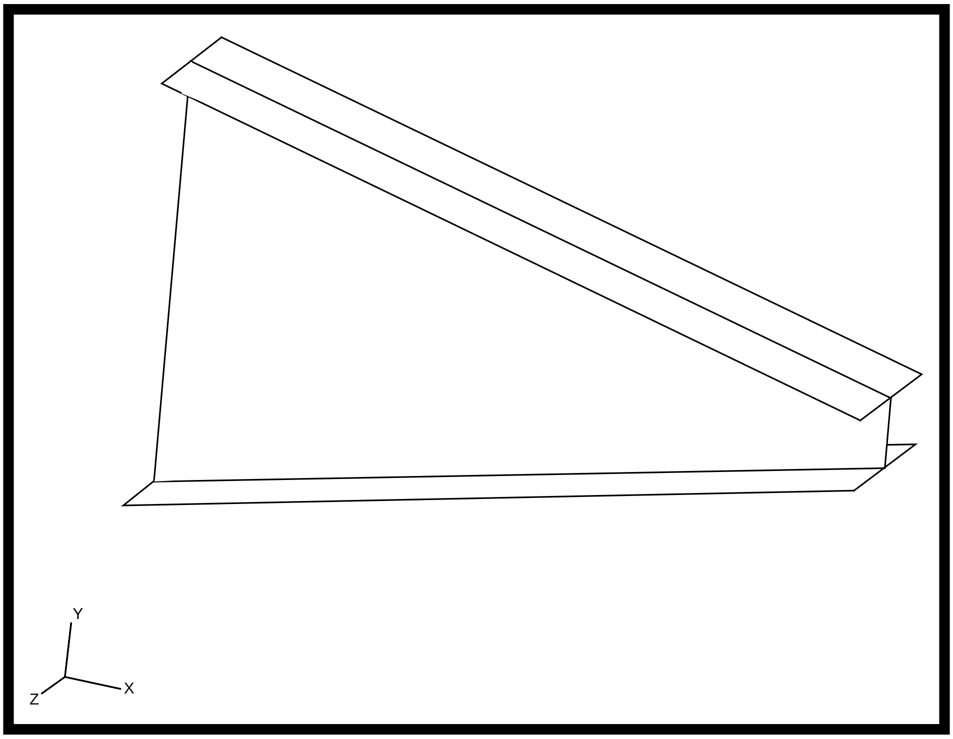
APPENDIX E

CBEAM Tapered Flanged Beam with Shear Relief



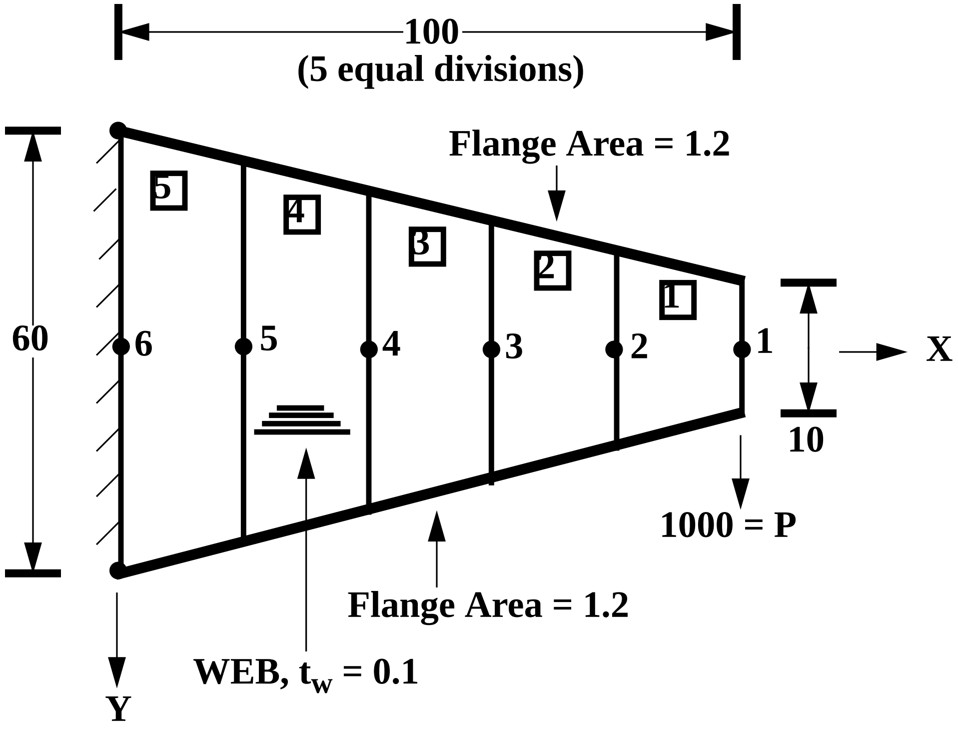
Objectives:

- Model a loaded, tapered, flanged cantilever beam with CBEAM elements, including shear relief in element properties.
- Create a revised model which does not include shear relief.
- Compare both results with theory.

Model Description:

(Taken from MSC/NASTRAN Demonstration Problem Manual, Problem D2440)

This problem demonstrates the use of the shear relief factors, S1 and S2, of the BEAM element. A cantilever tapered flanged beam is modeled using five beam elements.



