

Use support force output of last M-STRUDL run to load COM624 shaft models w/ shear and moment on a free head (short & long shafts / longit. & trans. EQ.)

DS-2

BRIDGE SECTION
Oregon State Highway Division

Sheet 000004

Bridge Name Rocky Pt Viaduct

Calculations by SS Date 7-16-93 Bridge No. 7780n

Use results of COM624 @ select critical pts along shafts to check against col. strength by ULTCOL.

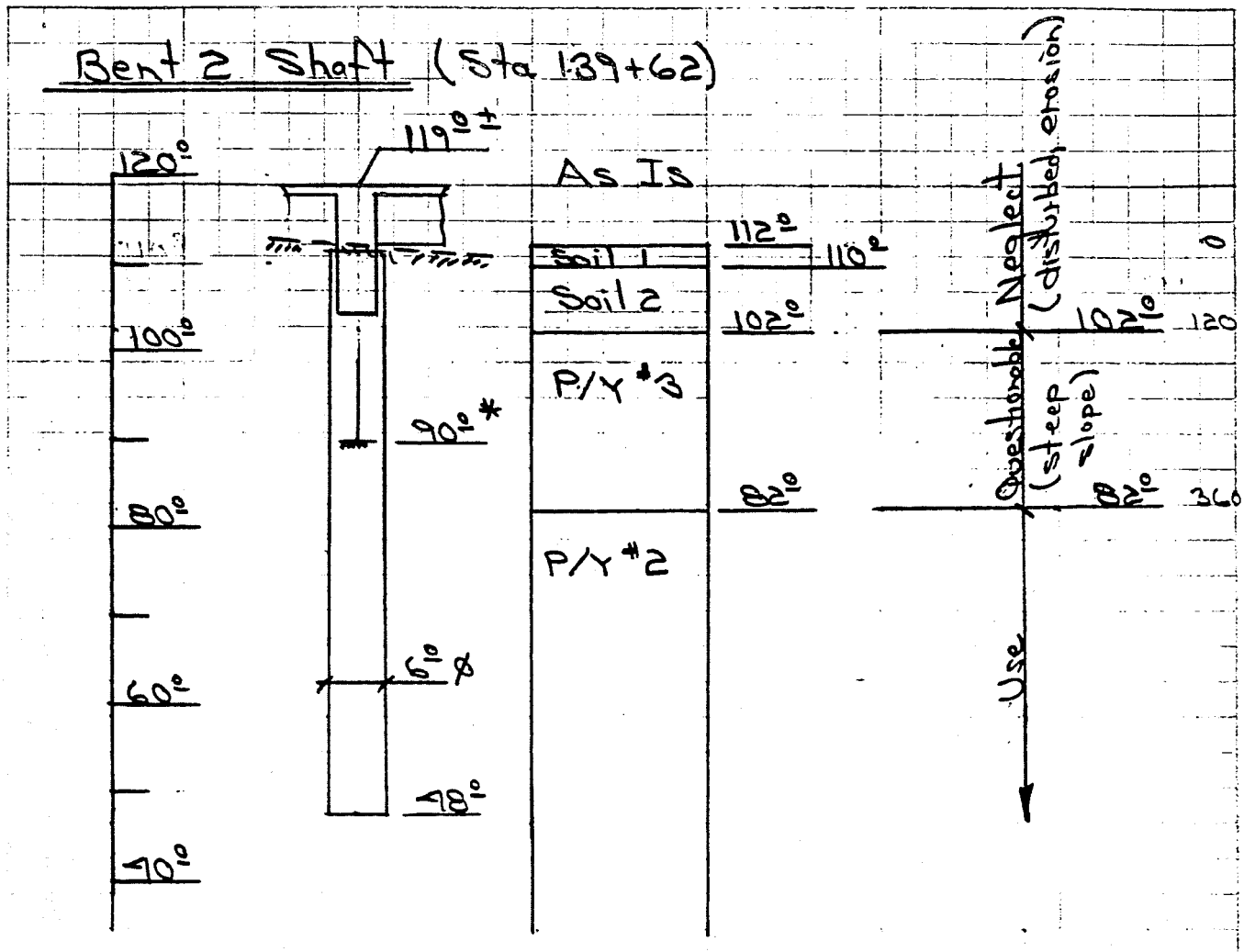
DS-3

BRIDGE SECTION
Oregon State Highway Division

Sheet 000005

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-15-93 Bridge No. 7780A



*Assumed fixity for first M-STRUDL run. (22 ft)

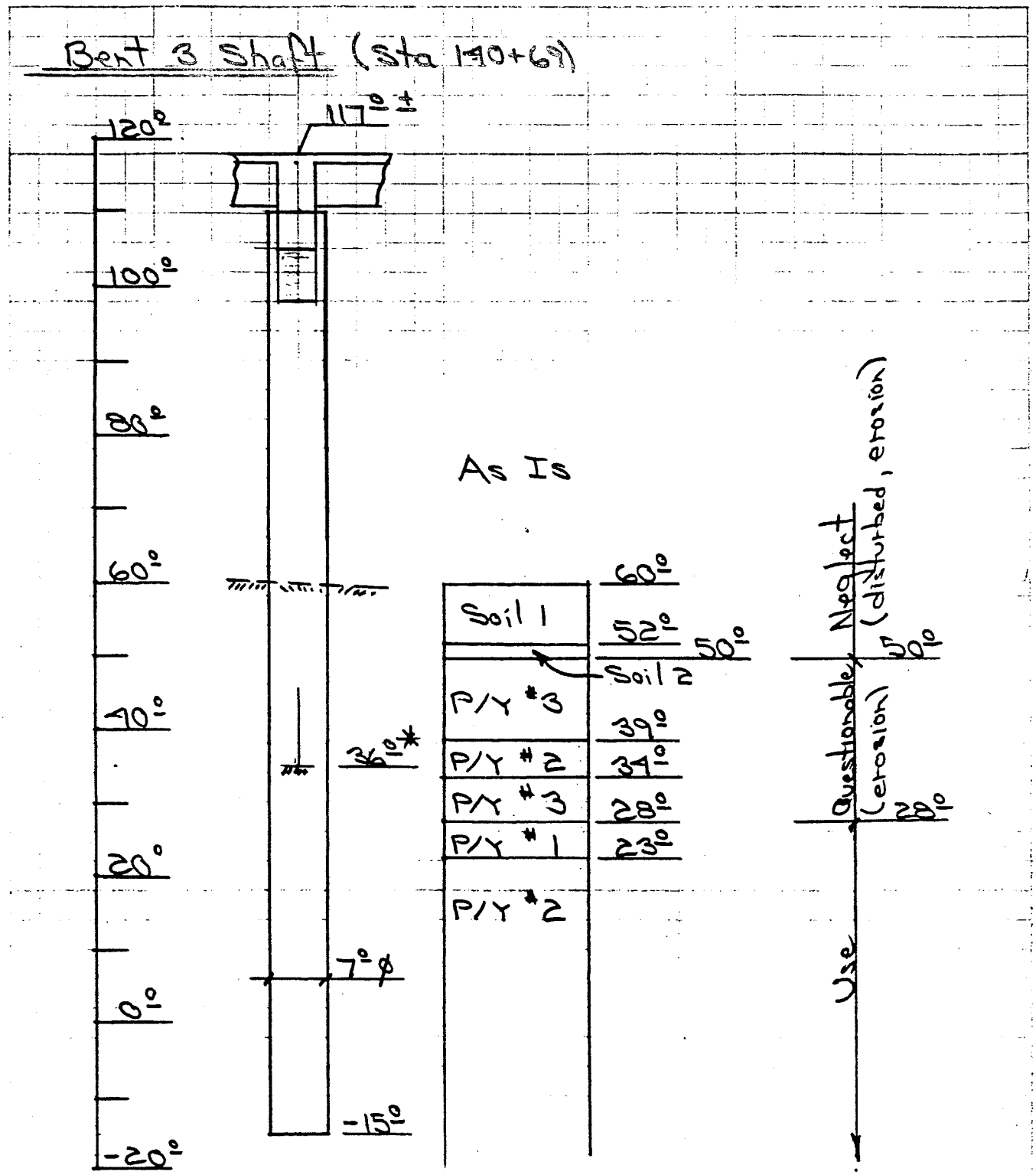
DS-4

BRIDGE SECTION
Oregon State Highway Division

Sheet 000006

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-15-93 Bridge No. 7780A



*Assumed fixity for first M-STRUDL run. (75 ft.)

DS-5

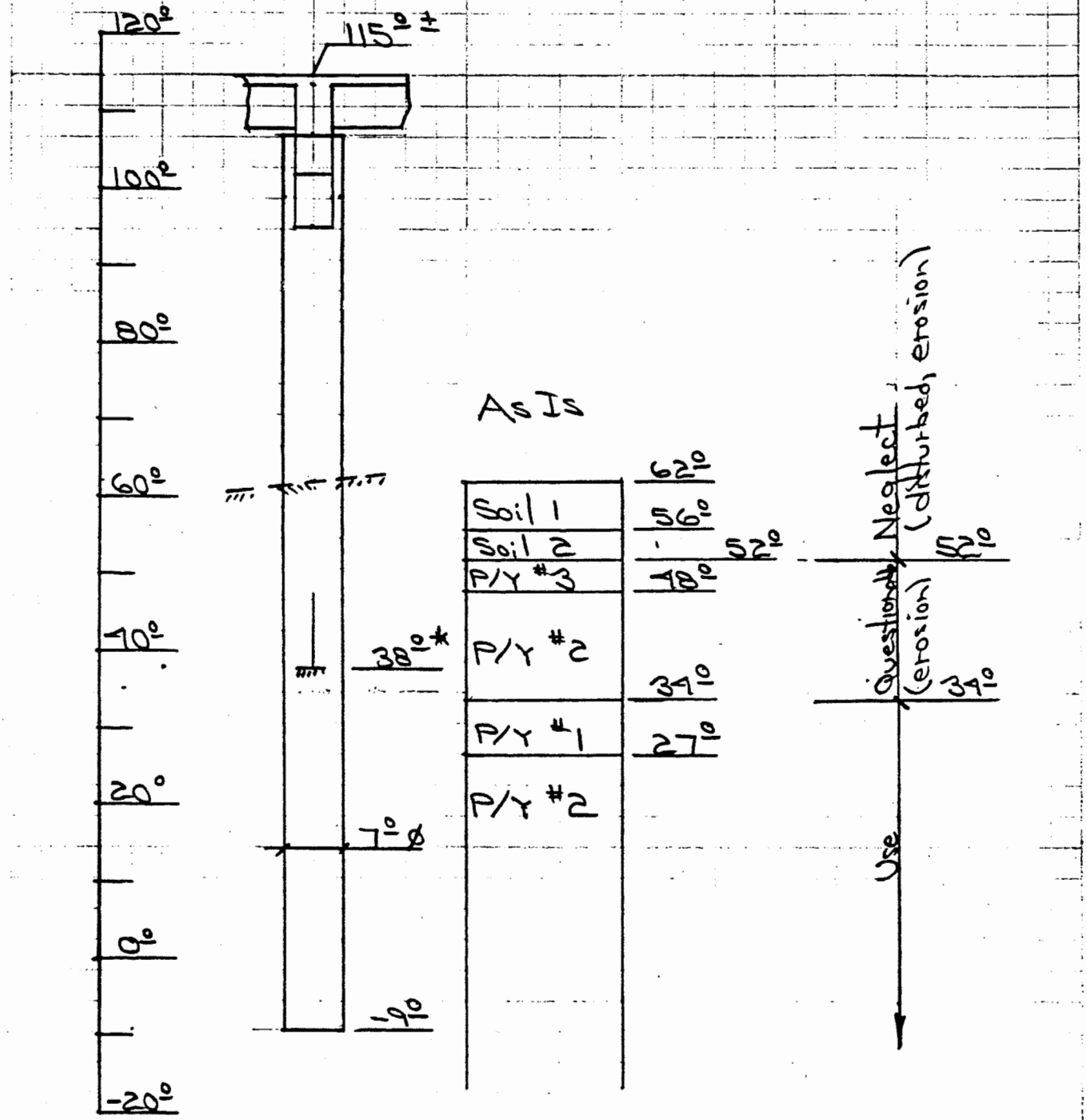
BRIDGE SECTION
Oregon State Highway Division

Sheet 000007

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-15-93 Bridge No. 7780A

Bent 4 Shaft (Sta 191+89)



