Projecting Sign against Typhoon

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Introduction

We see many kinds of different projecting signs on the street. But how many of them can withstand the external forces due to heavy winds such as those produced in a typhoon. It can be very dangerous if it is not installed and designed properly to withstand wind force. This paper shows a simple model to illustrate the structural concepts used for a projecting sign in heavy wind conditions.

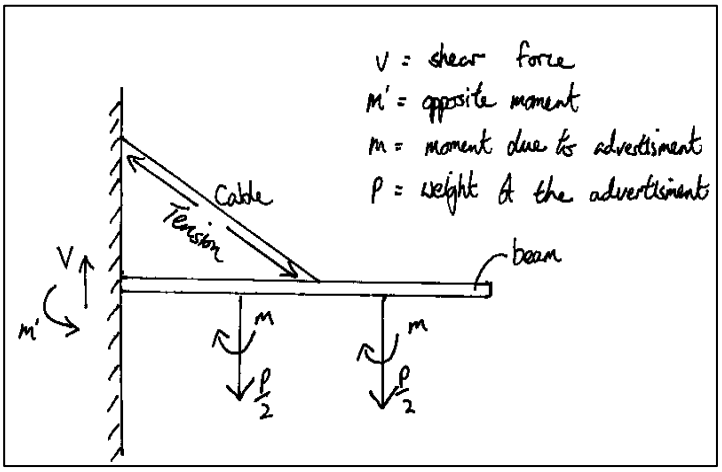
Concept used: The model is base on a few concepts, Energy transfer, Energy in Pendulum & Equilibrium concept

Equipment used:

- Ribena Carton (modelled as the projecting sign)
- ¼ lbs Wight
- Hair dyer (used to produce wind force)
- String
- Ruler (acted as a beam)

Method:

1. A Ruler is attached to a vertical metal beam.
2. String is used to hold the ruler and the Ribena carton in equilibrium condition.
3. A hair dyer is used to blow the empty carton.
4. A hair dyer is used to blow the carton with an additional ¼ lbs added to it.



For equilibrium condition [1], this model has satisfied the following conditions. ∑Horizontal Force=0 ∑Vertical Force =0 ∑Moment = 0.Due to the combined self-load of the ruler and the weight of the carton, the string is placed in tension. The horizontal forces created on each side of the cable are equal. The moment due to the carton must be equal to the opposite moment M'. The shear force V has to be larger

than the vertical downward forces due to the weight of the carton.

Fig (A)

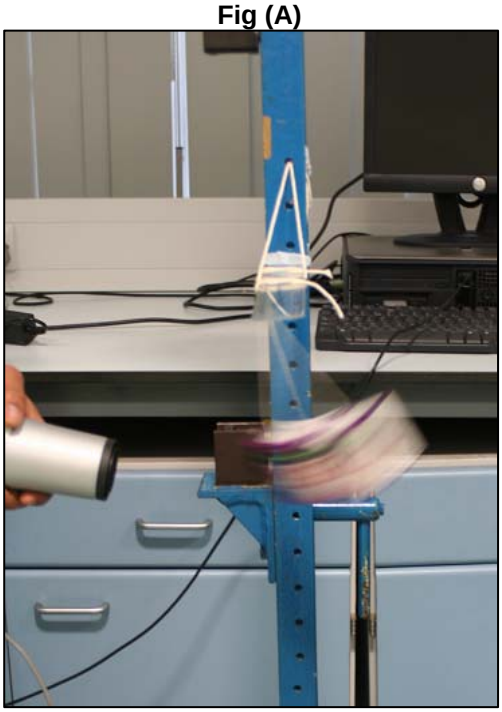


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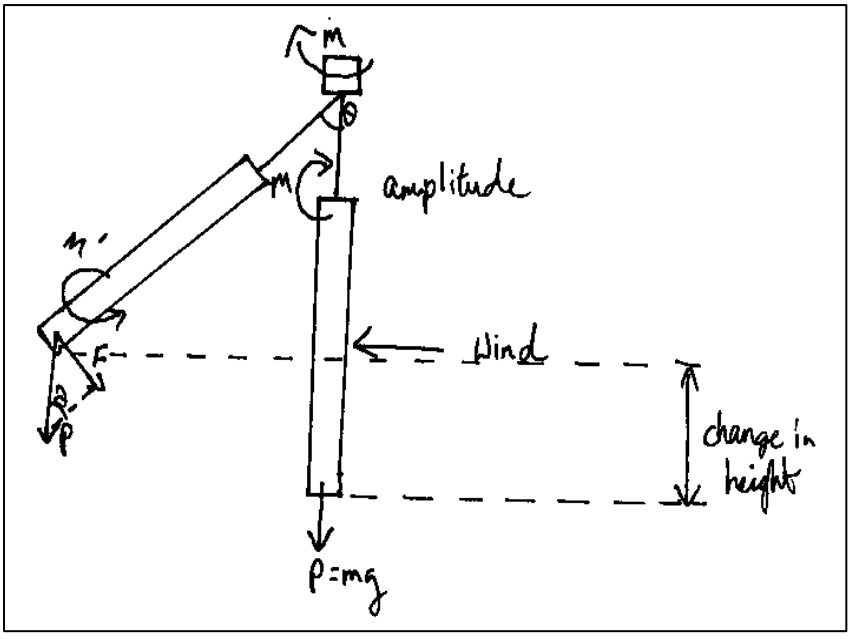
Fig (B)

external wind force is generated by the hair dryer. The two pictures above shows the moment of the carton due to wind force. Fig (A) shows the moment of the empty carton, Fig (B) shows the moment of the carton with addition weight of 1/4lbs added within the carton.