Material	=	aluminum
E	=	10.0E6 psi
G	=	3.84E6 psi

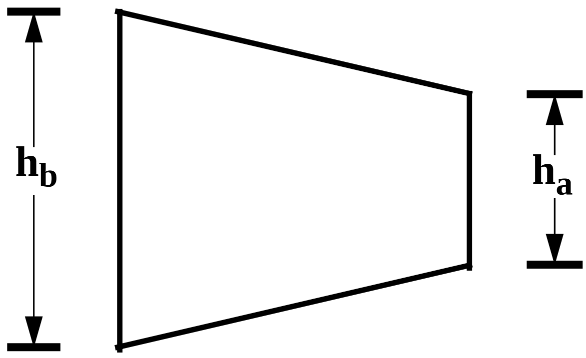
Element Properties

EID	A(A)	I1(A)	I2(A)	A(B)	I1(B)	I2(B)	PID
1	1.0	60.	1.0	2.0	240.	1.	1
2	2.0	240.	1.0	3.0	540.	1.	2
3	3.0	540.	1.0	4.	960.	1.	3
4	4.0	960.	1.0	5.0	1500.	1.	4
5	5.0	1500.	1.0	6.0	2160	1.	5

The shear relief factors, S1, (for plane 1) are calculated from the following relation that is derived in Section 2.6.4.6 of the MSC/NASTRAN Application Manual.

$$S = \frac{2(h_a - h_b)}{(h_a + h_b)}$$

Where, for a given tapered element,



Suggested Exercise Steps:

- Open a new database.
- Create a curve and mesh it with bar elements (CBEAM). Use the meshing feature so that elements and nodes (GRID) will be generated automatically by MSC/ PATRAN.
- Define material (MAT1) and element properties (PBEAM). To define beam properties, use **Tapered Section** option under the *1D Properties* form.

  Note 1: In order to define properties for both ends of the beam, two values will need to be entered into the same databox. For example:

Cross Sect. Areas	**4, 3**
Inertia 1,1	**960, 540**

  Note 2: It is extremely critical that all element property definitions are based on appropriate beam connectivity/sequence. Shear relief shall be calculated accordingly as well.

- Apply a fixed boundary constraint (SPC1) at one end of the beam and a transverse force to the free end of the beam (FORCE).
- Use the load and boundary sets to define a loadcase.
- Prepare the model for a Linear Static analysis (SOL 101 & PARAMs).
- Generate and submit input file to the MSC/NASTRAN solver.
- Create a revised MSC/NASTRAN input file without referencing shear relief.
- Compare both results with theory.

Shear Relief Factors:

EID	ha	hb	Shear Relief Factor, S1
1	10	20	-0.666667
2	20	30	-0.400000
3	30	40	-0.285714
4	40	50	-0.222222
5	50	60	-0.181818

Results:

	Tip Deflection
Theory	0.0326
NASTRAN	0.0321
Theory (without Shear Relief)	0.0390

Sample NASTRAN Input File:

```
ID SEMINAR, Appendix E
SOL 101
TIME 60
CEND
SEALL = ALL
SUPER = ALL
TITLE = CBEAM Tapered Flanged Beam with Shear Relief
ECHO = SORT
MAXLINES = 999999999
SUBCASE 1
SUBTITLE=sub_1
  SPC = 2
  LOAD = 2
  DISPLACEMENT(SORT1,REAL)=ALL
  SPCFORCES(SORT1,REAL)=ALL
  STRESS(SORT1,REAL,VONMISES,BILIN)=ALL
BEGIN BULK
PARAM    POST    -1
PARAM    PATVER  3.
PARAM    AUTOSPC YES
PARAM    INREL   0
PARAM    ALTRED  NO
PARAM   COUPMASS 0
PARAM    K6ROT   0.
PARAM    WTMASS  .00259
PARAM    GRDPNT  0
PARAM,NOCOMPS,-1
PBEAM    1       1       2.      240.    1.                      + A
+       A 10.            -10                                     + B
+       B YES    1.      3.      540.    1.                      + C
+       C 15.            -15.                                    + D
+       D                -.4
```

```
CBEAM    2    1    2    3    0.    1.    0.
PBEAM    2    1    3.    540.   1.              +E
+    E 15.        -15.                          +F
+    F YES   1.    4.    960.   1.              +G
+    G 20.        -20.                          +H
+    H            -.285714
CBEAM    3    2    3    4    0.    1.    0.
PBEAM    3    1    1.    60.    1.              +I
+    I 5.         -5.                           +J
+    J YES   1.    2.    240.   1.              +K
+    K 10.        -10.                          +L
+    L            -.666667
CBEAM    1    3    1    2    0.    1.    0.
PBEAM    4    1    4.    960.   1.              +M
+    M 20.        -20.                          +N
+    N YES   1.    5.    1500.  1.              +O
+    O 25.        -25.                          +P
+    P            -.222222
CBEAM    4    4    4    5    0.    1.    0.
PBEAM    5    1    5.    1500.  1.              +Q
+    Q 25.        -25.                          +R
+    R YES   1.    6.    2160.  1.              +S
+    S 30.        -30.                          +T
+    T            -.181818
CBEAM    5    5    5    6    0.    1.    0.
MAT1     1    1.+7   3.84+6
GRID     1          100.   0.    0.
GRID     2          80.    0.    0.
GRID     3          59.9999 0.   0.
GRID     4          39.9999 0.   0.
GRID     5          20.0000 0.   0.
GRID     6          0.     0.    0.
SPCADD   2    1
LOAD     2    1.    1.    1
SPC1     1    123456  6
```

```
FORCE    1      1      0      1000.   0.     -1.      0.
ENDDATA
```