Appendix 6

Tendon Examples

(Preliminary 08.01.01)

Table of Contents

Appendix 6 - Tendon Examples

This appendix includes a set of examples, which demonstrates the use of tendons.

1 Tendons by reference lines

This is an example that shows the uses of tendons along reference lines.

Example folder: *Tendon-1*
Example files: *Tendon-1.inp*

These steps in NovaFrame model the structure:

1. Defining a reference line with geometry. (Reference line Sheet)
2. Build the model with, nodes, elements, constraints etc. (Build model Sheet)
3. Define a tendon. (Tendon Sheet)
4. Defines loads that activate the tendon. (Load Sheet)

These steps in NovaDesign will define the cross section:

5. Defining a section on reference line 1

The model consists of a straight beam with two spans. The cross section is rectangular and is defined in NovaDesign as a section at profile number 0.000, reference line no 1.

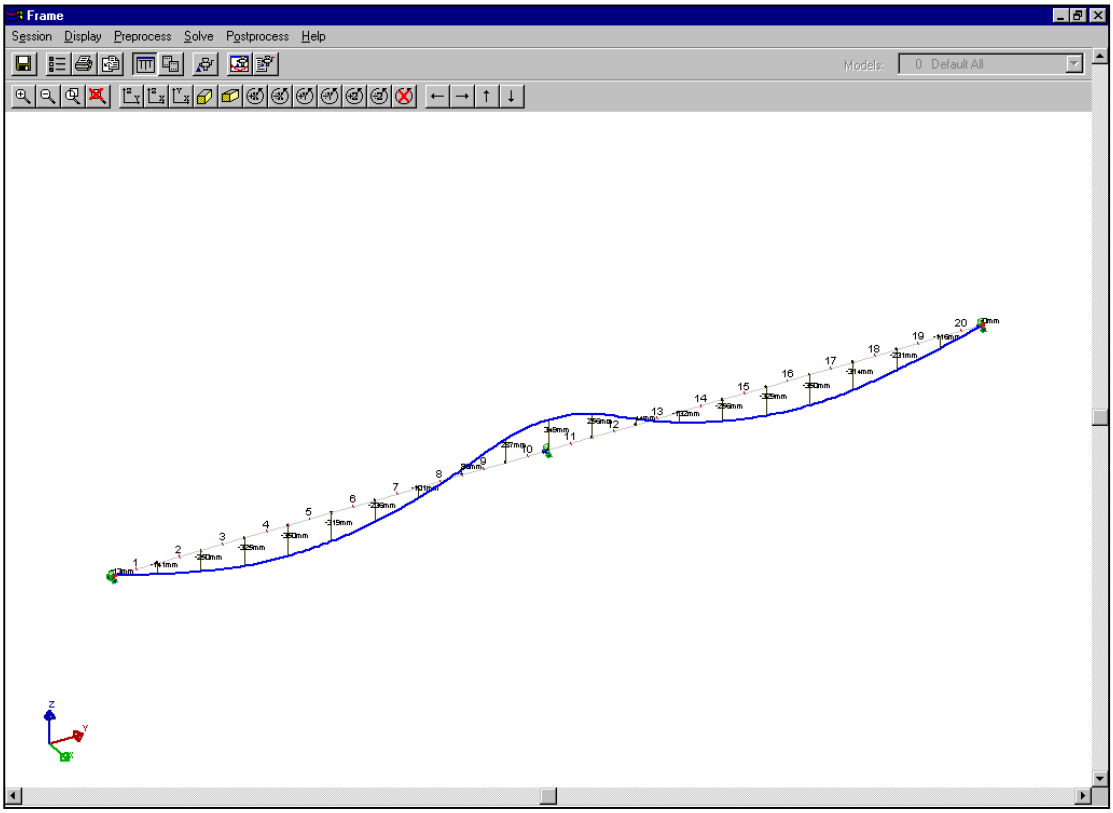

Figure 1.1 Beam with element numbers and tendon offsets in N-direction.

```
Project name: Tendon 1


%%% REFERENCE LINES  %%%
REFLINE, 0, 0, "Cross sections"
REFLINE, 1, 1, "Road          "


%%% REFERENCE LINE HORIZONTAL SEGMENTS %%%
%       Seg RfL Typ Stat1 X1    Y1       Stat2   X2     Y2        R1    R2    A
RFLHORI  1  1  1   0.000 0.000 0.000   100.000 0.000 100.000   0.000 0.000 0.000


%%% REFERENCE LINE VERTICAL SEGMENTS %%%
%          SegNo  RfL  Type      Stat1      Z1      Stat2         Z2         R
RFLVERT      1     1     1       0.000      0.000    100.000      0.000      0.000
```

Figure 1.2 ASCII input, Reference line sheet

```
Project name: Tendon 1


 %%% NODE INPUT %%%
%          N1  N2   dN   StartX    StartY   StartZ    DeltaX    DeltaY   DeltaZ
RFLNODE  1  21  1  1  0.000  100.000


%%% ELEMENT INPUT %%%
%          E1 E2   dE 1.Nod 2.Nod Incr
ELEMINS     1   20   1    1    2   1


%%% BOUNDARY CONDITION INPUT %%%
%         N1  N2  dN   XTr  YTr  ZTr  XRot YRot ZRot
BOUNDINS     1     1     1    1    1    1    0    1    1
BOUNDINS    11    11     1    1    0    1    0    1    1
BOUNDINS    21    21     1    1    0    1    0    1    1


