Engineering Mechanics
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Statics - 4.4

Given this, the active forces I can list. Force mg acting downward at P, mg acting downward at Q, A_y acting upward at A. These are the active forces, I have just listed them.

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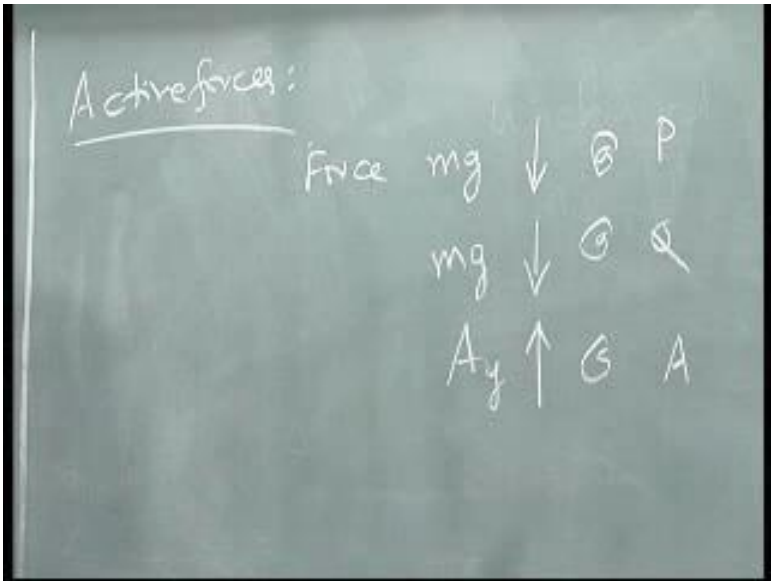

I can now write the appropriate virtual displacement so that it's easy to do the calculations. Let me erase it and write it nicely. I will identify the points where the active forces are existing. This is point, this is the force with the appropriate direction. I am going to write the virtual displacement then I will do an F dot delta disp. Remember I am just going to do a multiplication here, if I take the appropriate directions. At P it is mg downward. This can be written as minus mg because upward is taken as positive. Again here minus mg, just to give you an idea the directions are like this.

How about at A? It is A_y upward. Displacements: We gave a displacement of positive direction here delta y_A. What did we get for these two? This is a positive quantity, upward is what we have given. This at Q we got it to be plus delta y_A by 4 in the positive direction. This is delta 3 by 4 delta y_A in the positive direction. What do we finally get? If we multiply these two, we get minus 3 by 4 mg delta y_A minus 1 by 4 mg delta y_A. This one is A_y times delta y_A.

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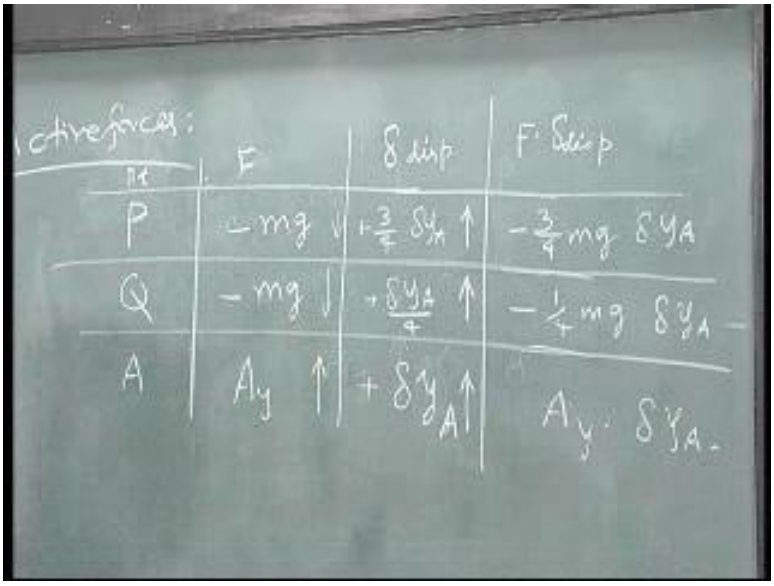

Delta y_A is common in all of them, so we can immediately write from virtual work principle A_y minus 3 by 4 mg minus 1 by 4 mg times delta y_A equals 0. delta y_A is an arbitrarily applied virtual displacement which means that this has to be equal to zero means A_y equals mg.

