Curtin University Of Technology
Department Of Civil Engineering

Structural Analysis 365 – Worksheet #1
Influence of Member Attributes - TRUSS

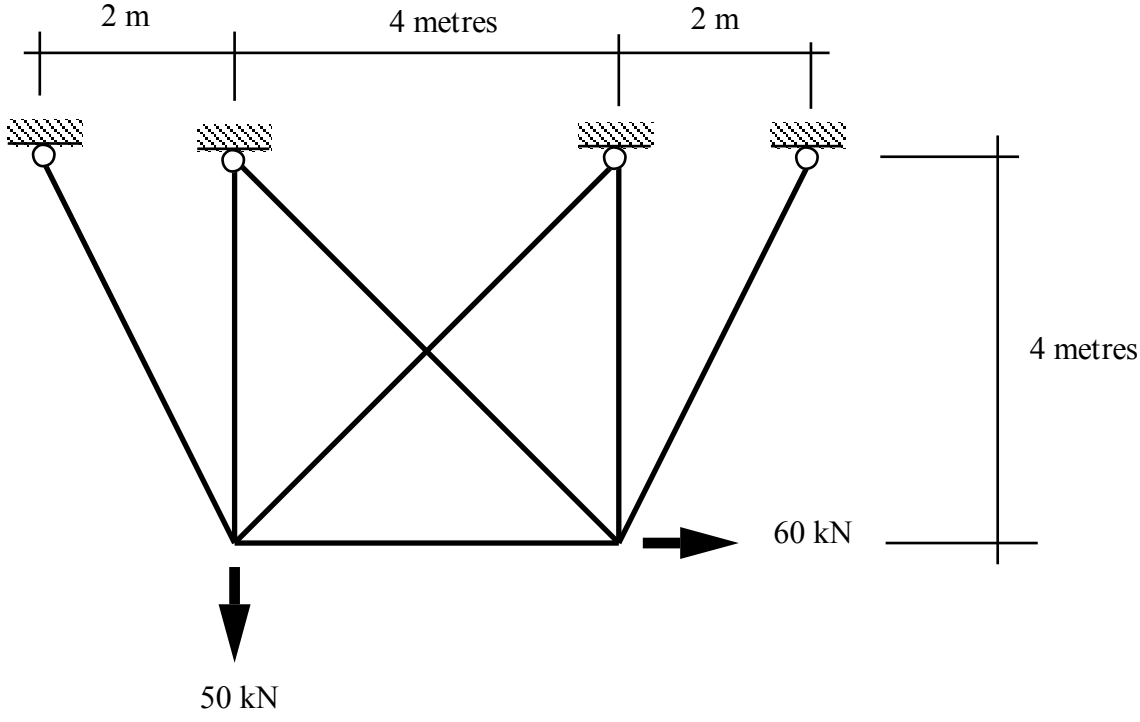
Issued : 24 March 2006

Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

Use the truss shown to explore the significance of member attributes and properties on the deflections and member actions

Try

1. With and without moment releases at joints
2. Same A values but vary I
3. Same I values but vary A
4. Verticals and horizontals with area of 2A (as in class problem)
5. Diagonals as "**tension only**" members



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Structural Analysis 365 – Worksheet #2
Influence of Member Attributes - FRAME