%%% DESIGN SECTION INPUT %%%
%           E1    E2   dE   From  To    Step
DESGINS     1    20     1  0.000  1.000  0.500
```

Figure 1.3 ASCII input, Build model sheet

```
Project name: Tendon 1


%%% TENDON INPUT %%%%
%       No  Type  MatNo  DesNo   Area   Duct  G.Fck  Name
TENDON  1   POST   1       1     493.5   50.0  0.0   "Ten 1"


%%% TENDON GROUP INPUT %%%%
%       No  NoOfTen Space-L  Space-N   RelTo  Off-L  Off-N
TENGROUP   1   3    0.000      150.0       0  0.000  0.000


%%% TENDON GEOMETRY TYPE INPUT %%%%
%       No  GeoType  RfLNo    RelCode  PointNo
TENGEO  1  BYRFL  1  RELCOG 0


%%% TENDON GEOMETRY INPUT %%%%
%       No  Curve  From  To     Step  Off-A   Off-B      C
TENGEON  1  1   0.000   20.000  0     0.000  -0.350  0.000
TENGEON  1  5  20.000   50.000  0    -0.350   0.350  0.250
TENGEON  1  5  50.000   80.000  0     0.350  -0.350  0.750
TENGEON  1  3  80.000  100.000  0    -0.350   0.000  0.000


%%% TENDON LOSSES INPUT %%%%
%       No  Friction  Wobble   Wedge   Creep   Shrink     S1     S2     T2
TENLOSS  1     0.200   0.002   5.000   0.000    0.000  0.000  0.000  0.000


%%% TENDON STRESSING INPUT %%%%
%       No  End1    End2    First
TENSTRESS  1   85.000  85.000   1
```

Figure 1.3 ASCII input, Tendon model sheet.

```
Project name: Tendon 1

%%% LOAD INPUT %%%
%        No  E1  E2  dE Type Dir     A1     A2     A3     A4  Name
LOADINS  1   1   20   1  15   5       1      0      0    111  "Ten 1 Full"
LOADINS  2   1   20   1  15   5       1      1      0    111  "Ten 1 Parasite"
```

Figure 1.4 ASCII input, Load sheet.

The cross section is defined in NovaDesign and consists of a rectangular cross section (bXh = 0.5m X 1.0m). The cross section is defined on reference line no.1 at profile 0.000.

Two loadcases are defined using the same tendon.
Loadcase 1 calculates the effect of the tendon and includes the tendon force and the eccentricity moments in the final results.
Loadcase 2 calculates only the parasite forces and the deformation of the beam caused by the tendon.

If one compares the results of the two loadcases one will see that the deformations are equal for both loadcases.

