Title:

Designing the Most Effective Load-Bearing Columns in Construction Engineering

Question:

While I was driving toward downtown Pittsburgh, I noticed that there was many bridges and buildings with mainly cylinder columns supporting them. So, I thought the subject of my science fair this year would be great to determine which column shape would be the best at handling the most weight (or load as it is called in construction engineering). Is the cylinder shape the best? Or can we improve on that?

So, I came up with a strategy to create different models of 3-dimensional column shapes and tried to see which one holds more weight using equal-size block weights.

Hypothesis:

I hypothesize that some of the shapes will do better than others in keeping more weight on top of them than others. I think the hexagonal prism and the cylinder would compete with each other on keeping the most weight ahold to them while, the pentagon will do better than the triangle, and the square would do the worst out of all of the shapes.

Experimental design:

We used these materials for our experiments:

-Hard-stock paper

-tape

-ruler

-scissors

-large wooden blocks (130.5g)

-small wooden blocks (16.5g)

-scale

-thin (5x8") paper

Procedure:

First experiment:

1. ***We made a variety shapes out of hard-stock paper.***
2. ***The shapes ranged from***
    - ***Triangular prism***
    - ***Rectangular prism***
    - ***Pentagonal prism***
    - ***Hexagonal prism***
    - ***Cylinder***

3. ***We put one column at a time on a hard surface and put a hard piece of paper on top of the column, then put as much large wooden blocks on top of the column as much as it could hold. And counted how many wooden blocks it could hold.***

Results:

First experiment:

The result for different amounts of wooden blocks are as follow:

chart	Triangle	Rectangle	Pentagonal prism	Hexagonal prism	cylinder
# Of blocks (130.5g) In 1st try	7	14	14	14	14
# Of blocks (130.5g) In 2nd try	6	11	15	17	16

Triangular Prism was able to hold 7 blocks (910 grams)

The Rectangular Prism was able to hold 11 blocks (1,430 g) and on our second test 14 blocks (1,820 g)

The Pentagonal Prism was able to hold 14 blocks (1,820 g) and on our second test, 15 blocks (1,950 g)

The Hexagonal Prism was able to hold 14 blocks (1,820 g) and on the second test, it was able to hold 17 blocks (2,210 g)

The Cylinder was able to hold 14 blocks (1,820 g) and on the second test, it was able to hold 16 blocks (2,080 g)

Our results show that if we use the hexagonal prism and cylinder column, it will hold the most weight comparing to the other shapes. So, we decided that we should take the top two best columns and test them in a bridge form with two columns instead of one.

So, we decided to do the second part of my experiment.

Second experiment:

1. ***We made two bridges out of thin (5x8") paper. The first bridge had two-cylinder columns and the second bridge had two-hexagonal prism columns. The distance between two columns was 4". On top of these two columns, there was compressed cardboard.***

2. ***We stacked small wooden blocks (16g) on top of the bridge.***

chart	***2 column Cylinder bridges***	***2 columns Hexagonal prism bridges***
Test 1	*12*	*10*
Test 2	*14*	*12*

The Bridge made out of two cylinder was able to hold 12 small blocks (360gr) and on the second test it held 14 blocks (420g)

The bridge made from two hexagonal prism was able to hold 10 small blocks (300gr) and on the second test it held 12 blocks (360g)

Third experiment:

3. ***We made two, 1 story buildings out of thin (5x8") paper. The first building had four-cylinder columns and the second building had four-hexagonal prism columns. The distance between two columns was 2.5". On top of these four columns, there was compressed cardboard.***

4. ***We stacked small wooden blocks (16g) on top of the bridge.***

chart	***4 column Cylinder bridges***	***4 columns Hexagonal prism bridges***
# of small wooden blocks (each 16g)	*26*	*26*

The 1 story building made out of four-cylinder columns was able to hold 26 small blocks (416g)

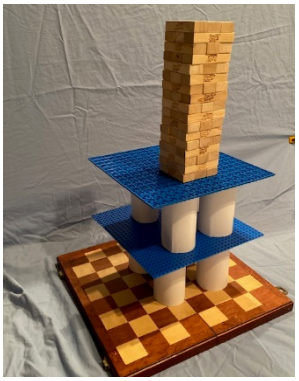
The Bridge made out of four hexagonal prism columns was able to hold 26 small blocks (416g)

Fourth experiment:

1. *We made two, 2 story buildings out of thin (5x8") paper. The first building had eight-cylinder columns and the second bridge had eight-hexagonal prism columns. The distance between two columns was 2.5". On top of these eight columns lay compressed cardboard.*

2. *We stacked small wooden blocks (16g) on top of the building.*


The 2-story building made out of eight-cylinder columns was able to hold 48 small blocks (768g)

The 2-story building made out of eight-cylinder columns was able to hold 51 small blocks (816g)

Discussion:

As you see the results for Cylinder columns and hexagonal prism columns in all different experiments (The 1 column, 2 columns, and 4 columns) are rewarding and these shapes are able to hold more weight that Triangular prism, Rectangular prism ,and Pentagonal prism.

The result for Triangular prism was worse than the others. It seems that it can hold less weight than the others.

Conclusion:

These experiments shows that if we build a column that has more sides it can handle more weight on top. So it's better to make buildings or bridges or any load-bearing structures out of Cylinders (with infinite sides) and maybe the hexagonal prism is a good substitute for cylinder columns if those are easier to manufacture.

Note: These experiments focused only on shapes of cylinders with the same material being used to have a good comparison. Future design work will need to bring in the type of material to design a column that can hold even more weight.

This is the way engineering works – repeating and re-designing over and over again until the best design is made for people to use and feel safe using.