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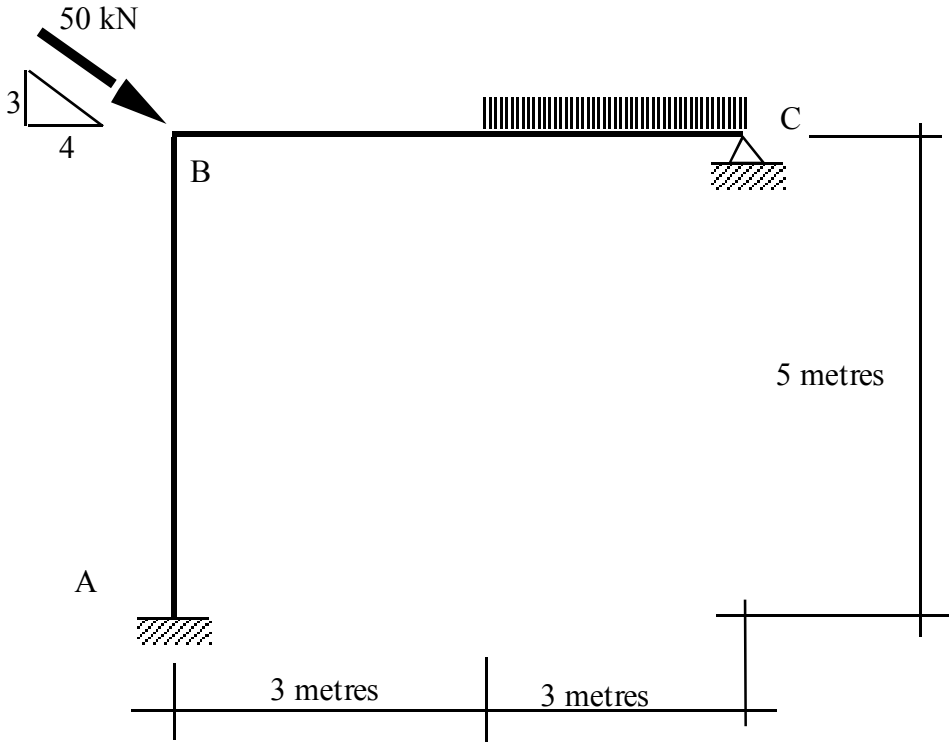
Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

Use the frame shown to explore the significance of member attributes and properties on the deflections and member actions

Try

1. Varying the relative I values of members AB and BC
2. Same I values but vary A
3. Joint C with fully fixed joint and member end release for moment about Z
4. Joint C as a roller
5. Joint C as a moment resisting roller



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Structural Analysis 365 – Worksheet #3
Non Uniform Sections

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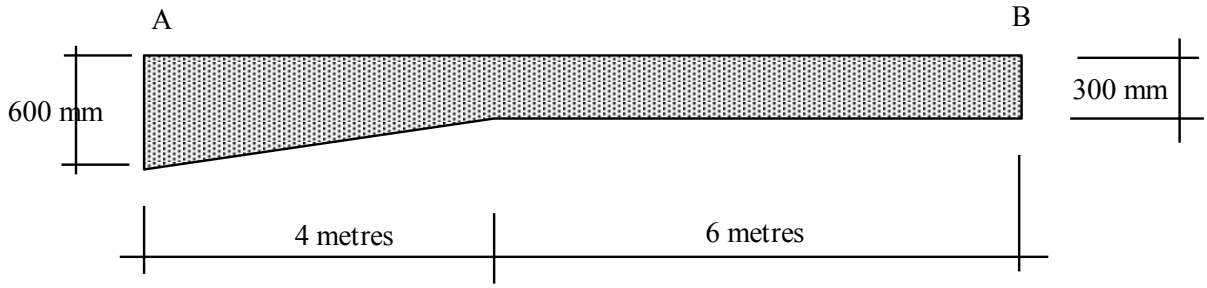
Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

PART A:

Evaluate the rotational stiffness (4EI/L for constant cross section) and carry over factors for the haunched beam AB and compare them with values for a uniform section beam. The cross section of the beam is rectangular and 150 mm wide (thickness) throughout.

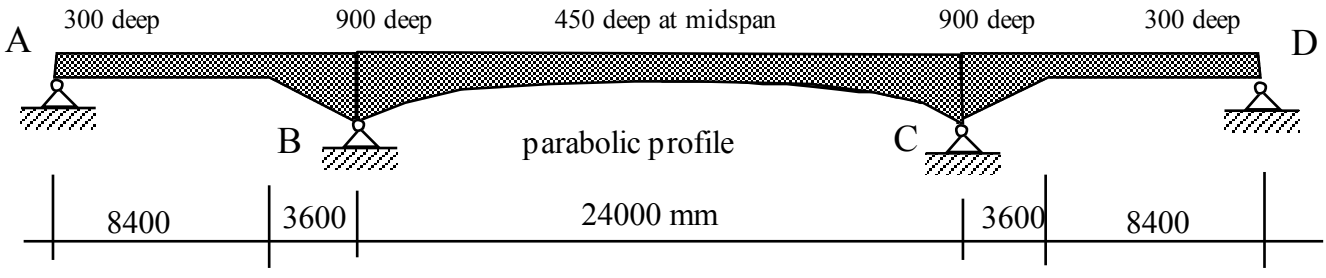


PART B:

