Geometry & Structural Engineering

The Movie:

Structural engineers use shapes to design huge buildings and bridges. Featured: Ysrael Seinuk, design engineer, The Cantor/Seinuk Group. *(Movie length: 3:02)*

Background:

The island of Manhattan is 23 square miles; if each human being on it were allotted a 50 foot x 50 foot space to live and work, there would be room for about 250,000 people. How is it, then, that the actual resident population is over 1.5 million, swelled by another 2 million workers every day? The answer, of course, is the product of thousands of architects and engineers and hundreds of thousands of skilled construction workers: over three hundred skyscrapers, including 20 of the tallest buildings in the world. And the most important, and remarkable, feature of every one of these buildings is simply the fact that they stand tall and stable against the forces of gravity and wind.

Curriculum Connections:

Fractions 1

32 of the floors of a 34-story building are to be 16-1/2 feet tall, the other two floors are 28-1/4 feet and 36-3/8 feet. What is the total height of all of the floors of the building?

Fractions 3
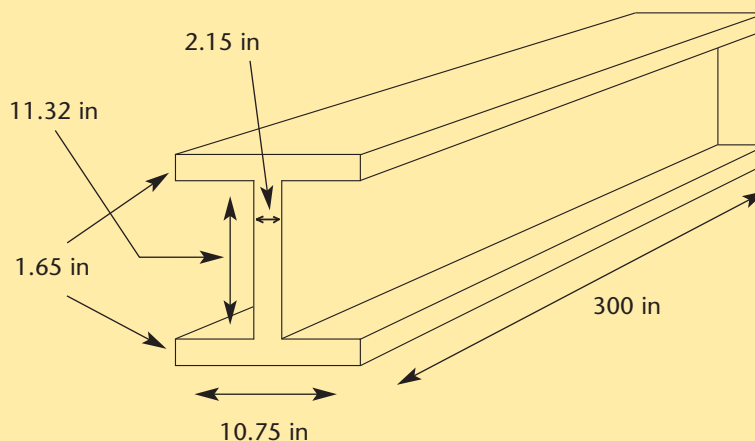
One square foot of glass weighs 6-3/16 pounds. What is the weight of an 80 square foot picture window for the front of a building?

Decimals, Measurement (area, volume) 2

How many cubic inches of steel are in this I-beam?

2.15 in

11.32 in

1.65 in

300 in

10.75 in

Percents   4

Steel is a combination of two elements, iron and carbon, along with some impurities. The kind of steel used to make the framework of buildings is called "mild steel", and is not more than 0.3% carbon. How many pounds of carbon, at most, are contained in a building framework which is made from 500 tons of steel?

Statistics, Percent   6

These are the heights of the thirteen tallest buildings in New York. How many of the thirteen buildings have heights that are within 25% of the average height? Compare the average height of the buildings built before 1940 with the average height of the buildings built after 1940.

Skyscraper	Height (meters)	Construction completed
Woolworth Building	241	1913
Chrysler Building	319	1930
Trump Building	283	1930
Empire State Building	381	1931
American International Building	290	1932
Rockefeller Center	259	1933
One Chase Manhattan Plaza	248	1960
MetLife Building	246	1963
Citigroup Center	279	1977
Worldwide Plaza	237	1989
City Spire	248	1989
Conde Nast Building	247	1999
Trump World Tower	269	2001

Percents   5

The wind speed in a hurricane can be as great as 175 miles per hour. If an engineer wants to design a building that will withstand hurricanes with a safety factor of 60%, what wind speed should he design for?

Ratios, Measurement (area, volume)   7

Make a scale drawing of your school building, measuring all of the dimensions you need to know in order to do so. Determine its surface area and volume. (Hint: To measure large dimensions, such as the length of the building, use paces and measure the length of a pace.)

Statistics   8

A new skyscraper, when completed, is expected to house 10,000 people. If you wanted to know the approximate total expected weight of all of those people, how would you determine it?

Probability, Percents `9`

The bolts which connect the beams in a building must be free of defects. Suppose a manufacturer claims that 100% of the bolts it shipped to you are perfect. When you inquire, you find that only 10 bolts out of a shipment of 100,000 had been tested and were proven to be defect-free. What is the probability that in fact only 90% of the bolts in the shipment are perfect? 95%? Do you think the manufacturer's claim is valid?

Geometry (triangles) `10`

If each line segment in this drawing represents a beam, what is the total length of beams required in this wall? (All four of the angled beams inside the rectangle are the same length.)