The section force of loadcase 1 equals to the parasite forces of loadcase 2 plus the axial force of the tendon at a given design section and the eccentricity moment at the same design section.

Viewing results from the analysis:
Since there are no axial constraints in the static model the losses of cable force can be viewed by plotting the axial force (PM) for loadcase 1. See Figure 1.5-7.

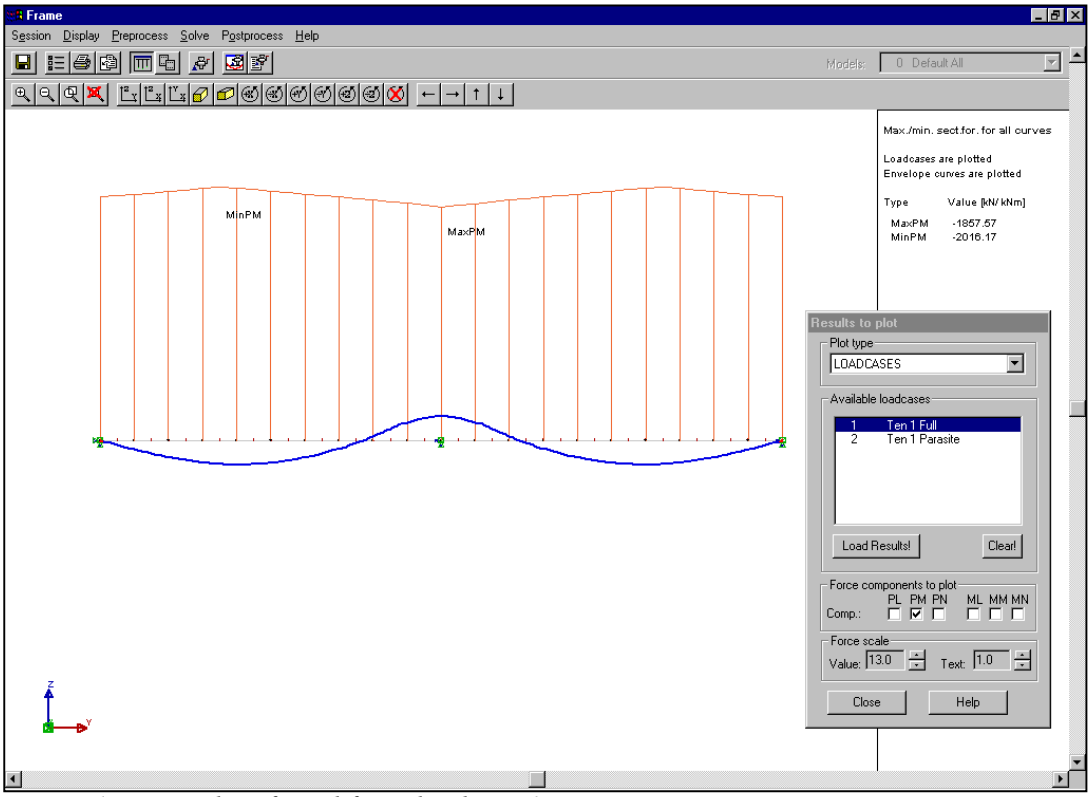

Figure 1.5 Plot of axial force loadcase 1.