Draw the bending moment diagram for the structure shown when

- a UDL of 20 kN/m is applied to the beam ABCD.
- The UDL is only along BC and point loads of 80 kN are applied at third points of BC

The cross section of the beam is rectangular and 500 mm wide throughout.



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Structural Analysis 365 – Worksheet #4
Moving Loads

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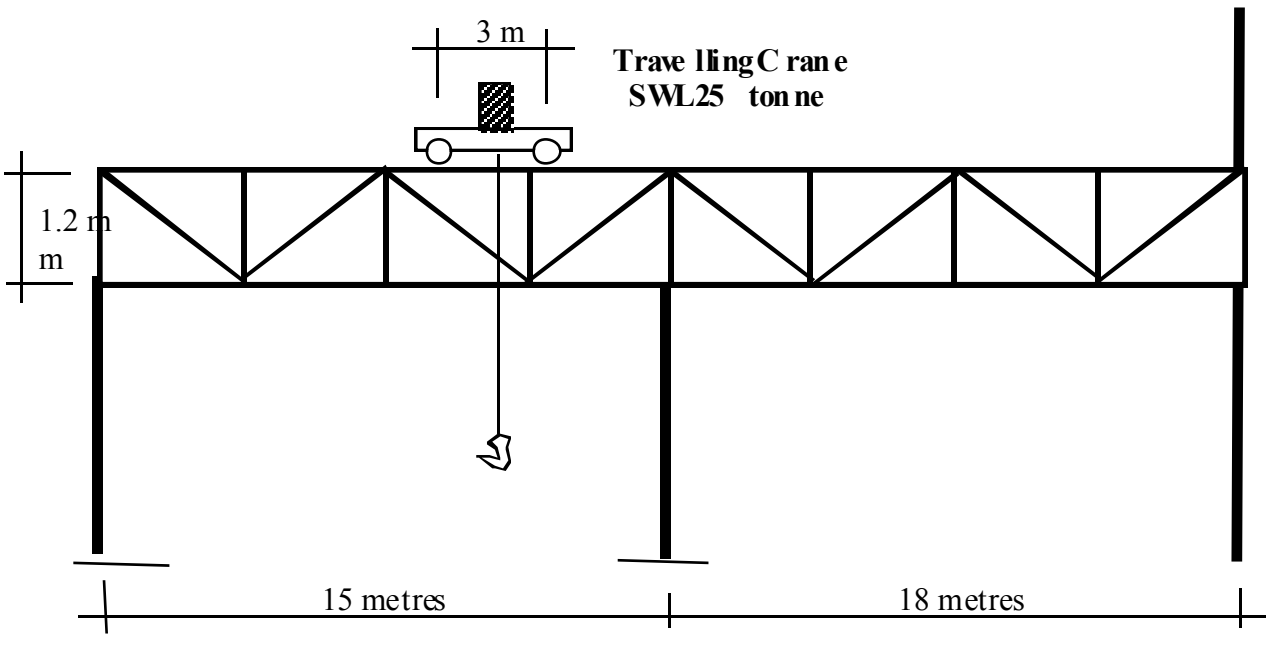
Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

A local factory has a travelling crane which runs on rails inside the building and on a truss system for 33 metres outside the building as shown in elevation below. The wheels on the crane are 3 metres apart and the crane beam spans 20 metres (out of the page).

Assume the columns are substantial and provide adequate lateral restraint to the truss. Also assume that the cross sectional areas of the members of the truss are as follows:-

- diagonal members 400 mm^2,
- vertical members 600 mm^2
- top chord members 2000 mm^2
- bottom chord members 1000 mm^2

1. Determine the force envelope (range of force from minimum to maximum) for each member of the truss assuming that (i) the crane can travel along the truss until its outer wheel is 400 mm from end of truss and (ii) in the direction of the crane beam (i.e. out of page in diagram below) the crane hook can be as close as 0.9 metres to the supporting truss.
2. If the deflection at any point exceeds span/300 make recommendations (supported by calculation) to reduce the deflection below that amount.