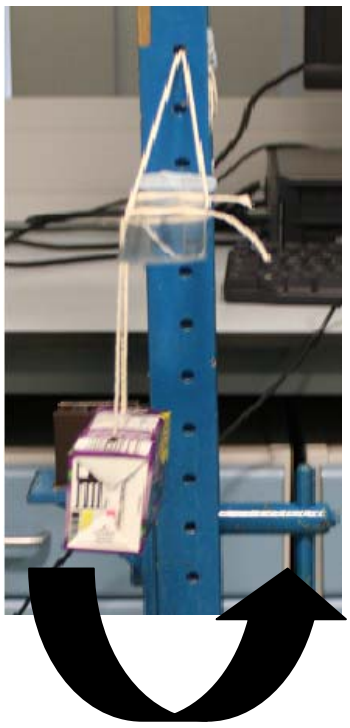
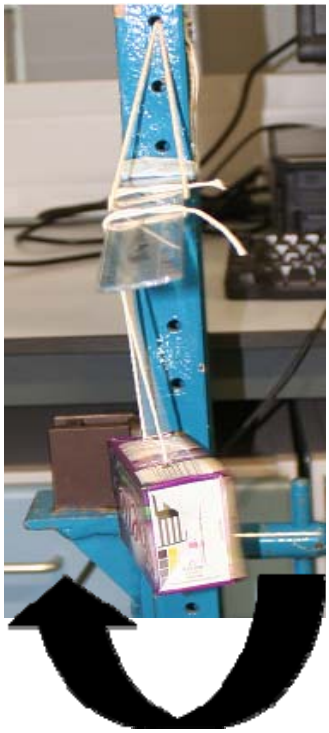
The empty carton and the carton with additional 1/4 lbs were subjected to the same wind force. With the additional load added to the carton, the force F generated by the weight of the carton is lot larger than the F generated by weight of the empty carton which makes a smaller change in height. The weight of the carton is **inversely proportional** to the change in height and its angular rotation.
By using Taylor's formula[2], the suitable weight for the 0.56m x 0.324m advertisement that can withstand typhoon can be estimate.

Taylor's formula gives the following: Fw = 0.0003 A V^2

Where:
Fw = the force of the wind acting normal to a surface facing the wind in lbs
A = the area of the surface facing the wind in square feet
V = velocity of the wind in miles per hour
Data: Typhoon: 215 miles per hour[3] , A: 0.56m x 0.324m. By using Taylor's formula Fw = 2.56 lbs = 1.143kg = 11.2 N.

For a 0.56m x 0.324m advertisement. With a 15 Maximum angular rotation due to typhoon, the minimum weight of the projecting sign is approximately around 3.45kg
Calculation method: 11.2/cos (15) = 11.59N = F. From this the P can be calculated by F/Sin (20) = 33.9N = 3.45 kg.
In reality, for a 0.56 x 0.324m projecting sign, the weight is around 1.5 – 3.5 kg[4].

Photo (1) **Photo (2)** **Photo (3)**


When the wind stopped blowing, the carton would swing back and forth Photo (1) & Photo (2). If there is no friction, the carton will continue with this swinging moment forever because of the law of conservation of energy.
Total Mechanical Energy = Potential Energy(mgh) + Kinetic Energy($0.5mv^2$)[5].
Due to friction, the carton will eventually stop in it equilibrium condition Photo (3).


[6]

[7]

Many places have used this structural concept for advertisement or as a street decoration. Photo on the left shows the massive construction of projecting sign in Hong Kong. Photo on the right shows Hong Kong is being affected by Typhoon.
References:

Knowledge applied to this model was taught by Dr.Adrian Bell & Dr Tian Jian Ji

[1] http://www.slideshare.net/wehaa/physics-equilibrium

[2] Book. Wind loading of structures by John D.Holmes, page 49

[3] http://www.guycarp.com/portalapp/publicsite/catdocument.pdf?instratreportid=1993

[4] http://www.signtech.co.uk/pdfs/rotobrochure.pdf

[5] http://library.thinkquest.org/2745/data/lawce1.htm

[6] http://i.telegraph.co.uk/multimedia/archive/00793/hong-kong-temple-st_793434c.jpg

[7] http://www.terradaily.com/images/hong-kong-typhoon-fengshen-afp-bg.jpg