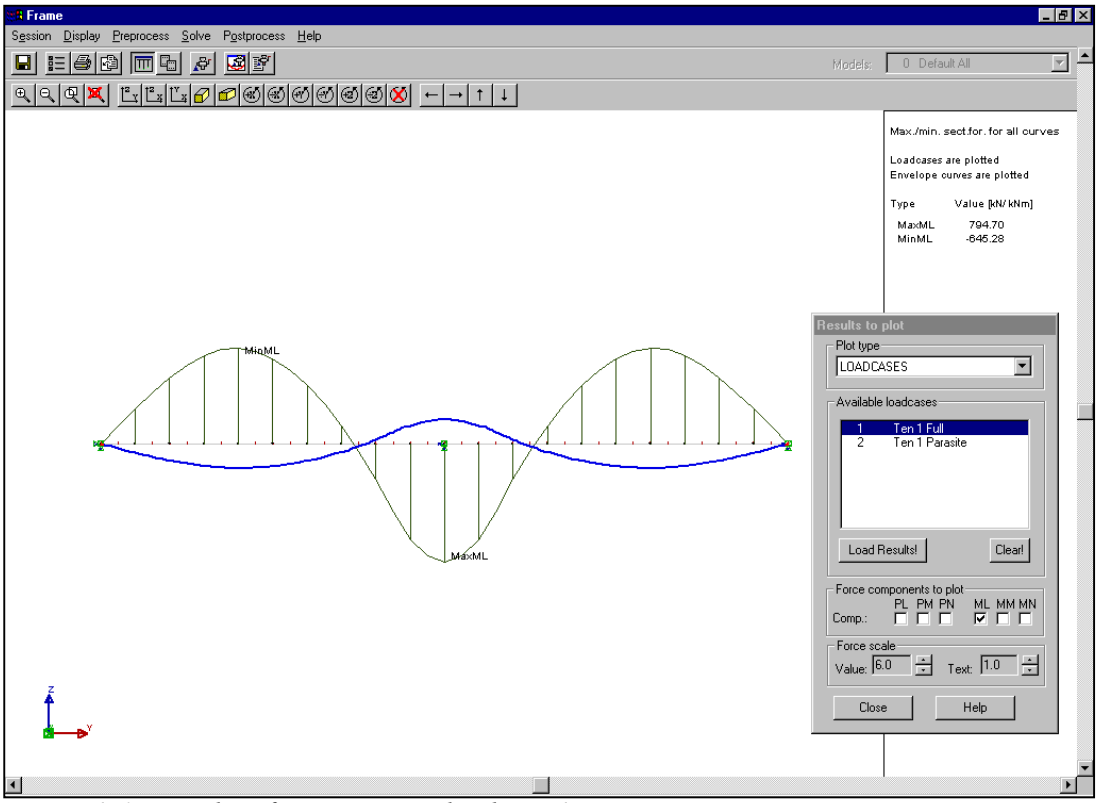

Figure 1.6 Plot of moment ML, loadcase 1.