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Structural Analysis 365 – Worksheet #5
Grillages

Issued : 24 March 2006

Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

A grillage is a rigid jointed planar structure with loads perpendicular to the plane of the structure.

PART A:

Use a grillage analysis to find the bending moments and deflections of a rectangular reinforced concrete slab spaning 9 metres and 7.2 metres wide with simple supports along the two opposing short edges. The slab is 400 mm thick, 40 MPa concrete and the live loading is 4 kPa.

Suggestion: Put main 'beams' at 1200 centres and transverse 'beams' at 1500 centres with properties of the surrounding section of slab. What torsional stiffness is appropriate?

PART B:

Model a timber bridge with longitudinal logs each 450 mm diameter at 1200 centres with a transverse timber deck (125 thick) placed on top.

Use E = 14 GPa for Jarrah

Apply 4 wheel loads from a truck – each load is 96kN and wheels are spaced 1200 mm longitudinally and 1800 mm laterally. See if you can find the worst load location.

Assume the skew angle for the supports is 20 degrees (see plan view below).

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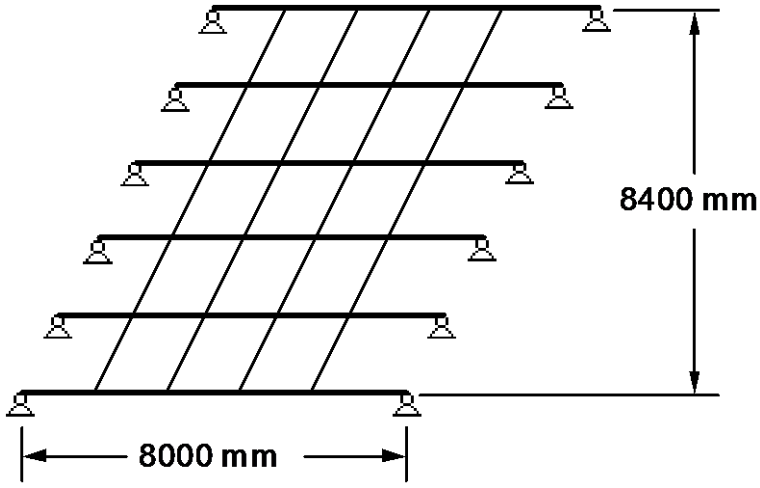
8400 mm
8000 mm

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Structural Analysis 365 – Worksheet #6
Interesting Structures

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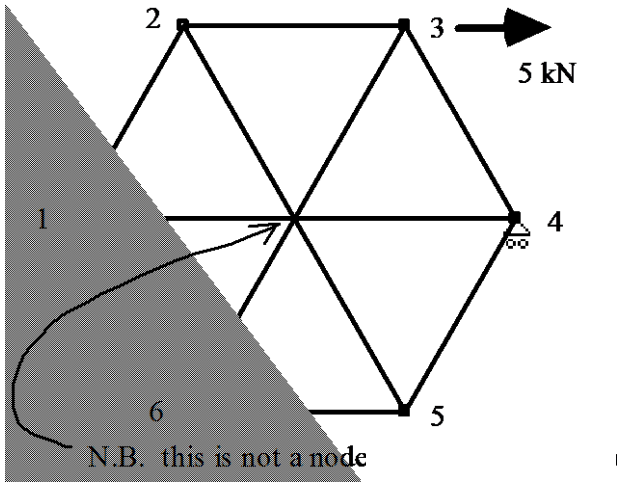
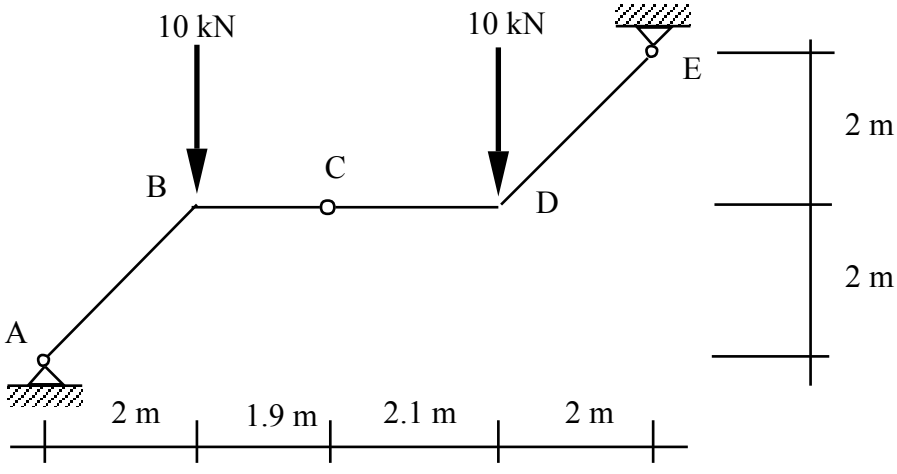
Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

