Diagrams

A diagram is just a visual representation of the normal force/bending moment/shear force in the entire structure. Drawing them doesn't have to be difficult. But before you start drawing, you first have to make sure that you have a clear drawing of the object, in which all the forces and torques are drawn. If you miss one force, it will mess up your entire diagram. We will discuss a few methods to draw the three diagrams now.

1 Normal force diagram

To draw a normal force diagram, you first ought to make sure you know the normal force at one point in the diagram. (On the edges of an object, the normal force is usually 0.) Draw that point in the diagram. Then, starting from that point, you "travel" over the object. It is often wisest to travel from left to right. The normal force in the object stays constant (so draw that too!), until you run into a force (or when the structure bends, but we'll come to that later, we assume a straight rigid bar now). Dissect the force into 2 components, one perpendicular to the structure, and one tangential to it. The perpendicular component doesn't effect the normal force diagram (it does effect the shear force diagram), but the component tangential to the structure does effect the normal force. You should look at the effect this component has on the part of the structure you're "traveling" to. If the force is pointing in the direction you came from, it is tensing the part of the structure you're traveling to, thus it's positive, and the normal force diagram should go up with the magnitude of the component. If the component is compressing the part of the structure you're traveling to, it is negative, and the normal force diagram should go down. In table **??** is an overview of the sign convention.

If you run into a distributed load tangential to the structure (note that most distributed loads are perpendicular to the structure, and therefore do not effect the normal force diagram), you should draw that in the normal force diagram too. The sign convention is identical as discussed previously, but the diagram doesn't "jump" up. Instead, the normal force diagram slowly goes up, and the slope of the line with which it goes up is equal to the distributed load.

	Normal force diagram		Shear force diagram	
Traveling	Force pointing left	Force pointing right	Force pointing up	Force pointing down
Left to right	+	-	+	-
Right to left	-	+	-	+

Table 1: Normal/Shear force diagram traveling overview (A plus indicates the diagram goes up).

2 Shear force diagram

Just like with the normal force diagram, you ought to make sure you know the shear force at one point. Then you once more travel along the structure and look at how the value of the shear force changes. It's easiest to travel from left to right along the structure. Every time you run into a force, dissect it, as discussed in the previous paragraph. The component perpendicular to the structure effects the shear force diagram. If it points up, the shear force diagram should go up, and if it points down, the shear force diagram should go down. That's rather easy. However, if you're traveling along the structure from right to left, exactly the opposite applies. It is important to check whether the diagram eventually gets back to a 0 value. If it doesn't, you've probably done something wrong, and might want to calculate the shear force at certain positions, to see whether they match the diagram.

Distributed loads are slightly more difficult, but nothing to worry about either. We're once more traveling along the structure from left to right. If the distributed load points upward, the shear force diagram should go up in a line with a slope equal to the size of the load. If the distributed load points downward, the

shear force diagram should go down. However, when you're traveling from right to left, this is exactly the other way around. In table 1 is an overview of the sign convention.

3   Bending moment diagram

All that's left, is the bending moment diagram. But the bending moment diagram is the derivative of the shear force diagram. So you should use the shear force diagram to draw the bending moment diagram. Start at a point of which you know the value of the bending moment diagram (usually on the left edge where it's 0). Then travel from left to right, and make sure the slope of the bending moment diagram is equal to the value of the shear force diagram at every point. If you run into an external torque in the structure, a vertical line will appear in the bending moment diagram. A clockwise torque is positive, and a counter-clockwise torque is negative. If you travel through the structure from left to right, positive means the diagram jumps up, and negative means it jumps down. If you travel through the structure from right to left, this is exactly opposite. In table 3 is an overview of the sign convention.

	Bending moment diagram	
Traveling	Clockwise moment	Counter-clockwise moment
Left to right	Diagram goes up	Diagram goes down
Right to left	Diagram goes down	Diagram goes up

Table 2: Bending moment diagram overview.

4   Non-lineair structures

The past paragraphs all have assumed that the structure consisted of just one (horizontal) bar. This is of course not always the case. There may be structures with an angle in it (for example this shape: $\wedge$). Other structures sometimes even split up (for example: $\top$). If the angle in which a structure bends is 90 degrees, a simple rule applies. The normal force diagram turns into the shear force diagram, and the shear force diagram turns into the normal force diagram. The bending moment diagram stays the same.

However, such a bend is not always the case. In more complicated situations, it is easier to cut the structure up in parts, making the cut at the point where the structure bends or splits up. Draw all the parts separately. On every part, at every position you made a cut, you should draw the normal force, shear force and bending moment (if present) the other parts are acting on that part. Now the diagrams can be drawn in the normal way for every part, keeping in mind the internal forces and moments you've just drawn. If you've done everything in the right way, every part should be in equilibrium. This is often worth checking.