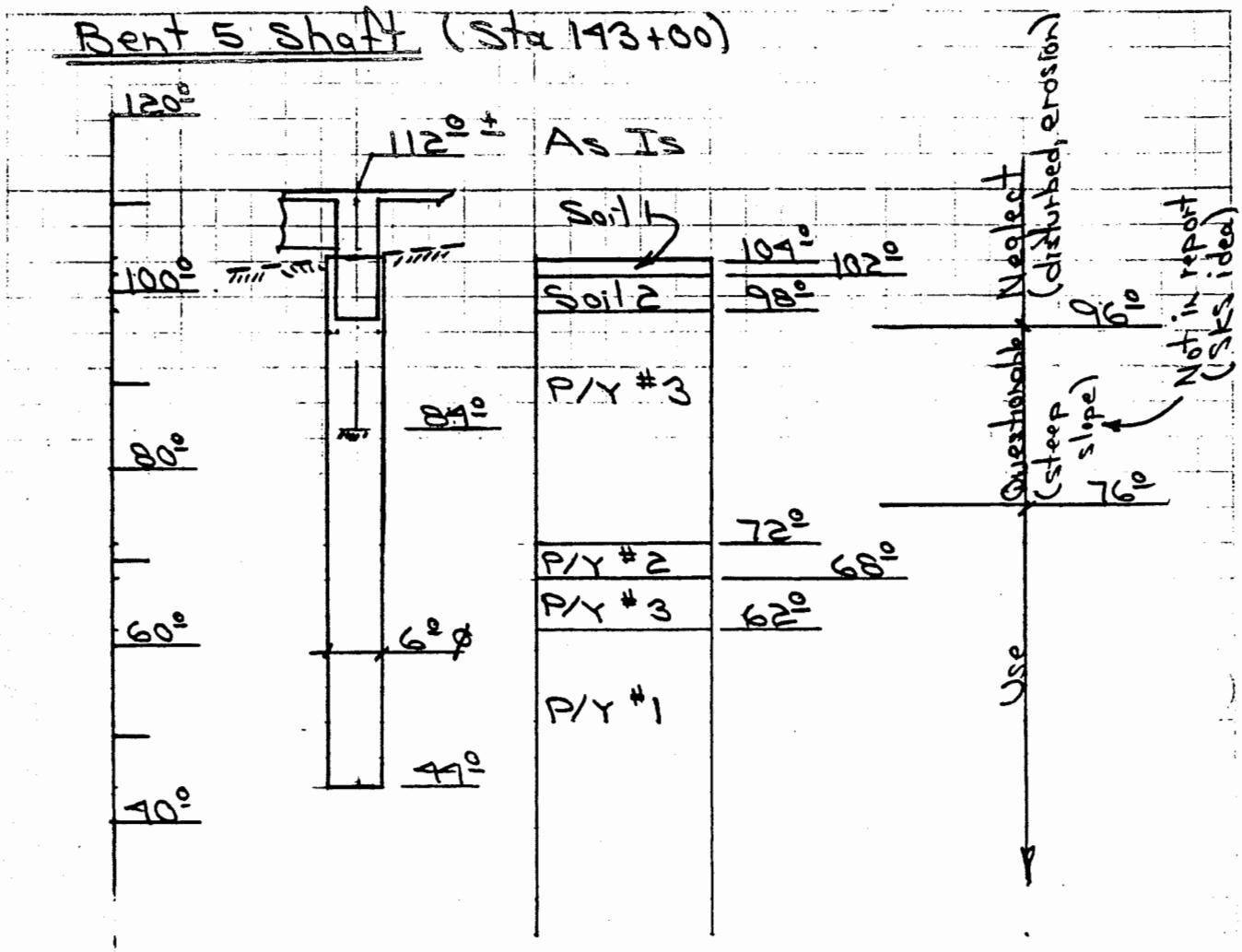
*Assumed fixity for first M-STRUDL run. (70 ft.)

BRIDGE SECTION
Oregon State Highway Division

Sheet 000008

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-15-93 Bridge No. 7780A



*Assumed fixity for first M-STRUDL run. (21 ft.)

Short Shaft Analysis follows.

DS-7

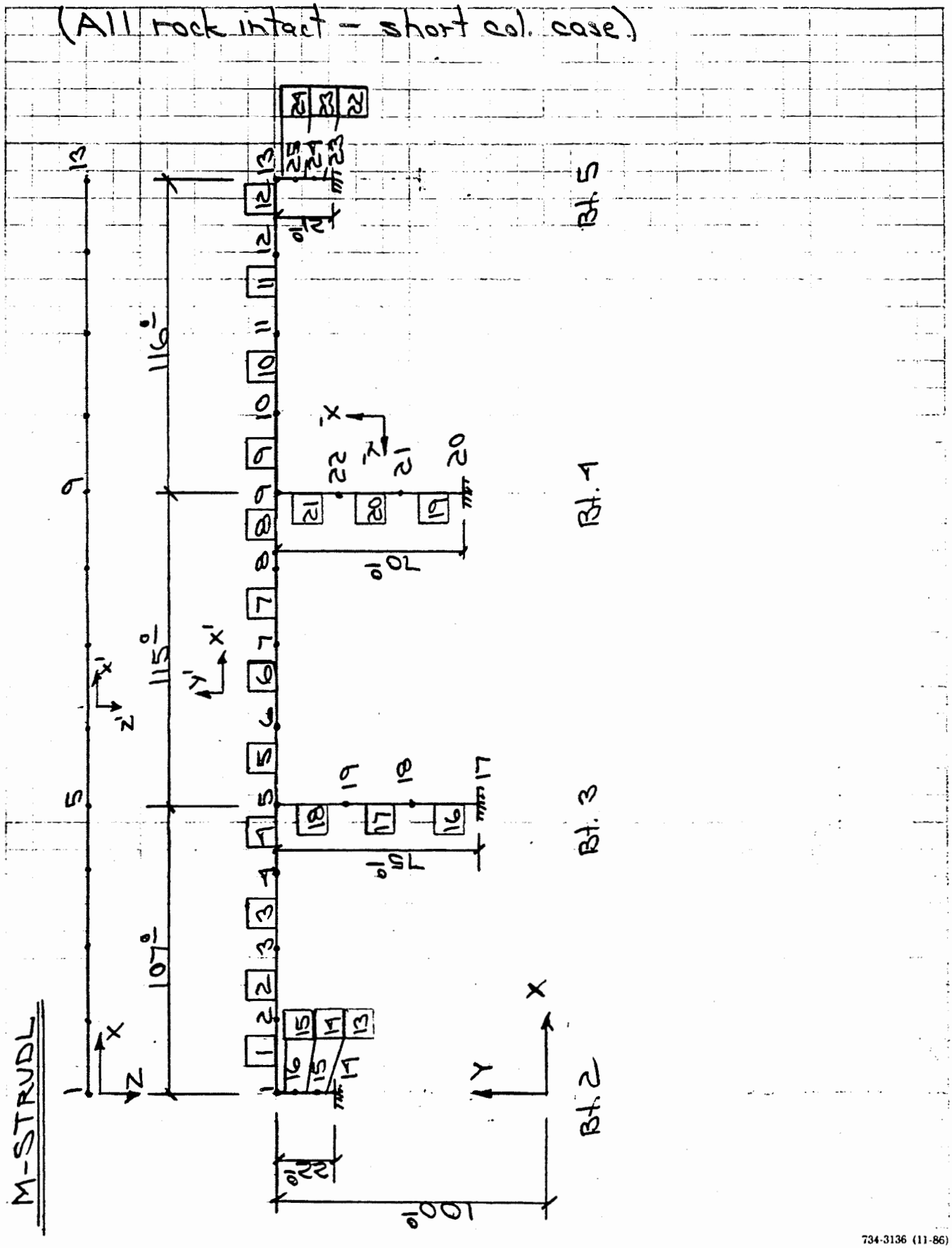
BRIDGE SECTION
Oregon State Highway Division

Sheet 000009

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-15-93 Bridge No. 7780A

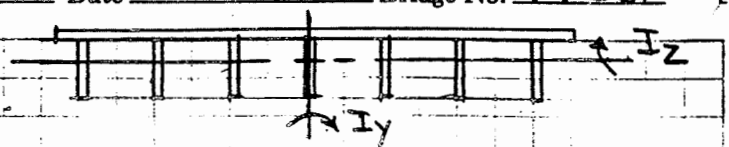
(All rock intact - short col. case)



BRIDGE SECTION
Oregon State Highway Division

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-16-93 Bridge No. 7780A



Mem 1-12:

BI75" (26" flanges) (f'_c = 4500 to 5000 psi)

$A = 860\ in^2$

$I = 579{,}908\ in^4$

$Y_T = 37.86"$ ($Y_B = 37.14"$)

7 beams w/ ≈ 6'-8" spcg.

Deck (8" x 46'-10", f'_c = 4500 psi)

$$\therefore\ A = \frac{860(7)}{144} + \frac{8(46.8)}{12}$$

$$= 73.0\ ft^2$$

$$I_x = \left[46.8(0.67)^3 + 2.2(0.5)^3(7)(2) + 5.3(0.67)^3(7)\right]\left[\frac{1}{3}\right]$$

$$= 9.7\ ft^4 \quad (J,\ torsion)$$

$$I_y = 2.9(7) + \frac{860}{144}\left[(20)^2 + (13.3)^2 + (6.7)^2\right](2) + 0.67\frac{(46.7)^3}{12}$$

$$= 13{,}130\ ft^4$$

$$I_z = \left[\frac{1{,}227{,}610}{20{,}736}\right](7) \quad \text{(by HP41 program)}$$

$$= 414.4\ ft^4$$

BRIDGE SECTION
Oregon State Highway Division

Sheet

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-16-93 Bridge No. 7780A

Density – modify the γ to include rail, AC, end panels, diaphs. & X-bms.

$$\text{Rail wt.} = \left[0.335 + \frac{1(27)}{12}(0.15)\right](370)(2)$$

$$= 275 \text{ k}$$

$$\text{AC wt.} = 0.025(77)(370)$$

$$= 710 \text{ k}$$

$$\text{End Panel wts.} = 1.33(76.8)(30)(0.15)$$

$$= 280 \text{ k}$$

$$\text{Diaph wts.} = 0.8(6.1)(6.0)(0.15)(6)(3)$$

$$= 80 \text{ k}$$

$$\text{X-Bm wts.} = \underset{\text{Bts 2-5 btwn bms}}{5.0(6.5)(6.0)(7)(4)(0.15)}$$
$$+ \underset{\text{Bts 2 \& 5}}{5.0(7.0)(78.5+77.8)(0.15)}$$
$$+ \underset{\text{Bts. 3 \& 4}}{5.0(5.0)(77.8)(0.15)(2)}$$
$$+ 5.0(7.0)(7.0)(0.15)(2)$$
$$+ 5.0(7.0)\frac{(18.9)}{3}(0.15)(4)$$

$$= 1850 \text{ k}$$

(Bt. 2 460 k
  3 475 k
  4 475 k
  5 440 k)

BRIDGE SECTION
Oregon State Highway Division

Bridge Name Rocky Pt Viaduct

Calculations by SS Date 7-16-93 Bridge No. 7780

$$\gamma = \frac{[73.0(0.15)(338) + 1850]}{73.0(338)}$$

$$= 0.225 \text{ k/ft}^3$$

$$E = 3800(171)$$

$$= 577{,}200 \text{ k/ft}^2$$

Mem 13-15 & 23-21: (6'ø)

$$A = \pi(3)^2$$

$$= 28.3 \text{ ft}^2$$

$$I_x = 0.79(3)^4(2)$$

$$= 128.0 \text{ ft}^4$$

$$I_y = I_z = 0.79(3)^4$$

$$= 64.0 \text{ ft}^4$$

$$\gamma = 0.15 \text{ k/ft}^3$$

$$E = 3600(171)$$

$$= 518{,}700 \text{ k/ft}^2$$

BRIDGE SECTION
Oregon State Highway Division

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-16-93 Bridge No. 7780A

Mem 16-21: (7'ϕ)

$A = \pi(3.5)^2$

$= 38.5\ ft^2$

$I_x = 0.79(3.5)^4(2)$

$= 237.0\ ft^4$

$I_y = I_z = 0.79(3.5)^4$

$= 119.0\ ft^4$

$\gamma = 0.15\ k/ft^3$

$E = 518900\ k/ft^2$

```
TITLE  BR. 7780A   ROCKY PT. VIADUCT   STARKEY   7-16-93   (SKSSTR1)
$ DYNAMIC LOADING MODEL
TYPE SPACE FRAME
UNITS KIPS FT RADIANS
SAVE ON
REPORT DEVICE SKSOUT1
JOI COO
1           0.0     100.0        0.0
5         107.0     100.0        0.0
9         222.0     100.0        0.0
13        338.0     100.0        0.0
14          0.0      78.0        0.0   S
15          0.0      85.3        0.0
16          0.0      92.7        0.0
17        107.0      25.0        0.0   S
18        107.0      50.0        0.0
19        107.0      75.0        0.0
20        222.0      30.0        0.0   S
21        222.0      53.3        0.0
22        222.0      76.7        0.0
23        338.0      79.0        0.0   S
24        338.0      86.0        0.0
25        338.0      93.0        0.0
1 TO 5 BY 1
5 TO 9 BY 1
9 TO 13 BY 1
$
MEM INC
1   1   2
12  12  13
13  14  15
14  15  16
15  16  1
16  17  18
17  18  19
18  19  5
19  20  21
20  21  22
21  22  9
22  23  24
23  24  25
24  25  13
1  TO 12  BY 1  I BY 1  J BY 1
$
MEMBER   PROPERTIES
APRO1  AX  73.0 IX    9.7     IY 13130.0 IZ   414.4   1 TO 12
APRO2  AX  28.3 IX  128.0     IY  64.0   IZ    64.0   13 14 15 22 23 24
APRO3  AX  38.5 IX  237.0     IY 119.0   IZ   119.0   16 17 18 19 20 21
$
MATERIAL PROPERTIES
A1     E 547200.0  DEN 0.225  CTE 0.000006    1 TO 12
A2     E 518400.0  DEN 0.150  CTE 0.000006   13 TO 24
$
DYNAMIC ANALYSIS REACTIONS MODES 9
$ A=0.29  S=1.0  G=32.2
```