The regular hexagonal structure shown in Figure 5A has a side length of 2 metres, a pin support at node 1 and a roller at node 4 with a 5 kN horizontal load applied at node 3. Analyse the structure as a truss (moment releases at all joints) and determine the member forces. Are they reasonable?



Analyse the structure shown below and determine the member forces. Are they reasonable? What happens if length BC is changed to 2.05 m? Why?



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Structural Analysis 365 – Worksheet #7
Three Dimensions - BEAM

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Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

QUESTION 1:

A single storey spiral staircase has a central spine at a radius of 1.75 m and an overall height of 3.24 metres with 18 steps along an 180 degree spiral. Each step is 250 wide (front to back) by 40 deep (thick) and 1500 long (750 mm each side of spine), made from hardwood with E of 14 GPa and is bolted to the spine across its centreline. The spine is fabricated from curving a 150x100x4 RHS with 100 mm by 8 mm plate used to attach the treads.

Loading can be 4 kPa on all treads or 2.5 kN concentrated load anywhere.

Examine the bending and torsion in the staircase components.

What is the maximum displacement of the point at midheight of the staircase on spine?

What is the maximum displacement of the point at midheight of the staircase on the cantilever end of a stair tread?

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Structural Analysis 365 – Worksheet #8
Three Dimensions - FRAME

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Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

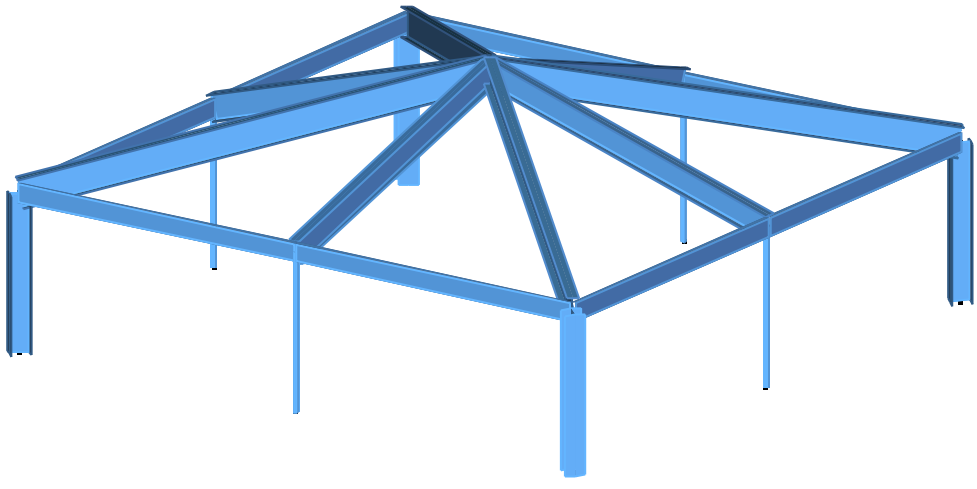
Analyse the following frame for the load cases shown.