20 feet

12 ft
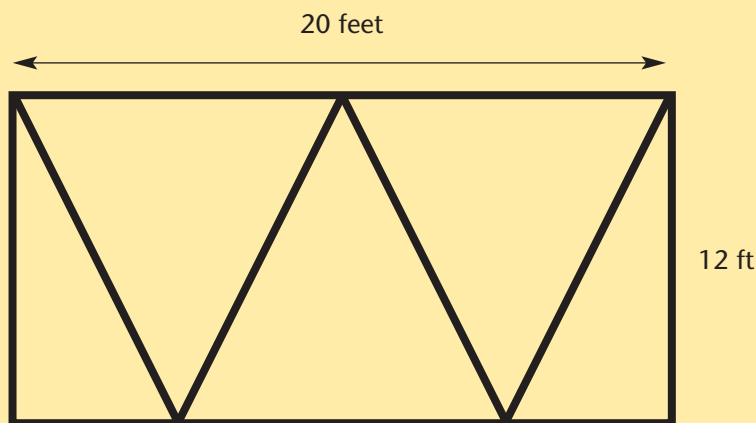
Geometry: Similar Triangles `11`

Determine the height of a building in your neighborhood, without measuring it.

Geometry: Solid Figures `12`

A rooftop restaurant in a new hotel will sit inside a glass structure as shown below. How many square feet of glass will be needed? If one ventilator outlet is required for every 5,000 cubic feet of space in the restaurant, how many ventilator outlets will be required? (Hint: You do not need to find the exact volume to answer this question.)

all edges are 35 feet long

rhombus

45° angles

square
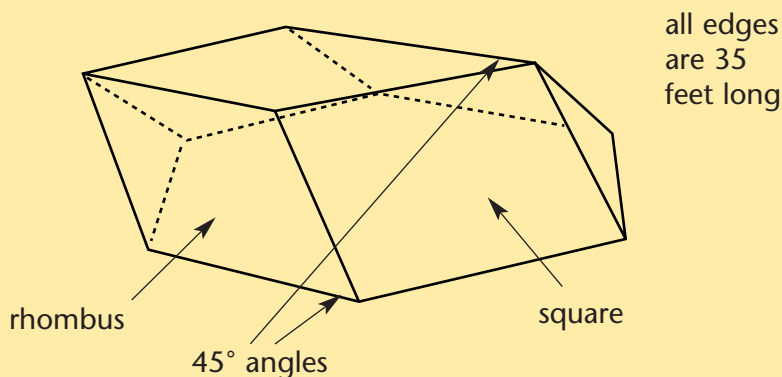
Trigonometry `13`

The stairs on the stairways in a building are each 10 inches deep, and each stair is 7 inches above the stair in front of it. What is the angle of ascent of the stairways?
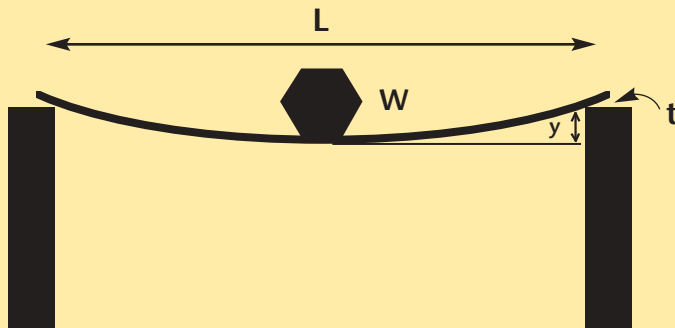
Algebra: Variables

Consider the situation of a beam supporting a weight in the center. Variables include:

- the dimensions of the beam: length (L), breadth (B), and thickness (t)

- the amount of weight supported (W) (also called the "load")

- the amount by which the beam bends (y) (called "deformation")

Algebra (patterns, relations and functions)

The amount of deformation of the beam is related to the length of the beam (as the length increases, so will the amount of deformation).

The amount of deformation of the beam is related to the amount of weight placed on it (as the weight increases, so will the amount of deformation).

The amount of deformation of the beam is related to the thickness of the beam (as the thickness increases, the amount of deformation will decrease).

If you enjoyed this Futures Channel Movie, you will probably also like these:

Roller Coasters, #1008	Designing safe roller coasters requires an understanding of forces.
The ABC's of Architecture, #4010	When Penn Station needed a new front entrance, they called upon architect Frances Halsband, and she called upon her knowledge of geometry.
Bicycle Design, #1012	Making bicycles that are strong enough for stunts requires the right combination of triangles and circles.