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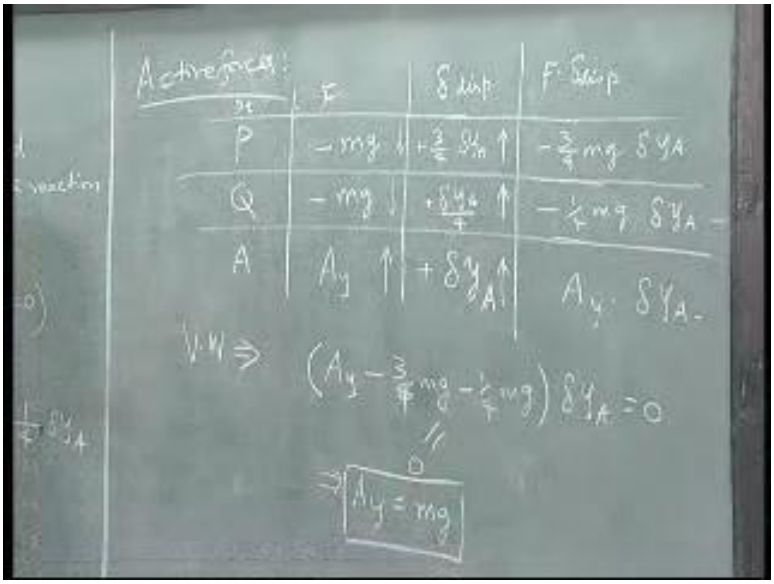

That seems to be obvious here, I have weights of these nicely symmetric one. The vertical reaction here and vertical reaction here should be half and half of the total weight.

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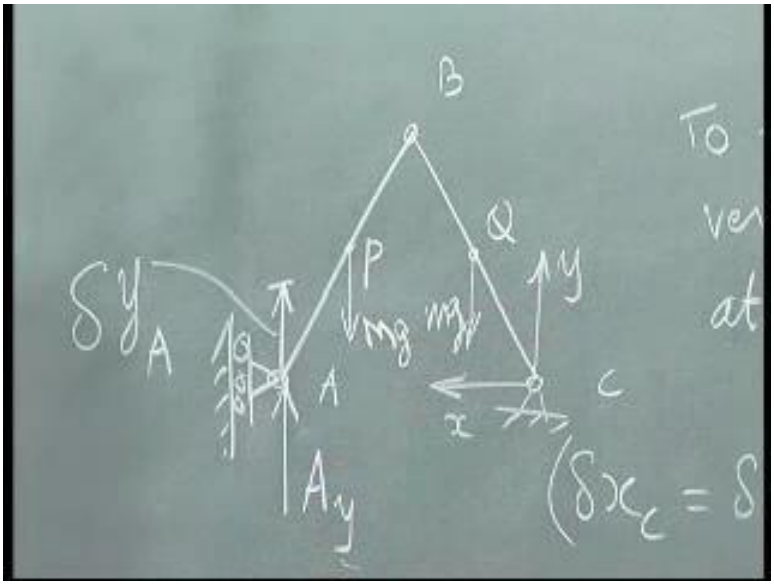

Total weight is mg plus mg so automatically A_y will be mg, C_y will also be mg. So that verifies that I have done correctly. The advantage of this is you don't have to do the entire equilibrium for this system but then you have to sacrifice on finding out kinematically admissible displacements and this is crucial. Mind you the science of signs is very important to get the appropriate equations. Thank you.

Supposing we had started with this, let's say the direction is like this and A_y and we had applied a virtual displacement in the upward direction. Now this would be downward like this and therefore a negative value and this would have become negative. What would happen here? I would have a negative sign here which means this is A_y equals minus mg or in another words A_y is acting upward with the magnitude mg, consistent. The equation of equilibrium is consistent to what you get.

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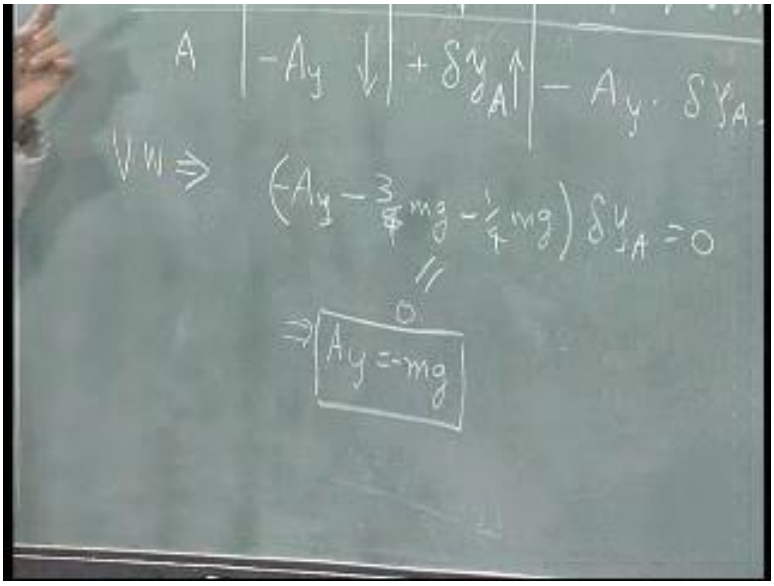

So never mind what virtual displacement you give, you will get finally this particular equilibrium equation. As an exercise I want you to apply a virtual displacement at B and do the problem. Another way of doing it is apply a virtual rotation between AB and BC and write down all the displacements with respect to each of them, either the rotation or the displacement at B and verify that you get exactly the same equation. You have to get same equation, the reason being you are using kinematically admissible virtual displacements. They will always be proportional if you take delta y_A here or some other quantity, they will all proportionately be different, this relationship cannot change. Thank you.