7 A bridge is constructed across a river in the way shown in Fig. 7.1. Two towers were sunk into the river bed and the roadway, which is supported by many cables, was made in stages. One end of each cable is attached to the roadway, passes over a tower and its other end is also attached to the roadway. Each cable is therefore an inverted V. As you pass over the bridge there are cables on both your right hand side and your left hand side. Having many cables is a much better system than that of a traditional suspension bridge which relies on the immense tensile strength of one pair of cables taking the entire load.

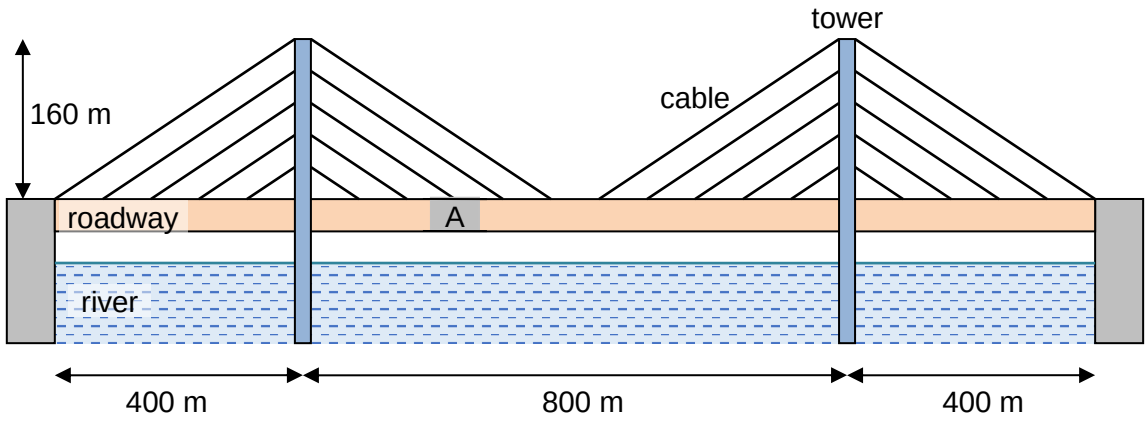

Fig. 7.1 (showing some of the cables)

Simplified data concerning the bridge are given below.

Length of bridge supported by the towers	= 1600 m
Height of tower above roadway	= 160 m
Total mass of all the cables	= 1.4×10^6 kg
Mass of roadway	= 8.5×10^6 kg
Maximum mass of load of traffic (assume uniform distribution)	= 11.5×10^6 kg
Horizontal distance between cables	= 20 m
Vertical distance between cables	= 8.0 m
Number of cables	= 80

(a) What reason does the paragraph give for the construction with many inverted V cables?

……..……..

……..……..

……..…… [2]

(b) Calculate the maximum total mass which each of the two towers may need to support.

mass = …… kg [2]

(c) Calculate the mass of 20 m of roadway and the traffic which those 20 m of roadway may have to support.

mass = …… kg [2]

(d) Calculate the angle between a cable and the horizontal.

angle to horizontal = ……° [2]

(e) Fig. 7.2 shows a close-up view of the fully laden 20 m section of road at A.
On Fig. 7.2, draw and label the forces acting on this road section and explain how this road section is in equilibrium.

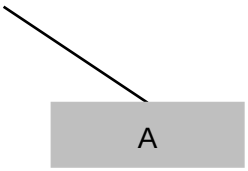

Fig 7.2

……..……..

……..…… [4]

(f) Calculate the tension in a cable when the bridge is fully laden. (The tension in all cables is assumed to be the same.)

tension = …… N [3]

(g) The force constant of the cable is 7.0×10^6 N m^{-1}.
Calculate the increase in the extension of the cable when the tension in it increases by 5.2×10^5 N.

increase in extension = …… m [2]

(h) Suggest why the maximum tension allowed in the cable is well below the breaking tension.

……..……..

……..…… [1]

(i) Explain where is there likely to be a tension in the roadway.

……..……..

……..……..

……..…… [2]

End of Paper