000014

```
LOAD EQL
RSA X 9.34 FREQ ACCE RESSOIL1 SRSS
LOAD EQT
RSA Z 9.34 FREQ ACCE RESSOIL1 SRSS
OUT DEC 5
LIST FREQ 1 TO 9
LIST DISP ALL
OUT DEC 2
LIST REA ALL
LIST MEM FOR 13 TO 24
FINISH
```

* RESULTS OF ANALYSIS *

TYPE OF THE PROBLEM : SPACE FRAME RESTART STATUS : NONE GIVEN
ACTIVE UNITS : KIPS FEET RADIANS

* TOLERANCE = 0.01 MAX. NO. ITERATIONS = 20

* TOTAL WEIGHT IN X DIRECTION = 6571.56
* TOTAL WEIGHT IN Y DIRECTION = 6571.56
* TOTAL WEIGHT IN Z DIRECTION = 6571.56

* NO. OF EIGEN VALUES REQUESTED : 9

MODE NO.	FREQUENCY HZ.	PERIOD SECOND	% MASS PARTICIPATED X DIR.	% MASS PARTICIPATED Y DIR.	% MASS PARTICIPATED Z DIR.	PARTICIPATION FACTOR X DIR.	PARTICIPATION FACTOR Y DIR.	PARTICIPATION FACTOR Z DIR.
1	1.26	0.792	0.00000	0.00000	87.60831	0.00896	0.00341	-4662.01257
2	2.60	0.385	74.74174	0.34546	0.00000	5536.97858	376.43765	-0.68762
3	2.75	0.364	0.00000	0.00000	0.02280	-0.35582	0.01497	59.03090
4	3.12	0.321	2.89195	2.07971	0.00000	624.76241	-529.81069	-0.25121
5	4.14	0.241	15.39728	4.11614	0.00000	-1429.39365	739.05156	-0.15999
6	4.82	0.207	0.44955	59.31767	0.00000	232.51222	2670.83886	0.41173
7	4.97	0.201	0.00000	0.00000	4.71671	-0.23800	-0.33794	-636.92200
8	8.06	0.124	0.00146	0.00075	1.44720	4.64826	3.33273	146.48330
9	9.21	0.109	0.00220	0.00000	1.75083	6.12136	-0.20158	-172.77841

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840

0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
3000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	GLOBAL DISPLACEMENTS Y DIRECTION	GLOBAL DISPLACEMENTS Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	GLOBAL ROTATIONS Y DIRECTION	GLOBAL ROTATIONS Z DIRECTION
1	0.06233	0.00039	0.00004	0.00000	0.00000	0.00222
2	0.06322	0.04162	0.00002	0.00000	0.00000	0.00091
3	0.06395	0.04787	0.00001	0.00001	0.00000	0.00046
4	0.06452	0.02717	0.00002	0.00001	0.00000	0.00105
5	0.06493	0.00209	0.00002	0.00001	0.00000	0.00071
6	0.06522	0.01653	0.00002	0.00001	0.00000	0.00048
7	0.06533	0.02358	0.00001	0.00001	0.00000	0.00028
8	0.06525	0.01750	0.00002	0.00001	0.00000	0.00048
9	0.06498	0.00264	0.00002	0.00001	0.00000	0.00093
10	0.06460	0.04337	0.00002	0.00001	0.00000	0.00157
11	0.06403	0.07626	0.00002	0.00001	0.00000	0.00051
12	0.06328	0.06354	0.00002	0.00000	0.00000	0.00138
13	0.06235	0.00048	0.00004	0.00000	0.00000	0.00287
14	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	0.01262	0.00013	0.00001	0.00000	0.00000	0.00306
16	0.03939	0.00026	0.00002	0.00000	0.00000	0.00377
17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	0.02037	0.00070	0.00013	0.00001	0.00000	0.00134
19	0.05354	0.00139	0.00019	0.00000	0.00000	0.00108
20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	0.02229	0.00088	0.00011	0.00001	0.00000	0.00157
22	0.05790	0.00176	0.00017	0.00000	0.00000	0.00117
23	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	0.01190	0.00016	0.00001	0.00000	0.00000	0.00304
25	0.03761	0.00032	0.00002	0.00000	0.00000	0.00396

*** LOAD INDEX : 2 LOAD TAG : EQT ***

RSA, FACTOR = 0.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	GLOBAL DISPLACEMENTS Y DIRECTION	GLOBAL DISPLACEMENTS Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	GLOBAL ROTATIONS Y DIRECTION	GLOBAL ROTATIONS Z DIRECTION
1	0.00001	0.00000	0.11234	0.00765	0.00139	0.00000
2	0.00001	0.00003	0.14870	0.00688	0.00135	0.00000
3	0.00001	0.00002	0.18284	0.00611	0.00121	0.00000
4	0.00001	0.00002	0.21237	0.00535	0.00100	0.00000
5	0.00001	0.00003	0.23535	0.00460	0.00072	0.00000
6	0.00001	0.00012	0.25111	0.00468	0.00038	0.00000
7	0.00001	0.00001	0.25648	0.00477	0.00002	0.00001
8	0.00001	0.00012	0.25099	0.00485	0.00038	0.00000
9	0.00001	0.00003	0.23498	0.00494	0.00073	0.00000
10	0.00001	0.00007	0.20926	0.00537	0.00104	0.00000
11	0.00001	0.00002	0.17557	0.00582	0.00128	0.00000
12	0.00001	0.00007	0.13625	0.00627	0.00144	0.00000
13	0.00001	0.00000	0.09428	0.00673	0.00149	0.00000
14	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	0.00000	0.00000	0.01653	0.00424	0.00046	0.00000
16	0.00001	0.00000	0.05852	0.00682	0.00093	0.00000
17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	0.00010	0.00001	0.03660	0.00270	0.00024	0.00000
19	0.00013	0.00002	0.12453	0.00415	0.00048	0.00000
20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	0.00007	0.00001	0.03604	0.00287	0.00024	0.00000
22	0.00009	0.00002	0.12395	0.00445	0.00049	0.00000
23	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	0.00000	0.00000	0.01398	0.00374	0.00050	0.00000
25	0.00001	0.00000	0.04891	0.00599	0.00099	0.00000

| M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/16/1993 14:18:20 |
| L I C E N S E E : Oregon DOT #11, OR |

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
14		-1475.95	-259.36	-0.44	-8.93	-1.01	-19295.16
17		-173.12	-556.82	-2.32	-44.88	-0.09	-5457.58
20		-236.33	-754.77	-2.36	-43.18	-0.13	-6897.71
23		-1466.27	-336.97	-0.47	-9.37	-0.95	-19515.21

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/16/1993 14:18:20
L I C E N S E E : Oregon DOT #11, OR
TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-16-93 PAGE 5

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
14		-0.51	-1.13	-1057.25	-23151.06	-1680.72	-4.10
17		-2.07	-7.91	-147.10	-8365.02	-473.43	-37.26
20		-1.54	-8.97	-164.36	-9404.99	-514.80	-26.89
23		-1.09	-2.68	-1018.17	-21309.29	-1877.47	-7.10

M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/16/1993 14:18:20
L I C E N S E E : Oregon DOT #11, OR
TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-16-93 PAGE 5

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
13	APRO2	14	259.36	1475.95	0.44	1.01	8.93	19295.16
		15	259.36	1475.95	0.44	1.01	5.71	8584.43
14	APRO2	15	259.28	1472.52	0.42	1.01	5.71	8584.43
		16	259.28	1472.52	0.42	1.01	2.59	2797.84
15	APRO2	16	259.11	1461.92	0.36	1.01	2.59	2797.84
		1	259.11	1461.92	0.36	1.01	0.19	13171.46
16	APRO3	17	556.82	173.12	2.32	0.09	44.88	5457.58
		18	556.82	173.12	2.32	0.09	13.17	1192.66
17	APRO3	18	555.82	148.21	0.82	0.09	13.17	1192.66
		19	555.82	148.21	0.82	0.09	33.70	2626.93
18	APRO3	19	553.83	84.36	1.36	0.09	33.70	2626.93
		5	553.83	84.36	1.36	0.09	0.35	4731.66

19	APRO3	20	754.77	236.33	2.36	0.13	43.18	6897.71
		21	754.77	236.33	2.36	0.13	11.85	1417.57
20	APRO3	21	753.12	211.39	0.87	0.13	11.85	1417.57
		22	753.12	211.39	0.87	0.13	32.19	3577.18
21	APRO3	22	749.84	147.17	1.39	0.13	32.19	3577.18

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
		9	749.84	147.17	1.39	0.13	0.28	7003.86
22	APRO2	23	336.97	1466.27	0.47	0.95	9.37	19515.21
		24	336.97	1466.27	0.47	0.95	6.06	9372.62
23	APRO2	24	336.89	1463.14	0.46	0.95	6.06	9372.62
		25	336.89	1463.14	0.46	0.95	2.87	2342.06
24	APRO2	25	336.73	1453.45	0.40	0.95	2.87	2342.06
		13	336.73	1453.45	0.40	0.95	0.12	11462.11

M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/16/1993 14:18:20
L I C E N S E E : Oregon DOT #11, OR
TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-16-93 PAGE 6

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
13	APRO2	14	1.13	0.51	1057.25	1680.72	23151.05	4.10

		15	1.13	0.51	1057.25	1680.72	15433.17	1.23
14	APRO2	15	1.13	0.50	1056.08	1680.72	15433.17	1.23
		16	1.13	0.50	1056.08	1680.72	7618.25	3.75
15	APRO2	16	1.12	0.50	1051.96	1680.72	7618.25	3.75
		1	1.12	0.50	1051.96	1680.72	62.09	7.27
16	APRO3	17	7.91	2.07	147.10	473.43	8365.02	37.26
		18	7.91	2.07	147.10	473.43	5070.10	14.47
17	APRO3	18	7.70	0.39	120.22	473.43	5070.10	14.47
		19	7.70	0.39	120.22	473.43	2371.82	24.14
18	APRO3	19	7.29	1.76	92.69	473.43	2371.82	24.14
		5	7.29	1.76	92.69	473.43	68.71	19.88
19	APRO3	20	8.97	1.54	164.36	514.80	9404.99	26.89
		21	8.97	1.54	164.36	514.80	5837.34	9.01

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
20	APRO3	21	8.75	0.43	142.76	514.80	5837.34	9.01
		22	8.75	0.43	142.76	514.80	2697.91	19.08
21	APRO3	22	8.33	1.09	114.84	514.80	2697.91	19.08
		9	8.33	1.09	114.84	514.80	31.22	6.39
22	APRO2	23	2.68	1.09	1018.17	1877.47	21309.29	7.10
		24	2.68	1.09	1018.17	1877.47	14182.16	1.55
23	APRO2	24	2.68	1.08	1017.16	1877.47	14182.16	1.55
		25	2.68	1.08	1017.16	1877.47	7062.10	8.39
24	APRO2	25	2.67	1.06	1013.66	1877.47	7062.10	8.39
		13	2.67	1.06	1013.66	1877.47	35.70	15.78

****
* RESULTS OF ANALYSIS *
****

TYPE OF THE PROBLEM : SPACE FRAME RESTART STATUS : NONE GIVEN
ACTIVE UNITS : KIPS FEET RADIANS

* TOLERANCE = 0.01 MAX. NO. ITERATIONS = 20

TOTAL WEIGHT IN X DIRECTION = 6571.56
TOTAL WEIGHT IN Y DIRECTION = 6571.56
* TOTAL WEIGHT IN Z DIRECTION = 6571.56

* NO. OF EIGEN VALUES REQUESTED : 9

MODE NO.	FREQUENCY HZ.	PERIOD SECOND	% MASS PARTICIPATED X DIR.	% MASS PARTICIPATED Y DIR.	% MASS PARTICIPATED Z DIR.	PARTICIPATION FACTOR X DIR.	PARTICIPATION FACTOR Y DIR.	PARTICIPATION FACTOR Z DIR.
1	1.26	0.792	0.00000	0.00000	87.60831	0.00896	0.00341	-4662.01257
2	2.60	0.385	74.74174	0.34546	0.00000	5536.97858	376.43765	0.68762
3	2.75	0.364	0.00000	0.00000	0.02280	-0.35582	0.01497	59.03090
4	3.12	0.321	2.89195	2.07971	0.00000	624.76241	-529.81069	-0.25121
5	4.14	0.241	15.39728	4.11614	0.00000	-1429.39365	739.05156	-0.15999
6	4.82	0.207	0.44955	59.31767	0.00000	232.51222	2670.83886	0.41173
7	4.97	0.201	0.00000	0.00000	4.71671	-0.23800	-0.33794	-636.92200
8	8.06	0.124	0.00146	0.00075	1.44720	4.64826	3.33273	146.48330
9	9.21	0.109	0.00220	0.00000	1.75083	6.12136	-0.20158	-172.77841

