Name(s)

Alexandra B. Armando

Project Number

J1801

Project Title

Bridges: A Comparison of Structural Capabilities

Abstract

Objectives/Goals

The purpose of my project was to determine which model of bridge (arch, beam or truss) could withstand the most weight. My hypothesis was that the truss bridge would withstand the most weight because it is stable and it has three cantilever arms extending from the bridge, which distributes the weight more evenly.

Methods/Materials

I used balsa wood to build three bridges of each model (arch, beam and truss), each of which bridge was one foot long. I continued experimentation by placing bricks on each bridge until they collapsed from the weight.

Results

The results of my project showed that the truss bridge held the most weight at 40 1/3 lbs, or about 8 bricks. The truss bridge could withstand about 19.77 more lbs than the arch bridge, which withstood the second most weight. The beam bridge, which held the least weight, supported only 29 1/3 lbs.

Conclusions/Discussion

I concluded from this experiment that the truss bridge withstands the most weight in a short distance of coverage out of the three models I tested. The truss bridge supported the most weight because of weight distribution through the cantilever arms and the small triangular structures, which help take some of the weight away from the bottom and distribute the weight throughout the bridge.

Summary Statement

My project consisted of testing three models of bridges (arch, truss and beam) to determine which model supported the most weight.

Help Received

My mother and step-father assisted me with sawing the wood, and supervised my testing.

Name(s)

Brendan D. Bane

Project Number

J1802

Project Title

Watch Out Man of Steel: Here Comes Spider-Goat and His Webs of Steel!

Abstract

Objectives/Goals

My objective was to test the strength of spider web silk to see if a hand rolled strand of spider web silk could hold at least fifteen times its weight. My goal was to confirm what scientists believe about spider silk: it is one of the strongest materials in the world, but it is impossible to harvest effectively so we need to find a way to make artificial spider silk.

Methods/Materials

Spider web silk was collected from a Chilean Rose-Hair Tarantula's cage. It was separated into four pieces. Each piece was rolled and shaped by hand into a strand approximately two inches long and weighing less than one gram. Two strands were slightly shorter and thinner than the other two, but did not have a measurable weight difference. The strands were not identical because spider web silk is a natural material that is difficult to harvest and hard to handle. Each strand was threaded through a series of 6 metal nuts. They weighed: under 1 gram, 1, 3, 5, 10 and 15 grams. Each strand was hand held with one nut hanging from it, in order to test the strength of the strand. The test was repeated with each strand and nut. The results were recorded.

Results

Two of the strands held each weight of nut without breaking. Two strands broke. One broke holding the 1 gram nut and the other broke holding the 3 gram nut. These two strands were the shorter strands.

Conclusions/Discussion

My conclusion is that a strand of spider web silk can hold at least 15 times its weight, depending on its shape and length.

Summary Statement

My project tested the strength of spider silk because scientists think it is one of the strongest materials in the world and if artificially created, it could be used as building materials, medical supplies or artificial limbs.

Help Received

My mother helped me type and assemble the display and report. My father and mother helped buy supplies and transporting the project. My tutor helped me research. I interveiwed entomology professors, Dr. T. Perring and Dr. T. Prentice, at Univ. Cal. Riverside.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Kyle J. Bardet

Project Number
J1803

Project Title
I Beam

Abstract

Objectives/Goals
To determine whether or not size effected the weight carrying and span capacity of an I-beam. If it did, what variations of the flange / web ratio made it stronger, and what variations made it weaker.
Hypothesis: I believe that the size of an I-beam (flange /web ratio) would effect the load carrying and span capacity of an I-beam. After researching, I thought that the higher and thicker the web, and the wider and thicker the flanges, the more weight an I-beam could carry with out deflecting as much.

Methods/Materials
Using the strips of Pine wood, I first designed and constructed 5 different sized I-Beams labeling them 1-5. I then calculated how many fluid ounces it would take to weigh a pound. I found that it would take 15.4 fl. Oz. to equal a pound. Then, I placed the I-Beam #1 on wood supports, and strapped on the five-gallon bucket using the thin fabric. I placed 15.4 fl. Oz. (1 pound) in the bucket. I placed a 24-inch straight edge across the top of the beam and measured the distance between the bottom of the straight edge and the I-beam with a 200mm ruler to find the amount of deflection. I repeated the process 4 more times and then did the rest of the I-beams in the same manner

Results
I-beam # 1 deflected 1.5 mm with one pound, 4mm with two pounds, 6mm with 3 pounds, and 9mm with 4 pounds. I-beam # 2 deflected 1.5mm with 4 pounds, 2mm with 5 pounds, 2.5mm with 6 pounds, and 3mm with 7 pounds. I-beam # 3 deflected 1.5mm with 9 pounds, 1.75 mm with 11 pounds, 2mm with 15 pounds, and 2.5 mm with 19 pounds. I-beam #4 deflected 1.5 mm with 7 pounds, 1.75mm with 9 pounds, 2mm with11 pounds, and 3mm with 15 pounds. I-beam #5 deflected .5mm with 4 pounds, 1mm with 7 pounds, 1.5mm with 10 pounds, and 2mm with 13 pounds.

