Folding bag hanger : Why it works

Uzair Safdar : 7326395

Concept: Centre of mass, stability.

The idea of the foldable bag hanger is for the hanger to be able to accommodate for the weight of the bag whilst using up minimal space. The nature of its design allows for the bag to hang from the edge of the table whilst only the circular base uses up table space.

The hanger consists of a main circular body (base) and a multi jointed foldable arm which extends below the base when the hanger is placed on a table. The bottom surface of the base, which comes into contact with the table surface, has a rubber coating which improves grip and slipping resistance.

The arm is connected to the body via a small adjustable pin which penetrates into the base. It is this pin that transfers the load from the arm to the base.

The hanger works under the concept of *centre of mass*.
The centre of mass is the point at which the mass of the model is seen to be concentrated at a point.

Fig 2

Having weighed the individual components of the hanger, the circular base (including pin) is 3 grams heavier than that of the folding arm.

Fig1

When closed the centre of mass is at the centre of the base. When opened the centre of mass lies along the line indicated closer towards the pin joint.

Fig 3 (Centre of mass, closed)

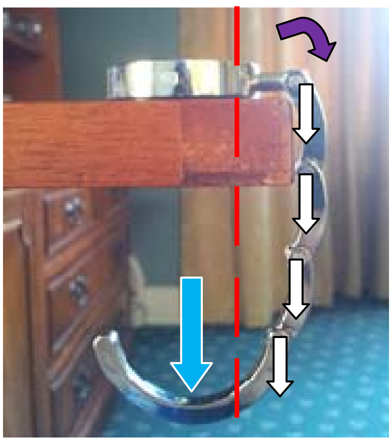

Fig 4 (Centre of mass, open & loading)

When a load is applied to the arm, due to the semi-circular shape the load acts in the middle of the hook. This load is transferred vertically through the joints in the arm and into the pin causing a bending moment (Fig 4). To reduce this, the pin should be kept at minimal length.

There are three ways in which the hanger could fail.

1) Sliding
2) Lifting
3) Fracture

1) The rubber grip helps to prevent the sliding of the base. When the load is applied, the grip increases as the load is a vertical which presses the grip tighter, increasing friction and provides some suction.

2) With this design, the base is above the point of loading and so will help give stability to the model. This however depends as to where the loading is applied to the arm.

Fig 5

The base covers a cross sectional width which can be seen to be the safe zone for loading. As long as the load applied is under this area, the base will not lift or slide.

When a vertical load is applied at the tip of the hook, lifting occurs at the pin end of the base.
When a vertical load is applied directly on the top of the folding arm, the base begins to lift on the far edge. In both cases the hanger as the system becomes unstable.

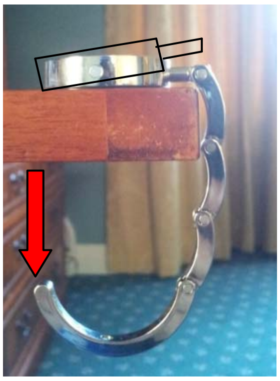

Fig 6

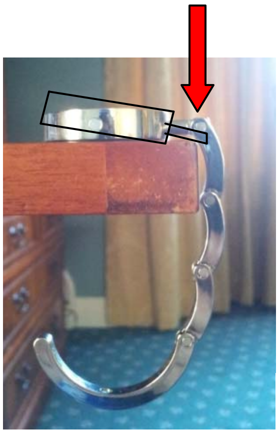

Fig 7

This reiterates the theory that the centre of mass of a model should lie within the area of its base, above or below. The original centre of mass when hanging is towards the pin under the base (figure 4). When a load is hung, the total centre of mass of the system lies closer to the centre of the base making the whole system more stable.

3) Load testing was done to determine the load capacity of the hanger and the nature of its failure.

Fig 8 (Weights in a bag)

The hanger was able to take up to 10kg of weight before it failed. The load was within the safe zone under the area of the base hence there was no slipping or lifting. The failure came to be in the lower hinge of the arm which can be seen in figure 10.

Fig 9 (Loading of bag via electronic scale)

Fig 10 (Fracture of hanger arm)

References

Catherine H. Colwell. (1999). Centre of Mass. Available: http://dev.physicslab.org/Document.aspx?doctype=3&filename=RotaryMotion_CenterMass.xml. Last accessed 18th Feb 2012