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	GLOBAL DISPLACEMENTS Y DIRECTION	GLOBAL DISPLACEMENTS Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	GLOBAL ROTATIONS Y DIRECTION	GLOBAL ROTATIONS Z DIRECTION
1	0.06233	0.00039	0.00004	0.00000	0.00000	0.00222
2	0.06322	0.04162	0.00002	0.00000	0.00000	0.00091
3	0.06395	0.04787	0.00001	0.00001	0.00000	0.00046
4	0.06452	0.02717	0.00002	0.00001	0.00000	0.00105
5	0.06493	0.00209	0.00002	0.00001	0.00000	0.00071
6	0.06522	0.01653	0.00002	0.00001	0.00000	0.00048
7	0.06533	0.02358	0.00001	0.00001	0.00000	0.00028

8	0.06525	0.01750	0.00002	0.00001	0.00000	0.00048
9	0.06498	0.00264	0.00002	0.00001	0.00000	0.00093
10	0.06460	0.04337	0.00002	0.00001	0.00000	0.00157
11	0.06403	0.07626	0.00002	0.00001	0.00000	0.00051
12	0.06328	0.06354	0.00002	0.00000	0.00000	0.00138
13	0.06235	0.00048	0.00004	0.00000	0.00000	0.00287
14	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	0.01251	0.00013	0.00001	0.00000	0.00000	0.00306
16	0.03939	0.00026	0.00002	0.00000	0.00000	0.00377
17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	0.02037	0.00070	0.00013	0.00001	0.00000	0.00134
19	0.05354	0.00139	0.00019	0.00000	0.00000	0.00108
20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	0.02229	0.00088	0.00011	0.00001	0.00000	0.00157
22	0.05790	0.00176	0.00017	0.00000	0.00000	0.00117
23	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	0.01190	0.00016	0.00001	0.00000	0.00000	0.00304
25	0.03761	0.00032	0.00002	0.00000	0.00000	0.00396

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	Y DIRECTION	Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	Y DIRECTION	Z DIRECTION
1	0.00001	0.00000	0.11234	0.00765	0.00139	0.00000

2	0.00001	0.00003	0.14870	0.00688	0.00135	0.00000
3	0.00001	0.00002	0.18284	0.00611	0.00121	0.00000
4	0.00001	0.00002	0.21237	0.00535	0.00100	0.00000
5	0.00001	0.00003	0.23535	0.00460	0.00072	0.00000
6	0.00001	0.00012	0.25111	0.00468	0.00038	0.00000
7	0.00001	0.00001	0.25648	0.00477	0.00002	0.00001
8	0.00001	0.00012	0.25099	0.00485	0.00038	0.00000
9	0.00001	0.00003	0.23498	0.00494	0.00073	0.00000
10	0.00001	0.00007	0.20926	0.00537	0.00104	0.00000
11	0.00001	0.00002	0.17557	0.00582	0.00128	0.00000
12	0.00001	0.00007	0.13625	0.00627	0.00144	0.00000
13	0.00001	0.00000	0.09428	0.00673	0.00149	0.00000
14	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	0.00000	0.00000	0.01653	0.00424	0.00046	0.00000
16	0.00001	0.00000	0.05852	0.00682	0.00093	0.00000
17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	0.00010	0.00001	0.03660	0.00270	0.00024	0.00000
19	0.00013	0.00002	0.12453	0.00415	0.00048	0.00000
20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	0.00007	0.00001	0.03604	0.00287	0.00024	0.00000
22	0.00009	0.00002	0.12395	0.00445	0.00049	0.00000
23	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	0.00000	0.00000	0.01398	0.00374	0.00050	0.00000
25	0.00001	0.00000	0.04891	0.00599	0.00099	0.00000

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

11

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE
USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
14		-1475.95	-259.36	-0.44	-8.93	-1.01	-19295.16
17		-173.12	-556.82	-2.32	-44.88	-0.09	-5457.58
20		-236.33	-754.77	-2.36	-43.18	-0.13	-6897.71
23		-1466.27	-336.97	-0.47	-9.37	-0.95	-19515.21

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE
USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
14		-0.51	-1.13	-1057.25	-23151.06	-1680.72	-4.10
17		-2.07	-7.91	-147.10	-8365.02	-473.43	-37.26
20		-1.54	-8.97	-164.36	-9404.99	-514.80	-26.89
23		-1.09	-2.68	-1018.17	-21309.29	-1877.47	-7.10

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
13	APRO2	14	259.36	1475.95	0.44	1.01	8.93	19295.16
		15	259.36	1475.95	0.44	1.01	5.71	8584.43
14	APRO2	15	259.28	1472.52	0.42	1.01	5.71	8584.43
		16	259.28	1472.52	0.42	1.01	2.59	2797.84
15	APRO2	16	259.11	1461.92	0.36	1.01	2.59	2797.84
		1	259.11	1461.92	0.36	1.01	0.19	13171.46
16	APRO3	17	556.82	173.12	2.32	0.09	44.88	5457.58
		18	556.82	173.12	2.32	0.09	13.17	1192.66
17	APRO3	18	555.82	148.21	0.82	0.09	13.17	1192.66
		19	555.82	148.21	0.82	0.09	33.70	2626.93
18	APRO3	19	553.83	84.36	1.36	0.09	33.70	2626.93
		5	553.83	84.36	1.36	0.09	0.35	4731.66
19	APRO3	20	754.77	236.33	2.36	0.13	43.18	6897.71
		21	754.77	236.33	2.36	0.13	11.85	1417.57
20	APRO3	21	753.12	211.39	0.87	0.13	11.85	1417.57
		22	753.12	211.39	0.87	0.13	32.19	3577.18
21	APRO3	22	749.84	147.17	1.39	0.13	32.19	3577.18

RESULTANT MEMBER FORCES -----

ER	SECTION	JOINT	AXIAL	LOCAL Y	LOCAL Z	TORSIONAL	LOCAL Y	LOCAL Z

NO.	TAG.	NO.	FORCE	SHEAR FORCE	SHEAR FORCE	MOMENT	MOMENT	MOMENT
		9	749.84	147.17	1.39	0.13	0.28	7003.86
22	APRO2	23	336.97	1466.27	0.47	0.95	9.37	19515.21
		24	336.97	1466.27	0.47	0.95	6.06	9372.62
23	APRO2	24	336.89	1463.14	0.46	0.95	6.06	9372.62
		25	336.89	1463.14	0.46	0.95	2.87	2342.06
24	APRO2	25	336.73	1453.45	0.40	0.95	2.87	2342.06
		13	336.73	1453.45	0.40	0.95	0.12	11462.11

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	/--- AXIAL FORCE	---/--- LOCAL Y SHEAR FORCE	--/-- LOCAL Z SHEAR FORCE	--/-- TORSIONAL MOMENT	-/--- LOCAL Y MOMENT	--/-- LOCAL Z MOMENT	--/
13	APRO2	14	1.13	0.51	1057.25	1680.72	23151.05	4.10	
		15	1.13	0.51	1057.25	1680.72	15433.17	1.23	
14	APRO2	15	1.13	0.50	1056.08	1680.72	15433.17	1.23	
		16	1.13	0.50	1056.08	1680.72	7618.25	3.75	
15	APRO2	16	1.12	0.50	1051.96	1680.72	7618.25	3.75	
		1	1.12	0.50	1051.96	1680.72	62.09	7.27	
16	APRO3	17	7.91	2.07	147.10	473.43	8365.02	37.26	
		18	7.91	2.07	147.10	473.43	5070.10	14.47	
17	APRO3	18	7.70	0.39	120.22	473.43	5070.10	14.47	
		19	7.70	0.39	120.22	473.43	2371.82	24.14	
18	APRO3	19	7.29	1.76	92.69	473.43	2371.82	24.14	
		5	7.29	1.76	92.69	473.43	68.71	19.88	
19	APRO3	20	8.97	1.54	164.36	514.80	9404.99	26.89	
		21	8.97	1.54	164.36	514.80	5837.34	9.01	

RESULTANT MEMBER FORCES -----

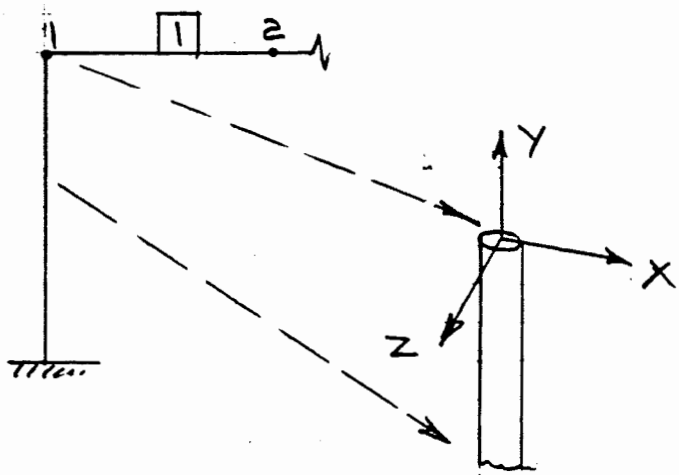
MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
20	APRO3	21	8.75	0.43	142.76	514.80	5837.34	9.01
		22	8.75	0.43	142.76	514.80	2697.91	19.08
21	APRO3	22	8.33	1.09	114.84	514.80	2697.91	19.08
		9	8.33	1.09	114.84	514.80	31.22	6.39
22	APRO2	23	2.68	1.09	1018.17	1877.47	21309.29	7.10
		24	2.68	1.09	1018.17	1877.47	14182.16	1.55
23	APRO2	24	2.68	1.08	1017.16	1877.47	14182.16	1.55
		25	2.68	1.08	1017.16	1877.47	7062.10	8.39
24	APRO2	25	2.67	1.06	1013.66	1877.47	7062.10	8.39
		13	2.67	1.06	1013.66	1877.47	35.70	15.78

BRIDGE SECTION
Oregon State Highway Division

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-26-93 Bridge No. 7780.

Develop the support stiffness matrix (typ. ea. bt.) to input w/ a modified M-STRUDL model (use nodes 1-13 w/ supports @ 1, 5, 9 and 13, and members 1-12 of earlier model)



$$\begin{bmatrix} F_x \\ F_y \\ F_z \\ M_x \\ M_y \\ M_z \end{bmatrix} = \left[\begin{array}{cc|cccc} X_1 & 0 & 0 & 0 & 0 & X_2 \\ 0 & X_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & X_1 & -X_2 & 0 & 0 \\ 0 & 0 & -X_2 & X_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & X_5 & 0 \\ X_2 & 0 & 0 & 0 & 0 & X_4 \end{array}\right] \begin{bmatrix} \Delta_x \\ \Delta_y \\ \Delta_z \\ \phi_x \\ \phi_y \\ \phi_z \end{bmatrix}$$

$\Delta_x \quad \Delta_y \quad \Delta_z \quad \phi_x \quad \phi_y \quad \phi_z$

BRIDGE SECTION
Oregon State Highway Division

Sheet 000031

Bridge Name Rocky Pt Viaduct

Calculations by SS Date 7-26-93 Bridge No. 7780A

From M-STRUDL, top of column forces:

Local coor. (typ.)

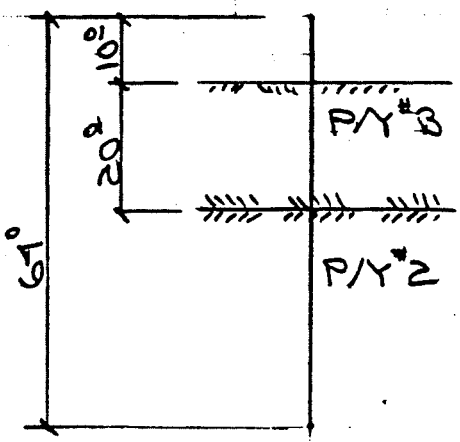
k & Ft

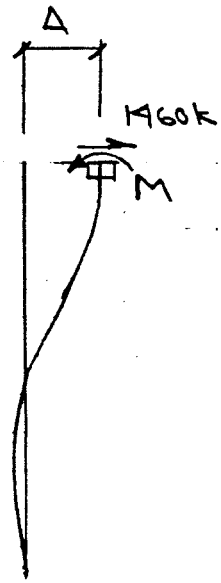
Bt.	Mem	EQL Vy	EQL Mz	EQT Vz	EQT My
2	15	1460	13,200	1050	60
3	18	80	1700	90	70
4	21	150	7000	110	30
5	24	1450	11,500	1000	90

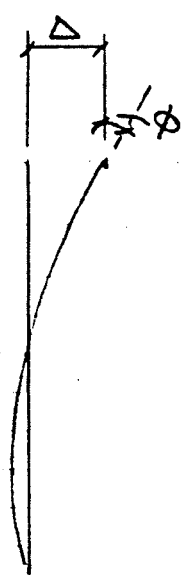
Use to develop stiff. matrix.