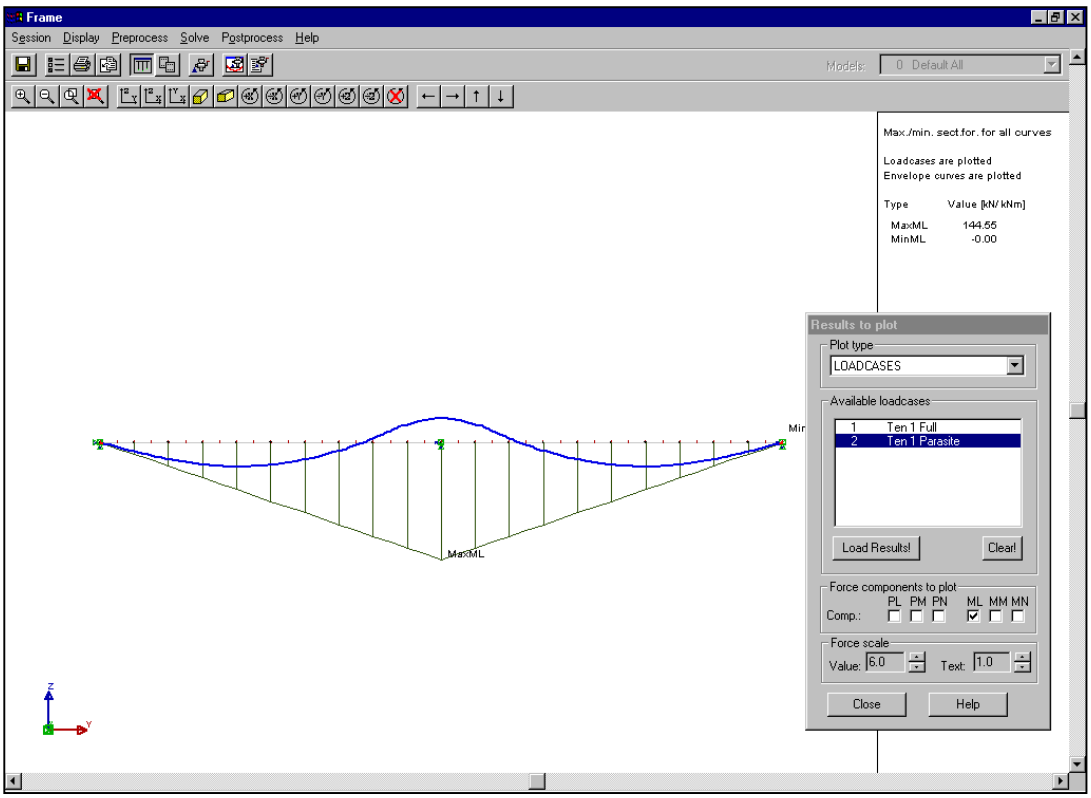

Figure 1.7 Plot moment ML, loadcase 2 - parasite forces only.

Viewing cable position:
In NovaFrame – select the section view and menu item: ***Display -> Step sections***...
You can now step along the reference line, (Select reference line 1), and view the position of the tendon a specific stations.

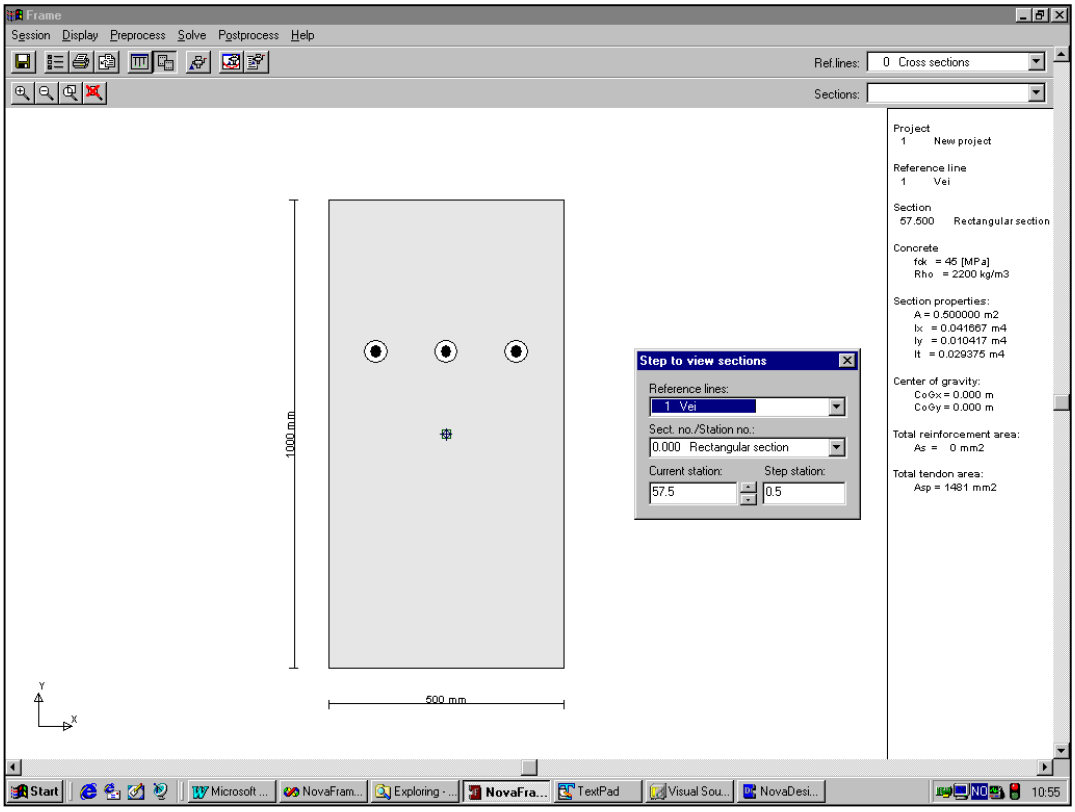

Figure 1.8 Section along reference line with tendon positions.