Observing The Damping Effect In Free Vibration

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Concept: Damper of a metal ball immersed in oil.
Model: Observing the damping effect in free vibration.
Materials: 600mm steel ruler x 2, 20mm plastic tube, car engine oil, 8mm diameter steel ball bearing x 2, fixed steel clamp, corks.

Three experiments were conducted to observe the damping effect of a mass immersed in oil in free vibration. Two steel rulers were used to conduct experiments, one with the damper (i.e. steel ball immersed in oil in a plastic tube sealed by corks at each ends) and one without. Connection of the damper and the steel ruler was made by drilling a 20mm diameter circular hole on steel ruler and then pushing the damper in it.
Videos of each experiment were made and are attached as PowerPoint slides.

EXPERIMENT 1

Both the steel rulers were attached to the clamp as shown is figure 1. Equal amount of force was applied to both steel rulers as shown in figure 2. After doing trial experiments it was observed the steel ball in oil damper did not move. Subsequent to this result after doing many trial experiment alterations were made to the amount of force applied.
As it can be seen from ***video of experiment 1*** (in a separate PowerPoint slide) the ruler with the damper came to rest before the other ruler. The movement of the steel ball can also be observed to be moving in opposite direction to the motion of the ruler. This force cancels the affect of force by motion and slows it down before the other ruler.

Figure 1: Experiment 1

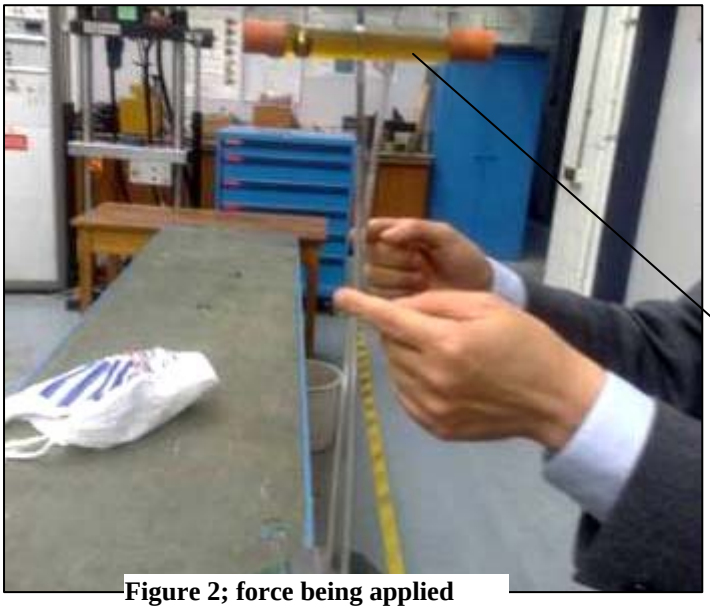

Figure 2; force being applied

Viscous damper with steel ball bearing.

EXPERIMENT 2

After analysing the results of experiment 1 a second experiment was conducted. The only thing different from before was length of both steel rulers was not same. After many trials an effort was made to get the same natural frequency of both steel rulers. This was done by lowering the damped steel ruler about ¼ the total length as seen in figure 3.

Observation from ***video of experiment 2*** shows that less number of oscillations was made by the damped steel ruler before it comes to rest while the other steel ruler was still in oscillation. Another point to note is that with the addition of damper the violence in the oscillation is gone; it smooth's the oscillation and comes to rest more quickly. Although one may argue that less force was applied but this is how viscous dampers are meant to work.

Figure 3: Front view of model for experiment 2

Figure 4: Experiment 2

EXPERIMENT 3

The third experiment was conducted to observe how damper behaves when one more steel ball bearing is added also the volume of oil was also reduced. Minor adjustment to length of steel rulers was made to get the same natural frequency.

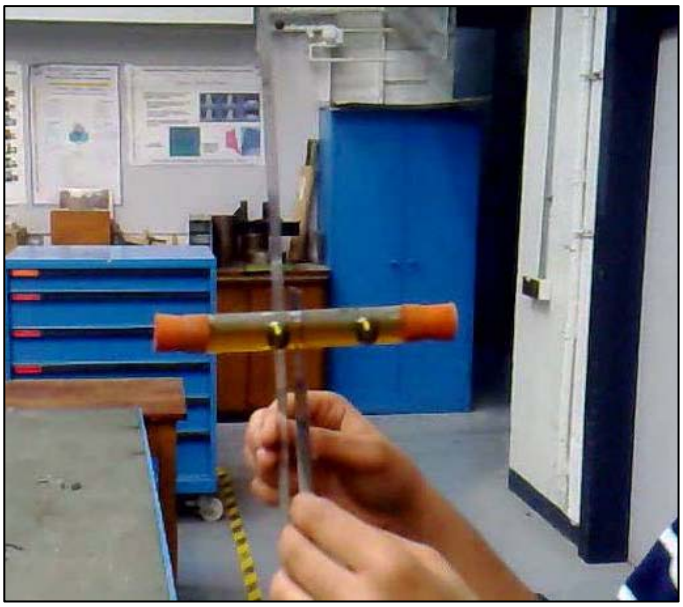

Figure 5: Experiment 3 - two ball bearings.

It was observed from ***video of experiment 3*** that both the steel ball bearing followed the same path opposite to the motion of steel rulers. It was hard to predict the difference in oscillation of exp2 and exp3 as the force applied was not same, (it is predicted by observing the point of release of rulers from mean vertical position in both experiment 2, 3 videos), volume of oil was decreased and another ball bearing was added. Three factors were changed. Yet sill the damped steel ruler made small oscillations to come to rest, then the other steel ruler.

CONCLUSION

From my experimental observations I can conclude that damping in a structure can effectively help reduce the free structural vibrations at resonance. I think this model easily reflected the concept of viscous damping with metal ball bearing.

References

- http://www.mace.manchester.ac.uk/project/teaching/civil/structuralconcepts/Dynamics/damping/damping_con.php [sited on date 01/03/09].
- Innovation of model, http://www.bbc.co.uk/iplayer/episode/b00hy9kk/Richard_Hammonds_Engineering_Connections_Series_1_Super_Skyscraper_Taipei_101/ [sited on date 01/03/09].

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