Run COM624 for stiffness coefficients

Bt 2:







w/ P = 1000 k For X_1 & X_2 For X_4

BRIDGE SECTION
Oregon State Highway Division

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-27-93 Bridge No. 7780A

$\Delta = 1.08"$ $M = 228{,}000$ k-in (run 1)

$\therefore X_1 = \frac{1960(12)}{1.08} = 16{,}200 \frac{k}{ft}$

$X_2 = \frac{228000}{1.08} = 211{,}100 \frac{k\text{-}ft}{ft}$

$\phi = \left(\arctan\left[\frac{1.08-0.86}{96.08}\right]\right)_x \frac{1.}{57.3}$ (run 2)

$= 0.00977$ rad

$\therefore X_1 = \frac{228{,}000}{0.00977}\left(\frac{1}{12}\right) = 3{,}980{,}000 \frac{k\text{-}ft}{rad}$

A check of X_2:

$X_2 = \frac{(1960-528)}{0.00977} = 195{,}700 \frac{k}{rad.}$ (8% off ✓)

By approx. calc.

$X_3 = \frac{EA}{L} = \frac{[518400^{conc}(28.3) + 1176000^{rebar}(0.63)]}{36.0}$

$= 180{,}600 \frac{k}{ft}$

$X_5 = \frac{IG}{L} = \frac{128.0(0.1 \times 518{,}700)}{36.0}$

$= 737{,}300 \frac{k\text{-}ft}{rad.}$

```
BR. 7780A  ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)
    1     1     0
   50     2     1     0
    0     0     3
   68.000   3600000.   120.000     0.000
    0     3
    2     1     1                 0
  100      0.00010000    100.00000000
    0.0000    72.0000  1327100.0    4075.0
    1     5   120.0000   360.0000  276.0
    2     5   360.0000   900.0000  883.0
   10
  120.0000
    0.000      0000.
    0.245      4870.
    0.490      7440.
    0.727      9430.
    1.022     11430.
    2.239     17690.
    3.456     22410.
    4.673     26380.
    5.890     29880.
    7.099     33040.
  359.0000
    0.000      0000.
    0.245      4879.
    0.490      7440.
    0.727      9430.
    1.022     11430.
    2.239     17690.
    3.456     22410.
    4.673     26380.
    5.890     29880.
    7.099     33040.
  360.0000
    0.000      0000.
    0.245     15580.
    0.490     26890.
    0.727     36450.
    1.022     46650.
    2.239     81740.
    3.456    110890.
    4.673    136840.
    5.890    160070.
    7.099    183010.
    1
    1  1460000.0  00.0  1000000.0
    2  0
    4000.  60000.  0.  29000000.
    0.  72.0   0.0   0.0   0.0
    14  40  1  7.7
END
```

000033

Fixed head

Input shear, head slope = 0

BR. 7780A ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)

UNITS--ENGL 0000

****
PILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE
****

I N P U T I N F O R M A T I O N
****

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 768.00 IN
MODULUS OF ELASTICITY OF PILE = .360E+04 KIP/IN**2
1 SECTION(S)

X	DIAMETER	MOMENT OF INERTIA	AREA
IN	IN	IN**4	IN**2
.00	72.000	.133E+07	.408E+04
768.00			

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = 120.00 IN

SLOPE ANGLE AT THE GROUND SURFACE = .00 DEG.

2 LAYER(S) OF SOIL

LAYER 1
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES
X AT THE TOP OF THE LAYER = 120.00 IN
X AT THE BOTTOM OF THE LAYER = 360.00 IN
VARIATION OF SOIL MODULUS, k = .276E+03 LBS/IN**3

LAYER 2
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES

X AT THE TOP OF THE LAYER = 360.00 IN
X AT THE BOTTOM OF THE LAYER = 900.00 IN
VARIATION OF SOIL MODULUS, k = .883E+03 LBS/IN**3

INPUT P-Y CURVES 3 CURVES, 10 POINTS ON EACH

X,IN	Y,IN	P,LBS/IN
120.00	.00	.00
	.25	4870.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
359.00	.00	.00
	.25	4879.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
360.00	.00	.00
	.25	15580.00
	.49	26890.00
	.73	36450.00
	1.02	46650.00
	2.24	81740.00
	3.46	110890.00
	4.67	136840.00
	5.89	160070.00
	7.10	183010.00

FINITE DIFFERENCE PARAMETERS
NUMBER OF PILE INCREMENTS = 50
TOLERANCE ON DETERMINATION OF DEFLECTIONS = .100E-03 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS = 100
MAXIMUM ALLOWABLE DEFLECTION = .10E+03 IN

INPUT CODES
OUTPT = 1
KCYCL = 1

KBC = 2
KPYOP = 0
INC = 3

BR. 7780A ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)

UNITS--ENGL

O U T P U T I N F O R M A T I O N
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PILE LOADING CONDITION

LATERAL LOAD AT PILE HEAD = .146E+04 KIP
SLOPE AT PILE HEAD = .000E+00 IN/IN
AXIAL LOAD AT PILE HEAD = .100E+04 KIP

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
.00	.108E+01	-.228E+06	.642E+04	.146E+04	.000E+00	.478E+10
46.08	.104E+01	-.160E+06	.460E+04	.146E+04	.000E+00	.478E+10
92.16	.919E+00	-.930E+05	.277E+04	.146E+04	.000E+00	.478E+10
138.24	.760E+00	-.279E+05	.100E+04	.123E+04	.965E+04	.478E+10
184.32	.588E+00	.192E+05	.765E+03	.818E+03	.827E+04	.478E+10
230.40	.424E+00	.487E+05	.157E+04	.471E+03	.675E+04	.478E+10
276.48	.282E+00	.638E+05	.198E+04	.195E+03	.526E+04	.478E+10
322.56	.167E+00	.679E+05	.209E+04	-.613E+01	.332E+04	.478E+10
368.64	.819E-01	.647E+05	.200E+04	-.146E+03	.521E+04	.478E+10
414.72	.255E-01	.538E+05	.170E+04	-.297E+03	.162E+04	.478E+10
460.80	-.713E-02	.392E+05	.131E+04	-.320E+03	.454E+03	.478E+10
506.88	-.223E-01	.253E+05	.932E+03	-.273E+03	.142E+04	.478E+10
552.96	-.262E-01	.143E+05	.634E+03	-.200E+03	.167E+04	.478E+10
599.04	-.236E-01	.683E+04	.431E+03	-.127E+03	.150E+04	.478E+10
645.12	-.178E-01	.247E+04	.313E+03	-.656E+02	.113E+04	.478E+10
691.20	-.108E-01	.509E+03	.259E+03	-.235E+02	.689E+03	.478E+10

737.28 -.362E-02 .471E+01 .246E+03 -.235E+01 .230E+03 .478E+10

COMPUTED LATERAL FORCE AT PILE HEAD = .14600E+04 KIP
COMPUTED SLOPE AT PILE HEAD = -.72280E-17 IN/IN

THE OVERALL MOMENT IMBALANCE = -.434E-07 IN-KIP
THE OVERALL LATERAL FORCE IMBALANCE = .710E-07 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .108E+01 IN
MAXIMUM BENDING MOMENT = -.228E+06 IN-KIP
MAXIMUM TOTAL STRESS = .642E+04 LBS/IN**2

NO. OF ITERATIONS = 7
MAXIMUM DEFLECTION ERROR = .860E-04 IN

S U M M A R Y T A B L E

****

LATERAL LOAD KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.146E+04	.000E+00	.100E+04	.108E+01	-.723E-17	-.228E+06	.642E+04

```
BR. 7780A  ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)
    1     1     0
   50      2      1      0
    0      0      3
  768.000    3600000.    120.000      0.000
    0      3
    4      1      1                  0
  100       0.00010000     100.00000000
    0.0000     72.0000   1327100.0     4075.0
    1      5   120.0000    360.0000   276.0
    2      5   360.0000    900.0000   883.0
   10
  120.0000
    0.000       0000.
    0.245       4870.
    0.490       7440.
    0.727       9430.
    1.022      11430.
    2.239      17690.
    3.456      22410.
    4.673      26380.
    5.890      29880.
    7.099      33040.
  359.0000
    0.000       0000.
    0.245       4879.
    0.490       7440.
    0.727       9430.
    1.022      11430.
    2.239      17690.
    3.456      22410.
    4.673      26380.
    5.890      29880.
    7.099      33040.
  360.0000
    0.000       0000.
    0.245      15580.
    0.490      26890.
    0.727      36450.
    1.022      46650.
    2.239      81740.
    3.456     110890.
    4.673     136840.
    5.890     160070.
    7.099     183010.
    1
    1  1.08   00.0  1000000.0
    2  0
    4000.  60000.  0.  29000000.
    0.  72.0   0.0   0.0   0.0
    14  40  1  7.7
END
```

Free head (w/ input Δ_x & M)

- Input Δ_x & M

UNITS--ENGL

****
PILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE
****

I N P U T I N F O R M A T I O N

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 768.00 IN
MODULUS OF ELASTICITY OF PILE = .360E+04 KIP/IN**2
1 SECTION(S)

X	DIAMETER	MOMENT OF INERTIA	AREA
IN	IN	IN**4	IN**2
.00	72.000	.133E+07	.408E+04
768.00			

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = 120.00 IN

SLOPE ANGLE AT THE GROUND SURFACE = .00 DEG.

2 LAYER(S) OF SOIL

LAYER 1
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES
X AT THE TOP OF THE LAYER = 120.00 IN
X AT THE BOTTOM OF THE LAYER = 360.00 IN
VARIATION OF SOIL MODULUS, k = .276E+03 LBS/IN**3

LAYER 2
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES

X AT THE TOP OF THE LAYER = 360.00 IN
X AT THE BOTTOM OF THE LAYER = 900.00 IN
VARIATION OF SOIL MODULUS, k = .883E+03 LBS/IN**3

000040

INPUT P-Y CURVES 3 CURVES, 10 POINTS ON EACH

X,IN	Y,IN	P,LBS/IN
120.00	.00	.00
	.25	4870.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
359.00	.00	.00
	.25	4879.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
360.00	.00	.00
	.25	15580.00
	.49	26890.00
	.73	36450.00
	1.02	46650.00
	2.24	81740.00
	3.46	110890.00
	4.67	136840.00
	5.89	160070.00
	7.10	183010.00

FINITE DIFFERENCE PARAMETERS
NUMBER OF PILE INCREMENTS = 50
TOLERANCE ON DETERMINATION OF DEFLECTIONS = .100E-03 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS = 100
MAXIMUM ALLOWABLE DEFLECTION = .10E+03 IN

INPUT CODES
OUTPT = 1
KCYCL = 1

KBC = 4
KPYOP = 0
INC = 3

000041

BR. 7780A ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)

UNITS--ENGL

O U T P U T I N F O R M A T I O N
****

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PILE LOADING CONDITION

LATERAL DEFLECTION AT PILE HEAD = .108E+01 IN
APPLIED MOMENT AT PILE HEAD = .000E+00 IN-KIP
AXIAL LOAD AT PILE HEAD = .100E+04 KIP

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
.00	.108E+01	.000E+00	.245E+03	.528E+03	.000E+00	.478E+10
46.08	.858E+00	.243E+05	.905E+03	.523E+03	.000E+00	.478E+10
92.16	.647E+00	.486E+05	.156E+04	.523E+03	.000E+00	.478E+10
138.24	.457E+00	.711E+05	.217E+04	.351E+03	.710E+04	.478E+10
184.32	.299E+00	.805E+05	.243E+04	.633E+02	.544E+04	.478E+10
230.40	.176E+00	.782E+05	.237E+04	-.146E+03	.349E+04	.478E+10
276.48	.870E-01	.685E+05	.210E+04	-.265E+03	.173E+04	.478E+10
322.56	.287E-01	.549E+05	.173E+04	-.316E+03	.572E+03	.478E+10
368.64	-.522E-02	.400E+05	.133E+04	-.323E+03	.331E+03	.478E+10
414.72	-.213E-01	.259E+05	.948E+03	-.281E+03	.135E+04	.478E+10
460.80	-.258E-01	.145E+05	.639E+03	-.210E+03	.164E+04	.478E+10
506.88	-.237E-01	.655E+04	.423E+03	-.137E+03	.151E+04	.478E+10
552.96	-.186E-01	.175E+04	.293E+03	-.743E+02	.118E+04	.478E+10
599.04	-.127E-01	-.536E+03	.260E+03	-.284E+02	.806E+03	.478E+10
645.12	-.690E-02	-.111E+04	.276E+03	.192E+00	.439E+03	.478E+10
691.20	-.159E-02	-.751E+03	.266E+03	.125E+02	.101E+03	.478E+10

737.28 .340E-02 -.172E+03 .250E+03 .983E+01 .216E+03 .478E+10

COMPUTED LATERAL FORCE AT PILE HEAD = .52304E+03 KIP

NO. OF ITERATIONS = 4
MAXIMUM DEFLECTION ERROR = .548E-04 IN

SUMMARY TABLE

LATERAL LOAD (KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.523E+03	.000E+00	.100E+04	.108E+01	-.485E-02	.808E+05	.244E+04

BRIDGE SECTION
Oregon State Highway Division

Sheet

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-28-93 Bridge No. 7780A

Run M-STRUDL.

