Researching How the External Force and Damping Coefficient Affects the Movement of Skyscrapers

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Safety is the most important factor in skyscrapers. The fact that skyscrapers can contain many facilities and people is one of its many advantages. However external pressure such as earthquakes or wind might make accidents that lead to casualties. Because of its large size, small accidents still make big scale of damage. In this paper, we tried to find out what kind of factors affected the movement of skyscrapers using the ‘One Dimentional Forced Damped Oscillation Interpretation Software’. Then we researched how to minimize the damage caused by it and the way to correspond to it.

INTRODUCTION

These days there are many skyscrapers constructed all over the world. Because accidents occured in these skyscrapers cause a lot of casualties and damages, isolating the vibration made by wind and typhoons is considered very important. Many of these skyscrapers use dampers to isolate it so we decided to understand the principle using the 'One Dimentional Forced Damped Oscillation Interpretation Software' provided by the EDISON. We researched the efficient method of constructing skyscrapers through a lot simulations in different circumstances using the software.

CALCULATION METHODS

observation end time(s), spring coefficient (N/m) , mass(kg) , damping coefficient(N·s/m) , the size(N) and period of the external force(s). First, to find out how each factor affects the oscillation, we compared the graphs that had different values of the external force and cofficients.

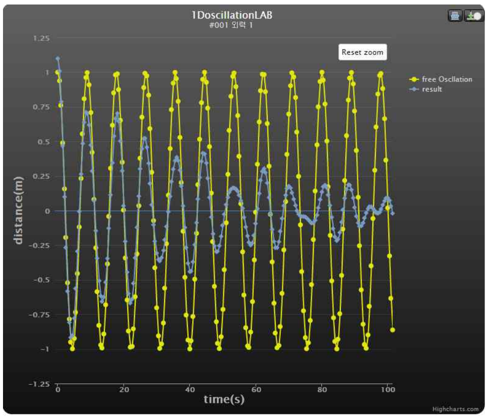

Fig 1. External Force Size Minimum

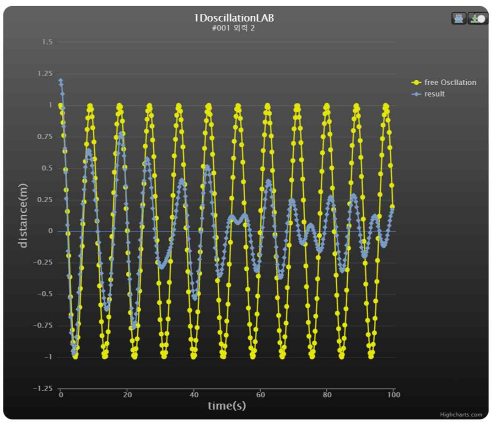

Fig 2. External Force Size Small

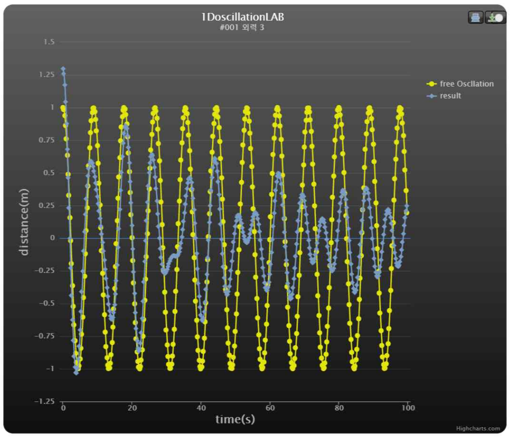

Fig 3. External Force Size Medium

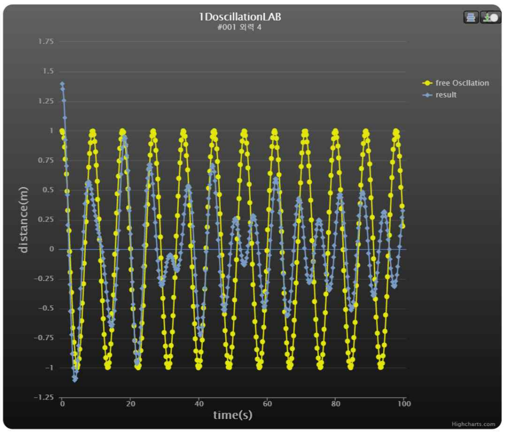

Fig 4. External Force Size Large

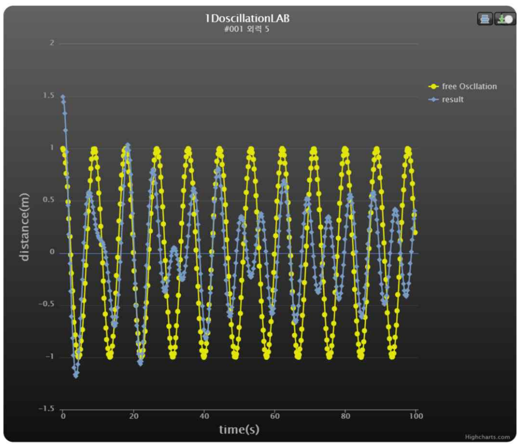

Fig 5. External Force Size Maximum

The pictures above are graphs earned by the software giving the same amount of difference in the size of the external force. By comparing the five graphs, we found out that the smaller the external force was, the amplitude decreased in a higher rate.

