

Muddy Card Responses Lecture M3

Why was moment created in 3rd PRS from 500 kN force acting along the y axis. This was actually a moment. It has units of kNm and was indicated as double headed arrow, which is the convention I use to indicate moment vectors.

Do we ever have pure moments in the real world? Yes and no. We will meet many moments in unified that can be considered as "pure". In reality, if we looked more closely they would almost always be the result of some force or pressure distribution. Nevertheless it is a very useful concept that I would encourage you to become familiar and comfortable with.

Where did your terms in $\sum M_y = \square$ come from with the plane? All the in-plane forces that I drew acting on the airplane (T, D, L_w , L_T , mg) potentially have a moment arm about the y axis (drawn out of the board). Since I put the center of gravity at the origin, the weight, mg, does not exert a moment about this axis.

Redo your PRS slides for this lecture. I got the first one wrong because it was impossible to see that #2 was a separate answer. Make the choices clearer. A couple of comments. First, clearly most of the class were able to see the choices clearly and opted for the correct one, so "impossible" is an exaggeration. Secondly, whether you got the answer right or not, the question achieved its goal in encouraging you to think, which is the goal. Nevertheless I will try to keep the questions clear and unambiguous.

Could you draw a clear picture of the plane you drew on the board with clearer details. I could not tell where somethings were supposed to go?

I will write it out fully at the beginning of tomorrow's lecture, so it will be available for reference.

How is the answer of the second CQ different from the answer choice 1? Choice 1 only had a moment (which was the correct one), there also needs to be a force to counteract the weight of the engine (10kN)

Why was the moment created in the 3rd PRS question from 500 kN acting along the y axis? Actually this was a moment of 500 kNm not a force. I indicated this with the double arrow on the vector, and the fact that the units were kNm

How do you determine which way the moment is acting? Not sure of the point of reference for this, but I will answer the question I think that you are asking. In the example of forces acting on the airplane I set up the problem by making educated guesses as to the point of application and direction of the various forces. I then set up the equilibrium of moments by summing moments acting about the origin. I made the arbitrary choice that positive moments would be counterclockwise. This is consistent with a moment acting along the y axis, obeying the right hand rule. I then proceeded to compile the equilibrium equation for moments by adding in the moment due to each force, one at a time. If when I solved the equation it turned out that I had guessed the direction of a force incorrectly, then I would have taken a negative value.

Why can we assume no moment from T, D, just because of small arm? Partly. From the dimensions of the airplane a, b are small compared to d, e. Also, we know that L_w should be significantly greater than D, the drag (L/D is an important measure of how good an airfoil is, for commercial transports, L/D is about 12, for high performance gliders it can be as high as 40). If T and D (which must be equal) are also small compared to L_w then it follows that $bT, aD \ll dL_T$ and eL_w

I don't understand why a and b are small compared to e and d? Are we assuming that the moment arms weren't as big as they were drawn? Yes - I exaggerated the moment arms to make it clear that potentially D and T could have moment arms. In reality one would try to ensure that they did not.

There were several other comments around this point of eliminating aD and Tb from the moment equilibrium equation

What is the difference among all these centers? Centre of mass, centre of pressure, aerodynamic centre, others? Centre of mass and centre of gravity are used more or less interchangeably (although they should not be). They refer to the location at which the total weight of an object can be considered to act (in a uniform gravitational field) without any accompanying moment. Centre of pressure is the location on an object through which the aerodynamic forces (pressures) can be considered to act without any accompanying moment. The aerodynamic centre is the location at which the aerodynamic forces can be considered to act at which the aerodynamic moment

coefficient is independent of angle of attack - which is useful in performing calculations. In general centre of pressure will change location with angle of attack (and other variables).

Any time we see a moment on a diagram (picture showing circular arc with arrow about a point) is it a pure moment? Yes. If there is an associated force I will indicate this separately.

Picture with 2 separate moments, M_1 and M_2 drawn in 2-d just like single moment M_1+M_2 ? Yes, at least in terms of defining an equipollent force system - we can just sum up the pure moments, and it does not matter where they are acting.

Instead of having lecture notes on the web is there anyway we could hand them out before lectures (like computers)? I thought about this, and reckoned that we would waste less paper if individual students printed out their own notes rather than print them centrally. I will try to do better at posting the notes ahead of the lecture.

How do you distinguish between a moment with an associated net force and a pure moment (i.e. on 2nd PRS question). Is there a difference in notation when you draw them? I will draw moment vectors with a double arrow and moments in 2-D as a circular arc about a point with an arrow to indicate direction. If there is an associated force I will draw that in separately.

Is it true that a pure moment at a particular point has no effect on the overall moment of a system of particles? No. A pure moment will have the same effect on the overall system (in the sense of causing an acceleration, or affecting its static equilibrium) regardless of where it is placed. But it will have an effect!

How does lateral stability work then? Doesn't the vertical tail act like a wing and generate some sort of lateral "lift"? This is correct. The vertical tail is a symmetric airfoil so it generates no net lateral force if it is orientated parallel to the airflow. If for some reason the airplane presents its vertical tail at some angle to the airflow (i.e. it yaws) then the tail will have an angle of attack with respect to the airflow and there will be a net (lateral) lift force, which will result in a restoring moment about the center of mass of the airplane. This is called "weather vane" stability.

How do you determine which way the moment is acting? There are two interpretations of this question. Here are some thoughts. If we are working with vectors the moment is given by $\underline{M} = \underline{r} \times \underline{F}$ and the direction is defined by the right hand rule

embedded in the vector (x) product. If I am setting up the equilibrium of a body, as in the example of the airplane, then I assume the directions of forces (and moments) and solve for them using equilibrium. If I have assigned a force (or moment) the incorrect direction in setting up the problem, solving the equilibrium equations will point this out to me.

How is the answer of the second CQ different from the answer choice 1? Choice 1 just has a moment, whereas there is also a force applied. If answer choices (1) and (2) were combined then it would be correct.

In the last example of the MD=80 you use $M=F.d$, why not use $\underline{M} = \underline{r} \times \underline{F}$ and how would you have done that? Since we were dealing with a 2-D (planar) force system, there is less of an advantage to using moments, and I thought that it improves the clarity of my explanation of what is happening physically. We could have assigned each force and position a vector (in 3-D), and then used $\underline{M} = \underline{r} \times \underline{F}$ to calculate the moments. Since all our forces were in the x - z plane, all the moments would have been in the y direction.

How is \underline{r} measured; does it go from the origin to the point at which the force acts? Yes, if the origin is the point about which we want to evaluate moments. Otherwise it is the position vector of a point on the line of application of the force relative to the point about which we want to take moments.