Use previous model w/ cols out & put in support stiffness matrix.

Results for top of column forces are:

Global Coor. (typ)

k & Ft

Bt.	Node	EQL Vx	EQL Mz	EQT Vz	EQT Mx
2	1	2120	30,100	880	80
3	5	200	7,900	110	80
4	9	240	8,700	140	50
5	13	2220	31,000	860	60

Use to develop new stiff. matrix

Use previously developed COM624 models

```
TITLE  BR. 7780A   ROCKY PT. VIADUCT   STARKEY   7-27-93  (SKSSTR2)
$ DYNAMIC LOADING MODEL (WITH SPRINGS)
TYPE SPACE FRAME
UNITS KIPS FT RADIANS
SAVE ON
$ REPORT DEVICE SKSOUT2
JOI COO
1           0.0    100.0       0.0   S
2         26.75    100.0       0.0
3         53.50    100.0       0.0
4         80.25    100.0       0.0
5         107.0    100.0       0.0   S
6         135.75   100.0       0.0
7         164.50   100.0       0.0
8         193.25   100.0       0.0
9         222.0    100.0       0.0   S
10        251.0    100.0       0.0
11        280.0    100.0       0.0
12        309.0    100.0       0.0
13        338.0    100.0       0.0   S
$
JOINT RELEASE
1  KFX 16200.   KFY 480600.  KFZ 16200.  KMX 3980000.  KMY 737300.  -
   KMZ 3980000. KXY 0.10     KYX -0.10   KXZ 211100.   KZX -211100.
5  KFX 1650.    KFY 260400.  KFZ 1650.   KMX 3210000.  KMY 578200.  -
   KMZ 3210000. KXY 0.10     KYX -0.10   KXZ 63200.    KZX -63200.
9  KFX 2070.    KFY 266700.  KFZ 2070.   KMX 3469000.  KMY 592100.  -
   KMZ 3469000. KXY 0.10     KYX -0.10   KXZ 73600.    KZX -73600.
13 KFX 16700.   KFY 346100.  KFZ 16700.  KMX 3910000.  KMY 530900.  -
   KMZ 3910000. KXY 0.10     KYX -0.10   KXZ 212500.   KZX -212500.
MEM INC
1   1   2
12  12  13
1  TO 12  BY 1  I BY 1  J BY 1
$
MEMBER   PROPERTIES
APRO1  AX  73.0 IX    9.7     IY 13130.0 IZ   414.4   1 TO 12
$
MATERIAL PROPERTIES
A1     E 547200.0  DEN 0.225  CTE 0.000006    1 TO 12
$
DYNAMIC ANALYSIS REACTIONS MODES 9
$ A=0.29  S=1.0  G=32.2
LOAD EQL
RSA X 9.34 FREQ ACCE RESSOIL1 SRSS
LOAD EQT
RSA Z 9.34 FREQ ACCE RESSOIL1 SRSS
OUT DEC 5
LIST FREQ 1 TO 9
LIST DISP ALL
OUT DEC 2
LIST REA ALL
FINISH
```

000044

****
* RESULTS OF ANALYSIS *
****

TYPE OF THE PROBLEM : SPACE FRAME RESTART STATUS : NONE GIVEN
ACTIVE UNITS : KIPS FEET RADIANS

* TOLERANCE = 0.01 MAX. NO. ITERATIONS = 20

* TOTAL WEIGHT IN X DIRECTION = 5551.65
* TOTAL WEIGHT IN Y DIRECTION = 5551.65
* TOTAL WEIGHT IN Z DIRECTION = 5551.65

* NO. OF EIGEN VALUES REQUESTED : 9

MODE NO.	FREQUENCY HZ.	PERIOD SECOND	% MASS PARTICIPATED X DIR.	% MASS PARTICIPATED Y DIR.	% MASS PARTICIPATED Z DIR.	PARTICIPATION FACTOR X DIR.	PARTICIPATION FACTOR Y DIR.	PARTICIPATION FACTOR Z DIR.
1	1.08	0.924	0.00000	0.00000	97.60917	0.08884	-0.00232	4699.38619
2	2.02	0.495	95.60383	0.04233	0.00001	5506.65043	115.86729	-1.36176
3	2.07	0.484	0.00002	0.00000	0.00893	1.46063	0.03656	-32.46847
4	3.04	0.329	0.41801	4.29717	0.00000	215.23067	-690.08759	-0.14417
5	3.84	0.260	3.65867	2.46524	0.00002	-619.24944	508.31562	-1.45170
6	4.41	0.227	0.00000	0.00001	2.39771	-0.21056	-0.92906	418.33276
7	4.75	0.211	0.07158	69.04865	0.00001	-82.34076	-2557.41270	-1.08335
8	10.22	0.098	0.00677	0.10846	0.00000	24.15969	96.73436	-0.22776
9	10.46	0.096	0.16774	0.30406	0.00000	-135.38246	-182.27716	-0.48378

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	Y DIRECTION	Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	Y DIRECTION	Z DIRECTION
1	0.10428	0.00035	0.00016	0.00001	0.00000	0.00204
2	0.10505	0.03453	0.00011	0.00001	0.00000	0.00062
3	0.10566	0.03591	0.00009	0.00000	0.00000	0.00045
4	0.10612	0.01801	0.00010	0.00000	0.00000	0.00080
5	0.10643	0.00131	0.00010	0.00000	0.00000	0.00035
6	0.10671	0.00721	0.00007	0.00000	0.00000	0.00018
7	0.10681	0.00887	0.00004	0.00000	0.00000	0.00010
8	0.10673	0.00524	0.00005	0.00000	0.00000	0.00019
9	0.10647	0.00154	0.00008	0.00000	0.00000	0.00025
10	0.10619	0.02087	0.00008	0.00000	0.00000	0.00092
11	0.10572	0.04369	0.00006	0.00000	0.00000	0.00051
12	0.10508	0.04215	0.00008	0.00001	0.00000	0.00070
13	0.10425	0.00040	0.00015	0.00001	0.00000	0.00226

M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/28/1993 13:47:56
L I C E N S E E : Oregon DOT #11, OR
TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 2

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

000047

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	Y DIRECTION	Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	Y DIRECTION	Z DIRECTION
1	0.00003	0.00000	0.17528	0.00928	0.00115	0.00000
2	0.00003	0.00003	0.20540	0.00833	0.00111	0.00000
3	0.00003	0.00004	0.23355	0.00737	0.00100	0.00000
4	0.00003	0.00002	0.25786	0.00642	0.00082	0.00000
5	0.00003	0.00000	0.27685	0.00548	0.00060	0.00000
6	0.00003	0.00002	0.29013	0.00559	0.00032	0.00000
7	0.00003	0.00002	0.29506	0.00571	0.00002	0.00000
8	0.00003	0.00001	0.29126	0.00582	0.00028	0.00000
9	0.00003	0.00000	0.27902	0.00593	0.00057	0.00000
10	0.00003	0.00002	0.25898	0.00672	0.00082	0.00000
11	0.00003	0.00003	0.23241	0.00750	0.00102	0.00000
12	0.00003	0.00002	0.20106	0.00829	0.00115	0.00000
13	0.00003	0.00000	0.16723	0.00907	0.00119	0.00000

| M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/28/1993 13:47:56 |
| L I C E N S E E : Oregon DOT #11, OR |
| TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 3 |

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1		-2120.21	-170.52	-0.82	0.17	-2.02	-30137.04
5		-197.93	-340.89	-0.04	0.11	-0.37	-7860.17
9		-238.94	-410.58	-0.04	0.17	-0.53	-8710.20
13		-2220.35	-138.72	-0.76	0.16	-1.48	-30973.81

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| M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/28/1993 13:47:56 |
| L I C E N S E E : Oregon DOT #11, OR |
| TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 4 |

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1		-0.63	-0.34	-880.98	75.64	-848.26	-9.44
5		-0.09	-0.59	-110.67	-83.50	-347.75	-3.88
9		-0.08	-0.67	-140.84	-48.65	-336.15	-3.04
13		-0.63	-0.28	-864.58	57.73	-633.54	-9.09

| M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/28/1993 13:47:56 |
| L I C E N S E E : Oregon DOT #11, OR |
| TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 4 |

*** LOAD INDEX : 1 LOAD TAG : EQL ***

000049

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
1	APRO1	1	1151.67	169.56	2.67	0.18	2.01	14069.61
		2	1151.67	169.56	2.67	0.18	69.58	11100.77
2	APRO1	2	920.22	194.11	5.13	0.18	69.58	11100.77
		3	920.22	194.11	5.13	0.18	206.49	6774.88
3	APRO1	3	687.48	265.82	4.11	0.18	206.49	6774.88
		4	687.48	265.82	4.11	0.18	316.22	2072.30
4	APRO1	4	453.91	320.40	0.70	0.18	316.22	2072.30
		5	453.91	320.40	0.70	0.18	334.65	9033.95
5	APRO1	5	394.40	65.89	3.58	0.06	334.73	1993.06
		6	394.40	65.89	3.58	0.06	231.90	2123.02
6	APRO1	6	142.11	41.46	6.81	0.06	231.90	2123.02
		7	142.11	41.46	6.81	0.06	37.41	1888.64
7	APRO1	7	113.06	75.56	7.31	0.06	37.41	1888.64
		8	113.06	75.56	7.31	0.06	174.50	1377.89
8	APRO1	8	365.18	100.45	4.88	0.06	174.50	1377.89
		9	365.18	100.45	4.88	0.06	314.53	3479.80
9	APRO1	9	387.93	340.69	0.65	0.16	314.21	10550.68
		10	387.93	340.69	0.65	0.16	332.47	1526.03
10	APRO1	10	641.15	275.10	3.47	0.16	332.47	1526.03
		11	641.15	275.10	3.47	0.16	231.89	7304.26
11	APRO1	11	893.58	170.49	5.17	0.16	231.89	7304.26
		12	893.58	170.49	5.17	0.16	82.36	11611.21
12	APRO1	12	1144.54	137.26	2.89	0.16	82.36	11611.21
		13	1144.54	137.26	2.89	0.16	1.46	13497.50

M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 7/28/1993 13:47:56
L I C E N S E E : Oregon DOT #11, OR
TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 5

*** LOAD INDEX : 2 LOAD TAG : EQT ***

000050

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

RESULTANT MEMBER FORCES -----

MEMBER NO.	SECTION TAG.	JOINT NO.	AXIAL FORCE	LOCAL Y SHEAR FORCE	LOCAL Z SHEAR FORCE	TORSIONAL MOMENT	LOCAL Y MOMENT	LOCAL Z MOMENT
1	APRO1	1	0.36	0.34	824.32	75.94	848.26	5.24
		2	0.36	0.34	824.32	75.94	21207.08	5.93
2	APRO1	2	0.30	0.13	698.01	75.94	21207.08	5.93
		3	0.30	0.13	698.01	75.94	39828.00	8.57
3	APRO1	3	0.24	0.21	556.67	75.94	39828.00	8.57
		4	0.24	0.21	556.67	75.94	54610.69	3.99
4	APRO1	4	0.18	0.39	398.47	75.94	54610.69	3.99
		5	0.18	0.39	398.47	75.94	65115.26	7.90
5	APRO1	5	0.14	0.28	324.02	8.46	64767.68	6.89
		6	0.14	0.28	324.02	8.46	73997.08	4.50
6	APRO1	6	0.09	0.14	121.77	8.46	73997.08	4.50
		7	0.09	0.14	121.77	8.46	77447.23	5.66
7	APRO1	7	0.09	0.19	86.52	8.46	77447.23	5.66
		8	0.09	0.19	86.52	8.46	74972.31	2.58
8	APRO1	8	0.13	0.32	290.66	8.46	74972.31	2.58
		9	0.13	0.32	290.66	8.46	66670.22	8.80
9	APRO1	9	0.15	0.35	346.79	58.19	67006.29	9.24
		10	0.15	0.35	346.79	58.19	57127.71	2.11
10	APRO1	10	0.21	0.21	519.95	58.19	57127.71	2.11
		11	0.21	0.21	519.95	58.19	42178.46	6.98
11	APRO1	11	0.27	0.10	672.40	58.19	42178.46	6.98
		12	0.27	0.10	672.40	58.19	22741.03	5.57
12	APRO1	12	0.34	0.28	805.92	58.19	22741.03	5.57
		13	0.34	0.28	805.92	58.19	633.54	4.74