LOADS:
- (i) Lateral loading(x direction) on two columns at the knee of 60 kN each
- (ii) Vertical loading of 2.5 kPa on all of the roof plus self weight
- (iii) Torsion - lateral load (x direction) of 40 kN acting on one column only
- (iv) Combination of case (i) and 1.5 times case (ii)

Explore the changes if
- (a) the eaves tie members are omitted
- (b) all the columns are changed to 76x76x4 SHS

DATA:
Frame is 20 metres square with eaves height of 5 metres and apex at 8 metres
Assume the roof is tiles on battens and rafters which sit on beams parallel to eaves and at 2000 mm centres
Bases of columns are bolted with a single U bolt to concrete pad footings

Corner columns	310UC96.8 with strong axis at 45 degrees to x-y
Middle columns	76x76x4 SHS
Hip Beams	460UB67.1 fully welded to columns
Rafters	410UB53.7 web side cleat at each end
Horizontal Tie	300x90x40.1 channel with flanges parallel to plane of roof, web side cleat connection to corner columns, bottom flange cleated to middle columns



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Structural Analysis 365 – Worksheet #9
Rigid Offsets & Springs

Issued : 24 March 2006

Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

PART A:

Analyse a three storey by four bay frame where storey height is 3.6m and bay width is 7.2m. Assume concrete beams 400 mm wide by 600 mm deep and 400 mm by 400 mm columns. Apply UDL of 40 kN/m on all beams.

What reduction in negative moment occurs if the finite width of the columns is included in the analysis? *(you may choose to use the rigid offset option if available)*

PART B:

Springs can be used to represent elastic foundations and the reaction of soils in retaining walls or the shortening of piles.

Examine the response of railway track supported on sleepers at 800 mm centres and subject to a wheel load of 200 kN from a dual axle bogey with axles at 2400 mm centres. Assume the rail has an area of 15000 mm^2, an I value of 50×10^6 mm^4 and an E of 200 GPa. The vertical stiffness of the ballast support under the sleepers can be taken as 390 MN/metre.

If the rail has a fishplate joint (shear transfer but no moment transfer) joining two lengths of rail at a point half way between sleepers how does this alter the results? Is it better or worse if the joint is placed directly over a sleeper?

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Structural Analysis 365 – Worksheet #10
Self Straining of Structures

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Use the available software to analyse the problems set out below. In your assessment you should include appropriate critical comments about the effectiveness of the software alternatives.

Draw the bending moment diagram for the structure shown when :-

(i) a UDL of 10 kN/m is applied to the beam BC

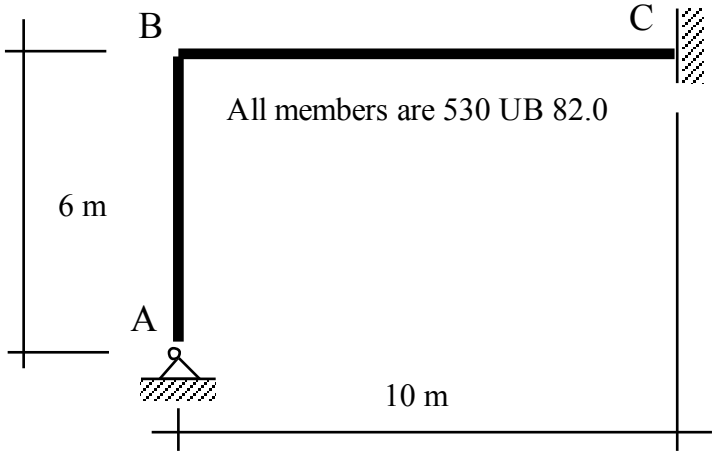
(ii) member AB undergoes a 20 degree C rise in temperature (coefficient of thermal expansion = 11 x 10^{-6} per degree).

(iii) member BC undergoes a thermal gradient with its top surface 20 degrees hotter than the bottom surface of the beam.

(iv) the support A settles by 15 mm vertically downwards and 10 mm horizontally to the right.

(v) the support A settles under load (use the UDL as the applied loading) by 0.6 mm for every kN of load. *(Use a spring to model the support but maintain lateral restraint)*

(vi) the member BC is fabricated 20 mm too short *(think about what this means to the structure and how it can be modelled).*



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