Principle of Moments: Bridges

Contrary to what you might have assumed from doing dozens of seesaw questions at GCSE, you can take moments around *any* point on an object, not just around obvious pivot points. As long as the object is in rotational equilibrium (*i.e.* its angular acceleration is zero), then the sum of clockwise moments around *any* point must equal the sum of anti-clockwise moments around the same point.

Consider a bridge which is 500m long (measured between the pillars) and has a weight of 4MN. A 100kN lorry starts to cross the bridge.

1) Add labelled arrows to the above diagram to represent the following forces:
   a. The weight of the lorry (labelled 100kN)
   b. The weight of the bridge (labelled 4MN)
   c. The reaction of the left-hand pillar on the bridge (labelled R_L)
   d. The reaction of the right-hand pillar on the bridge (labelled R_R)

2) Calculate the value of (R_L + R_R).

Since the bridge is not twisting or turning, the principle of moments tells you that the sum of clockwise moments around *any* point must equal the sum of anti-clockwise moments around the same point.

3) Complete the equation below to express the same idea as the above sentence, which uses the left-hand pillar as the pivot point:

   $500R_R =$

4) Solve this expression to find a value for R_R.

5) Now use a similar process to calculate a value for R_L, using the right-hand pillar as the pivot point

6) Write a calculation that shows that your answers to q4 and q5 are consistent with your answer to q2.

7) Now choose a point any distance along the bridge and take moments around it. You should find that they are balanced, since the bridge is stationary.

8) Calculate the values of R_R and R_L when the lorry is ¾ of the way across the bridge. (*If stuck, draw a diagram first*). You should also be able to do the same consistency check for your results that you did in q6.