BRIDGE SECTION
Oregon State Highway Division

Sheet 000051

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-28-93 Bridge No. 7780A

Bt. 2:

$$X_1 = \frac{2120(12)}{1.75} = 14{,}500 \text{ k/ft}$$

$$X_2 = \frac{343000}{1.75} = 196{,}000 \frac{\text{k-ft}}{\text{ft}}$$

$$\phi = \left(\arctan\left[\frac{1.75-1.90}{96.08}\right]\right) \times \left(\frac{1}{57.3}\right) = 0.00759 \text{ rad.}$$

$$X_4 = \frac{343{,}000\left(\frac{1}{12}\right)}{0.00759} = 3{,}764{,}000 \frac{\text{k-ft}}{\text{rad}}$$

$$X_3 = 180{,}600 \text{ k/ft} \qquad X_5 = 737{,}300 \frac{\text{k-ft}}{\text{rad.}}$$

Bt. 3:

$$X_1 = \frac{200(12)}{1.96} = 1690 \text{ k/ft}$$

$$X_2 = \frac{92000}{1.96} = 63{,}000 \frac{\text{k-ft}}{\text{ft}}$$

$$\phi = \left(\arctan\left[\frac{1.96-1.21}{90.00}\right]\right) \times \left(\frac{1}{57.3}\right) = 0.00244 \text{ rad.}$$

$$X_4 = \frac{92{,}000\left(\frac{1}{12}\right)}{0.00244} = 3{,}142{,}000 \frac{\text{k-ft}}{\text{rad.}}$$

$$X_3 = 260{,}900 \text{ k/ft} \qquad X_5 = 578{,}200 \frac{\text{k-ft}}{\text{rad.}}$$

BRIDGE SECTION
Oregon State Highway Division

Sheet

Bridge Name Rocky Pt. Viaduct

Calculations by SS Date 7-28-93 Bridge No. 7780A

Bt. 4:

$$X_1 = \frac{2490(12)}{1.39} = 2070 \ k/ft$$

$$X_2 = \frac{102{,}000}{1.39} = 73{,}400 \ \frac{k\text{-}ft}{ft}$$

$$\phi = \left(\arctan\left[\frac{1.39-1.18}{87.29}\right]\right) \times \left(\frac{1}{57.3}\right) = 0.00279 \text{ rad.}$$

$$X_4 = \frac{102{,}000}{0.00279(12)} = 3{,}410{,}000 \ \frac{k\text{-}ft}{rad.}$$

$$X_3 = 266{,}700 \ k/ft \qquad X_5 = 592{,}100 \ \frac{k\text{-}ft}{rad.}$$

Bt. 5:

$$X_1 = \frac{2220(12)}{1.82} = 14{,}600 \ k/ft$$

$$X_2 = \frac{354000}{1.82} = 194{,}500 \ \frac{k\text{-}ft}{ft}$$

$$\phi = \left(\arctan\left[\frac{1.82-1.77}{43.92}\right]\right) \times \left(\frac{1}{57.3}\right) = 0.00797 \text{ rad.}$$

$$X_4 = \frac{354{,}000}{0.00797(12)} = 3{,}701{,}000 \ \frac{k\text{-}ft}{rad}$$

$$X_3 = 346{,}100 \ k/ft \qquad X_5 = 530{,}900 \ \frac{k\text{-}ft}{rad.}$$

```
BR. 7780A  ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)
    1    1    0
   50     2     1     0
    0     0.    3
  768.000   3600000.   120.000     0.000
    0     3
    2     1     1                0
  100       0.00010000    100.00000000
    0.0000    72.0000  1327100.0    4075.0
    1     5   120.0000   360.0000  276.0
    2     5   360.0000   900.0000  883.0
   10
  120.0000
    0.000      0000.
    0.245      4870.
    0.490      7440.
    0.727      9430.
    1.022     11430.
    2.239     17690.
    3.456     22410.
    4.673     26380.
    5.890     29880.
    7.099     33040.
  359.0000
    0.000      0000.
    0.245      4879.
    0.490      7440.
    0.727      9430.
    1.022     11430.
    2.239     17690.
    3.456     22410.
    4.673     26380.
    5.890     29880.
    7.099     33040.
  360.0000
    0.000      0000.
    0.245     15580.
    0.490     26890.
    0.727     36450.
    1.022     46650.
    2.239     81740.
    3.456    110890.
    4.673    136840.
    5.890    160070.
    7.099    183010.
    1
    1  2120000.  00.0  1000000.0
    2  0
    4000.  60000.  0.  29000000.
    0.  72.0   0.0   0.0   0.0
    14  40  1  7.7
END
```

UNITS--ENGL

****
PILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE
****

I N P U T I N F O R M A T I O N
****

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 768.00 IN
MODULUS OF ELASTICITY OF PILE = .360E+04 KIP/IN**2
1 SECTION(S)

X	DIAMETER	MOMENT OF INERTIA	AREA
IN	IN	IN**4	IN**2
.00	72.000	.133E+07	.408E+04
768.00			

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = 120.00 IN

SLOPE ANGLE AT THE GROUND SURFACE = .00 DEG.

2 LAYER(S) OF SOIL

LAYER 1
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES
X AT THE TOP OF THE LAYER = 120.00 IN
X AT THE BOTTOM OF THE LAYER = 360.00 IN
VARIATION OF SOIL MODULUS, k = .276E+03 LBS/IN**3

LAYER 2
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES

X AT THE TOP OF THE LAYER = 360.00 IN
X AT THE BOTTOM OF THE LAYER = 900.00 IN
VARIATION OF SOIL MODULUS, k = .883E+03 LBS/IN**3

INPUT P-Y CURVES 3 CURVES, 10 POINTS ON EACH

X,IN	Y,IN	P,LBS/IN
120.00	.00	.00
	.25	4870.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
359.00	.00	.00
	.25	4879.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
360.00	.00	.00
	.25	15580.00
	.49	26890.00
	.73	36450.00
	1.02	46650.00
	2.24	81740.00
	3.46	110890.00
	4.67	136840.00
	5.89	160070.00
	7.10	183010.00

FINITE DIFFERENCE PARAMETERS
NUMBER OF PILE INCREMENTS = 50
TOLERANCE ON DETERMINATION OF DEFLECTIONS = .100E-03 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS = 100
MAXIMUM ALLOWABLE DEFLECTION = .10E+03 IN

INPUT CODES
OUTPT = 1
KCYCL = 1

KB[illegible] = 2
KPYOP = 0
INC = 3

BR. 7780A ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)

UNITS--ENGL

O U T P U T I N F O R M A T I O N

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PILE LOADING CONDITION

LATERAL LOAD AT PILE HEAD	=	.212E+04 KIP
SLOPE AT PILE HEAD	=	.000E+00 IN/IN
AXIAL LOAD AT PILE HEAD	=	.100E+04 KIP

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.175E+01	-.343E+06	.956E+04	.212E+04	.000E+00	.478E+10
46.08	.168E+01	-.246E+06	.691E+04	.212E+04	.000E+00	.478E+10
92.16	.150E+01	-.148E+06	.425E+04	.212E+04	.000E+00	.478E+10
138.24	.126E+01	-.529E+05	.168E+04	.182E+04	.126E+05	.478E+10
184.32	.988E+00	.184E+05	.743E+03	.127E+04	.112E+05	.478E+10
230.40	.727E+00	.659E+05	.203E+04	.797E+03	.943E+04	.478E+10
276.48	.494E+00	.935E+05	.278E+04	.408E+03	.747E+04	.478E+10
322.56	.302E+00	.105E+06	.310E+04	.112E+03	.547E+04	.478E+10
368.64	.156E+00	.105E+06	.310E+04	-.143E+03	.992E+04	.478E+10
414.72	.565E-01	.905E+05	.270E+04	-.444E+03	.359E+04	.478E+10
460.80	-.295E-02	.677E+05	.208E+04	-.515E+03	.188E+03	.478E+10
506.88	-.323E-01	.449E+05	.146E+04	-.458E+03	.206E+04	.478E+10
552.96	-.416E-01	.262E+05	.956E+03	-.346E+03	.265E+04	.478E+10
599.04	-.391E-01	.130E+05	.599E+03	-.226E+03	.249E+04	.478E+10
645.12	-.306E-01	.510E+04	.384E+03	-.123E+03	.195E+04	.478E+10
691.20	-.197E-01	.126E+04	.280E+03	-.493E+02	.125E+04	.478E+10

737.28 -.817E-02 .786E+02 .248E+03 -.839E+01 .519E+03 .478E+10

COMPUTED LATERAL FORCE AT PILE HEAD = .21200E+04 KIP
COMPUTED SLOPE AT PILE HEAD = -.14456E-16 IN/IN

THE OVERALL MOMENT IMBALANCE = .285E-06 IN-KIP
THE OVERALL LATERAL FORCE IMBALANCE = -.299E-05 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .175E+01 IN
MAXIMUM BENDING MOMENT = -.343E+06 IN-KIP
MAXIMUM TOTAL STRESS = .956E+04 LBS/IN**2

NO. OF ITERATIONS = 9
MAXIMUM DEFLECTION ERROR = .580E-04 IN

S U M M A R Y T A B L E

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LATERAL LOAD (KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.212E+04	.000E+00	.100E+04	.175E+01	-.145E-16	-.343E+06	.956E+04

```
BR. 7780A  ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)
    1    1    0
   50     2     1     0
    0     0     3
  768.000   3600000.   120.000     0.000
    0     3
    4     1     1                0
  100       0.00010000    100.00000000
    0.0000    72.0000  1327100.0    4075.0
    1     5   120.0000   360.0000  276.0
    2     5   360.0000   900.0000  883.0
   10
  120.0000
    0.000      0000.
    0.245      4870.
    0.490      7440.
    0.727      9430.
    1.022     11430.
    2.239     17690.
    3.456     22410.
    4.673     26380.
    5.890     29880.
    7.099     33040.
  359.0000
    0.000      0000.
    0.245      4879.
    0.490      7440.
    0.727      9430.
    1.022     11430.
    2.239     17690.
    3.456     22410.
    4.673     26380.
    5.890     29880.
    7.099     33040.
  360.0000
    0.000      0000.
    0.245     15580.
    0.490     26890.
    0.727     36450.
    1.022     46650.
    2.239     81740.
    3.456    110890.
    4.673    136840.
    5.890    160070.
    7.099    183010.
    1
    1  1.75  00.0  1000000.0
    2  0
    4000.  60000.  0.  29000000.
    0.  72.0   0.0   0.0   0.0
    14  40  1  7.7
END
```

00005

UNITS--ENGL

****
PILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE
****

I N P U T I N F O R M A T I O N
****

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 768.00 IN
MODULUS OF ELASTICITY OF PILE = .360E+04 KIP/IN**2
1 SECTION(S)

X	DIAMETER	MOMENT OF INERTIA	AREA
IN	IN	IN**4	IN**2
.00	72.000	.133E+07	.408E+04
768.00			

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = 120.00 IN

SLOPE ANGLE AT THE GROUND SURFACE = .00 DEG.