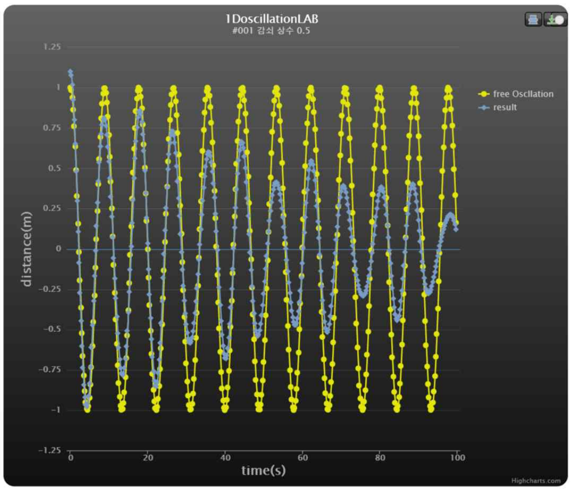

Fig 6. Damping Coefficient Minimum

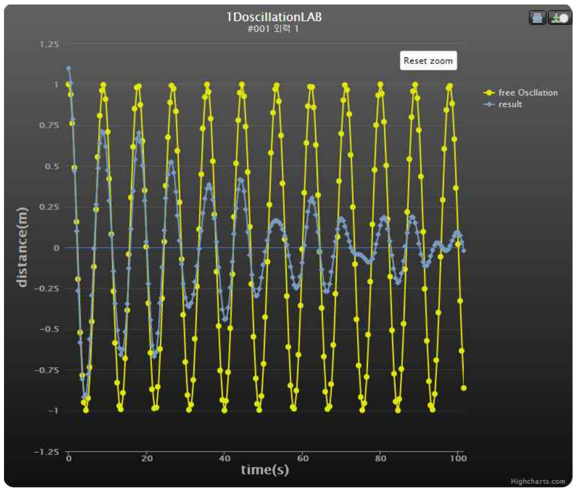

Fig 7. Damping Coefficient Small

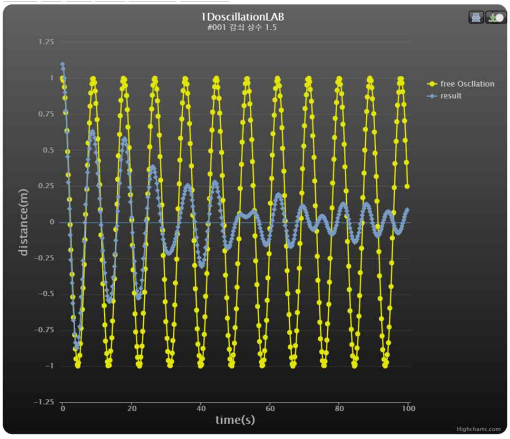

Fig 8. Damping Coefficient Medium

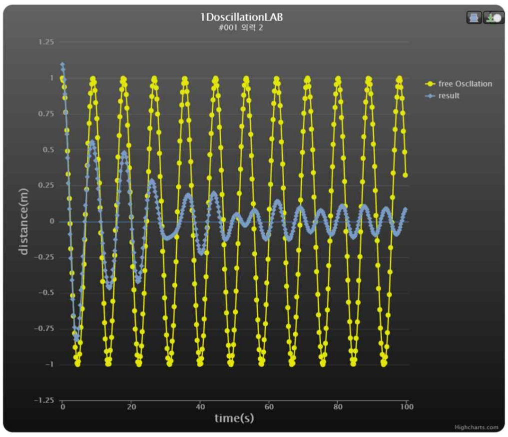

Fig 9. Damping Coefficient Large

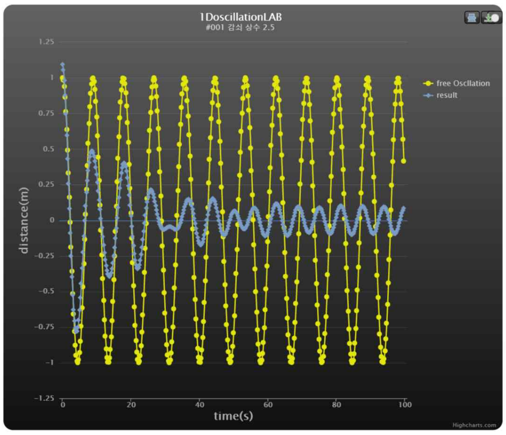

Fig 10. Damping Coefficient Maxmum

The pictures above are graphs earned by the software giving the same amount of difference in the size of the damping coefficient. By comparing the five graphs, we found out that the larger the damping coefficient was, the amplitude decreased in a higher rate.

Through the two simulations earned from the 'One Dimentional Forced Damped Oscillation Interpretation Software', we can note that small external forces and big damping oscillation coefficients made the amplitude decrease in a higher rate.

RESULTS AND DISCUSSION

Through the two simulations we had done previously, we found out that to make a stable skyscraper, we had to place the structure somewhere the wind's affect would be smaller and make the damping coefficient bigger.

Then we researched specific skyscrapers' structural designs and how to place and use the damper to cancel the external forces. First of all, people filled parts of the building with water to absorb the vibration. By moving the water to the opposite direction of the force, the water's inertia would decrease the movement of the building.

Another way was using dampers. Dampers are used to cancel the energy given using the inelastic deformation of the metal material. The Taipei 101 and the Shanghai World Financial Center are buildings that actually use dampers.

Decreasing the area of the surface at the higher floors to lessen the wind bunping against the building was also a method. The Shanghai World Financial Center spoken above uses this kind of method too. It made a very big hole at the top of the building so that the wind would go through it.

Fig 11. Shanghai World Financial Center

As you can see in Fig.11, the building looks like a bottle opener. It decreased the area of the surface on the top.

Lastly but also a very basic way is to make the outer wall thicker. But then too much concrete would be used. The skyscrapers wouldn't be able to stand the weight and the possibility of the building to collapse would rise. So these days, many designers use the other methods mentioned above.

CONCLUSION

By the result of the simulation, we found out that to reduce the movement of the building, we have to decrease the external force and increase the damping coefficient. Drilling a hole at the top of the building like Fig. 11 or designing the building in a steamlined shape is a way to reduce the external force. To increase the damping coefficient, using materials that has high damping coefficient like concrete to make the building was a way. Also, we could install a damper or fill water inside building to increase the inertia and reduce the movement of the building.

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