2 LAYER(S) OF SOIL

LAYER 1
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES
X AT THE TOP OF THE LAYER = 120.00 IN
X AT THE BOTTOM OF THE LAYER = 360.00 IN
VARIATION OF SOIL MODULUS, k = .276E+03 LBS/IN**3

LAYER 2
THE LAYER RESPONSE IS DEFINED BY INPUT P-Y CURVES

X AT THE TOP OF THE LAYER = 360.00 IN
X AT THE BOTTOM OF THE LAYER = 900.00 IN
VARIATION OF SOIL MODULUS, k = .883E+03 LBS/IN**3

INPUT P-Y CURVES 3 CURVES, 10 POINTS ON EACH

X,IN	Y,IN	P,LBS/IN
120.00	.00	.00
	.25	4870.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
359.00	.00	.00
	.25	4879.00
	.49	7440.00
	.73	9430.00
	1.02	11430.00
	2.24	17690.00
	3.46	22410.00
	4.67	26380.00
	5.89	29880.00
	7.10	33040.00

X,IN	Y,IN	P,LBS/IN
360.00	.00	.00
	.25	15580.00
	.49	26890.00
	.73	36450.00
	1.02	46650.00
	2.24	81740.00
	3.46	110890.00
	4.67	136840.00
	5.89	160070.00
	7.10	183010.00

FINITE DIFFERENCE PARAMETERS
NUMBER OF PILE INCREMENTS = 50
TOLERANCE ON DETERMINATION OF DEFLECTIONS = .100E-03 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS = 100
MAXIMUM ALLOWABLE DEFLECTION = .10E+03 IN

INPUT CODES
OUTPT = 1
KCYCL = 1

KBC = 4
KPYOP = 0
INC = 3

BR. 7780A ROCKY PT VIA-SHORT SHAFTS (BT 2) STARKEY 7-26-93 (SKSCOMA)

UNITS--ENGL

O U T P U T I N F O R M A T I O N

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PILE LOADING CONDITION

LATERAL DEFLECTION AT PILE HEAD	=	.175E+01	IN
APPLIED MOMENT AT PILE HEAD	=	.000E+00	IN-KIP
AXIAL LOAD AT PILE HEAD	=	.100E+04	KIP

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.175E+01	.000E+00	.245E+03	.784E+03	.000E+00	.478E+10
46.08	.140E+01	.361E+05	.123E+04	.777E+03	.000E+00	.478E+10
92.16	.107E+01	.722E+05	.221E+04	.777E+03	.000E+00	.478E+10
138.24	.766E+00	.106E+06	.312E+04	.543E+03	.970E+04	.478E+10
184.32	.512E+00	.122E+06	.354E+04	.145E+03	.762E+04	.478E+10
230.40	.310E+00	.121E+06	.353E+04	-.158E+03	.556E+04	.478E+10
276.48	.163E+00	.109E+06	.319E+04	-.365E+03	.323E+04	.478E+10
322.56	.627E-01	.891E+05	.266E+04	-.465E+03	.125E+04	.478E+10
368.64	.238E-02	.669E+05	.206E+04	-.494E+03	.151E+03	.478E+10
414.72	-.282E-01	.447E+05	.146E+04	-.450E+03	.180E+04	.478E+10
460.80	-.388E-01	.262E+05	.955E+03	-.349E+03	.247E+04	.478E+10
506.88	-.377E-01	.127E+05	.591E+03	-.235E+03	.239E+04	.478E+10
552.96	-.306E-01	.434E+04	.363E+03	-.134E+03	.195E+04	.478E+10
599.04	-.215E-01	.513E+02	.247E+03	-.573E+02	.137E+04	.478E+10
645.12	-.123E-01	-.133E+04	.282E+03	-.778E+01	.784E+03	.478E+10
691.20	-.367E-02	-.104E+04	.274E+03	.155E+02	.233E+03	.478E+10

737.28 .456E-02 -.253E+03 .252E+03 .142E+02 .290E+03 .478E+10

COMPUTED LATERAL FORCE AT PILE HEAD = .77653E+03 KIP

NO. OF ITERATIONS = 5
MAXIMUM DEFLECTION ERROR = .190E-04 IN

00001

S U M M A R Y T A B L E

****

LATERAL LOAD (KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.777E+03	.000E+00	.100E+04	.175E+01	-.763E-02	.123E+06	.358E+04

```
TITLE  BR. 7780A   ROCKY PT. VIADUCT   STARKEY   7-27-93   (SKSSTR2)
$ DYNAMIC LOADING MODEL (WITH SPRINGS)
TYPE SPACE FRAME
UNITS KIPS FT RADIANS                                          000063
SAVE ON
$ REPORT DEVICE SKSOUT2
JOI COO
1            0.0     100.0        0.0   S
2          26.75     100.0        0.0
3          53.50     100.0        0.0
4          80.25     100.0        0.0
5          107.0     100.0        0.0   S
6          135.75    100.0        0.0
7          164.50    100.0        0.0
8          193.25    100.0        0.0
9          222.0     100.0        0.0   S
10         251.0     100.0        0.0
11         280.0     100.0        0.0
12         309.0     100.0        0.0
13         338.0     100.0        0.0   S
$
JOINT RELEASE
1  KFX 14500.   KFY 480600.  KFZ 14500.  KMX 3764000.  KMY 737300.  -
   KMZ 3764000. KXY 0.10     KYX -0.10   KXZ 196000.   KZX -196000.
5  KFX 1640.    KFY 260400.  KFZ 1640.   KMX 3142000.  KMY 578200.  -
   KMZ 3142000. KXY 0.10     KYX -0.10   KXZ 63000.    KZX -63000.
9  KFX 2070.    KFY 266700.  KFZ 2070.   KMX 3410000.  KMY 592100.  -
   KMZ 3410000. KXY 0.10     KYX -0.10   KXZ 73400.    KZX -73400.
13 KFX 14600.   KFY 346100.  KFZ 14600.  KMX 3701000.  KMY 530900.  -
   KMZ 3701000. KXY 0.10     KYX -0.10   KXZ 194500.   KZX -194500.
MEM INC
1   1   2
12  12  13
1  TO 12  BY 1  I BY 1  J BY 1
$
MEMBER   PROPERTIES
APRO1  AX  73.0 IX    9.7     IY 13130.0 IZ   414.4   1 TO 12
$
MATERIAL PROPERTIES
A1    E 547200.0  DEN 0.225  CTE 0.000006    1 TO 12
$
DYNAMIC ANALYSIS REACTIONS MODES 9
$ A=0.29  S=1.0  G=32.2
LOAD EQL
RSA X 9.34 FREQ ACCE RESSOIL1 SRSS
LOAD EQT
RSA Z 9.34 FREQ ACCE RESSOIL1 SRSS
OUT DEC 5
LIST FREQ 1 TO 9
LIST DISP ALL
OUT DEC 2
LIST REA ALL
FINISH
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 ================================================================
| M-STRUDL BY CAST / REV.  V2.90 SBR :  722d TIME : 8/3/1993 10:22:41  |
| L I C E N S E E : Oregon DOT #11, OR                                 |
| TITLE:  BR. 7780A   ROCKY PT. VIADUCT   STARKEY   7-27-93 PAGE    1 |
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****
* RESULTS OF ANALYSIS *
****

TYPE OF THE PROBLEM : SPACE FRAME RESTART STATUS : NONE GIVEN
ACTIVE UNITS : KIPS FEET RADIANS

* TOLERANCE = 0.01 MAX. NO. ITERATIONS = 20

* TOTAL WEIGHT IN X DIRECTION = 5551.65
* TOTAL WEIGHT IN Y DIRECTION = 5551.65
* TOTAL WEIGHT IN Z DIRECTION = 5551.65

* NO. OF EIGEN VALUES REQUESTED : 9

MODE NO.	FREQUENCY HZ.	PERIOD SECOND	% MASS PARTICIPATED X DIR.	% MASS PARTICIPATED Y DIR.	% MASS PARTICIPATED Z DIR.	PARTICIPATION FACTOR X DIR.	PARTICIPATION FACTOR Y DIR.	PARTICIPATION FACTOR Z DIR.
1	1.03	0.972	0.00000	0.00000	98.10543	0.02377	0.01484	4781.78384
2	1.92	0.521	0.00075	0.00000	0.00598	9.27928	0.19787	-26.26521
3	1.93	0.519	96.44733	0.02855	0.00000	5511.43183	94.83110	0.38484
4	3.03	0.330	0.29960	4.43802	0.00000	180.78374	-695.79431	-0.60424
5	3.82	0.262	2.98120	2.30234	0.00011	553.17232	-486.12620	-3.28966
6	4.31	0.232	0.00000	0.00000	1.85415	0.03296	0.04040	369.88258
7	4.74	0.211	0.05786	69.05728	0.00151	73.69623	2545.95953	11.92423
8	10.17	0.098	0.00468	0.08689	0.00558	20.07736	86.50343	-21.91957
9	10.44	0.096	0.16053	0.33025	0.00327	129.86157	186.26355	-18.54550

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	Y DIRECTION	Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	Y DIRECTION	Z DIRECTION
1	0.11215	0.00036	0.00075	0.00004	0.00000	0.00205
2	0.11290	0.03411	0.00065	0.00003	0.00000	0.00060
3	0.11349	0.03496	0.00054	0.00002	0.00000	0.00046
4	0.11394	0.01717	0.00043	0.00001	0.00000	0.00078
5	0.11423	0.00125	0.00031	0.00001	0.00000	0.00032
6	0.11451	0.00645	0.00017	0.00000	0.00001	0.00016
7	0.11462	0.00783	0.00002	0.00000	0.00001	0.00009
8	0.11455	0.00447	0.00014	0.00000	0.00001	0.00017
9	0.11430	0.00143	0.00029	0.00001	0.00000	0.00020
10	0.11404	0.01889	0.00042	0.00001	0.00000	0.00086
11	0.11361	0.04090	0.00054	0.00002	0.00000	0.00052
12	0.11299	0.04033	0.00065	0.00003	0.00000	0.00065
13	0.11220	0.00040	0.00076	0.00004	0.00000	0.00221

| M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 8/3/1993 10:22:41 |
| L I C E N S E E : Oregon DOT #11, OR |
| TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 2 |

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25000:4.483200.29000:4.856800.33000:5.417200.40000:6.071000.50000:7.09840
0.53000:7.285200.56000:7.565400.59000:7.845600.63000:8.219200.67000:8.59280
0.71000:8.966400.77000:9.433400.83000:9.900400.91000:10.554201.00000:11.20800
1.11000:12.048601.25000:12.982601.43000:14.196801.67000:15.784602.00000:17.74600
2.50000:20.641403.00000:23.35000100.00000:23.35000

RESULTANT JOINT DISPLACEMENTS -----

JOINT NO.	GLOBAL DISPLACEMENTS X DIRECTION	Y DIRECTION	Z DIRECTION	GLOBAL ROTATIONS X DIRECTION	Y DIRECTION	Z DIRECTION
1	0.00001	0.00000	0.19689	0.01023	0.00110	0.00001
2	0.00001	0.00014	0.22573	0.00915	0.00106	0.00000
3	0.00001	0.00018	0.25266	0.00808	0.00096	0.00000
4	0.00001	0.00010	0.27590	0.00700	0.00079	0.00000
5	0.00001	0.00002	0.29404	0.00593	0.00057	0.00000
6	0.00001	0.00013	0.30672	0.00604	0.00031	0.00000
7	0.00001	0.00019	0.31145	0.00616	0.00002	0.00000
8	0.00001	0.00013	0.30786	0.00628	0.00027	0.00000
9	0.00001	0.00002	0.29622	0.00639	0.00054	0.00000
10	0.00001	0.00008	0.27715	0.00728	0.00078	0.00000
11	0.00001	0.00011	0.25186	0.00817	0.00097	0.00000
12	0.00001	0.00011	0.22197	0.00906	0.00109	0.00000
13	0.00001	0.00001	0.18969	0.00995	0.00114	0.00000

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| L I C E N S E E : Oregon DOT #11, OR |
| TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 3 |

*** LOAD INDEX : 1 LOAD TAG : EQL ***

* X - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1		-2027.04	-171.54	-3.27	0.65	-3.14	-29679.82
5		-207.39	-324.81	-0.11	-0.38	-2.80	-8196.60
9		-251.04	-381.54	-0.13	-0.34	-2.90	-9060.41

M-STRUDL BY CAST / REV. V2.90 SER : 722d TIME : 8/3/1993 10:22:41
L I C E N S E E : Oregon DOT #11, OR
TITLE: BR. 7780A ROCKY PT. VIADUCT STARKEY 7-27-93 PAGE 4

*** LOAD INDEX : 2 LOAD TAG : EQT ***

* Z - RSA, FACTOR = 9.34 FREQ. VS. ACCEL. CURVE

0.25:4.48	0.29:4.86	0.33:5.42	0.40:6.07	0.50:7.10
0.53:7.29	0.56:7.57	0.59:7.85	0.63:8.22	0.67:8.59
0.71:8.97	0.77:9.43	0.83:9.90	0.91:10.55	1.00:11.21
1.11:12.05	1.25:12.98	1.43:14.20	1.67:15.78	2.00:17.75
2.50:20.64	3.00:23.35	100.00:23.35		

* FOR REACTIONS OF DYNAMIC ANALYSIS AT SKEWED SPRING SUPPORTS, PLEASE USE THE MEMBER END FORCE RESULTS INSTEAD OF TABULATED RESULTS.

JOINT REACTIONS AT SUPPORTS -----

JOINT NO.	LD	GLOBAL REACTIONS X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1		-1.14	-2.22	-849.88	85.56	-811.13	-21.05
5		-0.16	-6.19	-108.91	-93.75	-331.98	-8.01
9		-0.26	-4.90	-143.96	-56.22	-319.49	-11.65
13		-0.92	-2.43	-833.95	65.31	-603.90	-16.46

DS-24
000068

BRIDGE SECTION
Oregon State Highway Division

Sheet

Bridge Name Rocky Pt Viaduct

Calculations by SS Date 7-28-93 Bridge No. 7780A

From the M-STRUDL w/ new matrix values:

Global Coor. (typ.)

k & Ft.

		EQL		EQT	
Bt	Node	Vx	Mz	Vz	Mx
2	1	2030	29,700	850	90
3	5	210	8,200	110	90
4	9	250	9,100	140	60
5	13	2070	30,000	830	60

Use as input to COM624 to get forces along shafts (runs follow "Long Shaft Analysis").