Conclusions/Discussion
Conclusion: In conclusion, my hypothesis was somewhat right and somewhat wrong. I found that size did affect a beams strength, and that the wider the flanges and taller the web, the stronger the I-beam would be. I also found out that the web height was more important than the flange width and thickness.

Summary Statement
THE DIMENSIONS OF AN I- BEAM AFFECTS ITS LOAD CARRYING AND SPANNING CAPACITIES.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Casey R. Bruckenstein

Project Number

J1804

Project Title

Buffest Brick

Abstract

Objectives/Goals

The purpose of my project was to test a homemade brick and to see which material added to that brick would make it the strongest. The materials I added were cloth, wire, straw and Nycon (a strengthening material used for concrete). One of the five bricks I made, did not have any material added to it, to make this a controlled variable.

Methods/Materials

Five bricks were made using wood molds of the same size. The cement, sand and water were carefully measured and half the mixture was poured into these molds. The different materials were laid onto the concrete and the remaining half of the mixture was pressed on top of the materials making a solid brick. Five sets of bricks, for a total of 25 bricks were made several days apart and set aside for 14 days to let them cure. I tested each brick by using water as a weight. A brick was laid across two saw horses and a metal bar was placed on top of the middle of the brick. Chains were hung on the metal bar and around a large water tank. Water was then poured into the tank to add weight and eventually break the brick. I then converted the amount it took to break each brick into pounds.

Results

My hypothesis was correct accept for the cloth brick. The brick with the cloth was the weakest and I think that was because the cloth acted like a shield in between the two concrete layers which made it weaker. The brick with the Nycon added to it consistently took the most amount of weight to break and the brick with the wire was the second strongest.

Conclusions/Discussion

This turned out to be a very complicated procedure because I originally thought it would take 50 pounds of water to break my bricks. I had to modify my testing apparatus 3 different times to finally break the first brick. The strongest brick took 891 pounds to break and I was very surprised how tough concrete can be.

Summary Statement

Adding four different materials to a homemade brick, I tested to see which brick would be the toughest.

Help Received

Parents helped with testing apparatus; Mother helped with back board.

Name(s)

Matthew S. Dal Zuffo

Project Number

J1806

Project Title

The Future of Building: Styroflex, A New Building Material

Abstract

Objectives/Goals

The goal of this project was to find an efficient building material (Styroflex) superior to standard drywall in the properties of strength, weight, water resistance, temperature and sound insulation, and flame resistance, while using recycled materials.

Methods/Materials

Two boxes were created from twelve 1x1" pieces of wood. One of these boxes was covered with Sytroflex, the other was covered with traditional drywall. Both of these boxes have undergone a series of tests to examine their efficiency. The following tests/comparisons were performed: strength (material: bb gun), weight (material: scale), water resistance (material: timer, container and colored water to monitor reaction to exposure to water), temperature (material: thermometers and heater) and sound insulation (materials: sound generator, amplifier and decible meter), and flame resistance (materials: propane/butane stove).

Results

Styroflex outperformed the standard drywall on the Weight, Durability, and Water Resistance Tests. The drywall box's performance was slightly better than Styroflex in the sound test through most frequencies, but this is possibly due to the fact that Styroflex is not as thick as drywall. Styroflex and drywall tied on the temperature test, and the drywall was found to be superior on the flame test, as the Styroflex began to burn slightly after about 30 seconds exposure to the flame.

Conclusions/Discussion

Although Styroflex was superior in many aspects (weight, durability and water resistance), the failure in the flame test requires that a flame retardant paint or similar material be added to the exterior recycled plastic sheeting. To increase the efficiency of the Styroflex as an insulator to sound and temperature, because of the light weight of the Styroflex, it could be made thicker to create a more dense and more efficient insulating building material.

Summary Statement

My project involved the creation and testing of a new multi-layered material using recycled plastic that would replace standard drywall as a building material.

Help Received

My father cut the recycled plastic sheeting as it was difficult to cut and required the use of a saw.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Erika Marie C. Go

Project Number

J1807

Project Title

Brickwork: The Effect of the Size of Sand Particles in the Strength of a Concrete Brick

Abstract

Objectives/Goals

The objective is to find which size of sand particles would make a concrete brick stronger using silica sand #30 (finer sand), and silica sand #18 (coarser sand.

Methods/Materials

There are two specific tests that I did. One would be the compression test and the other would be the durability test. In the compression test I placed each brick into the compressor, and compressed the brick until it broke in half. In the durability test I took a ladder and placed it half a yard a way from a rock. I climbed up the ladder (carefully). Once on the second step to the top of the ladder, I dropped the brick. After doing so, I record results, and repeat the same process again. In all 132 bricks were tested and three different brick types were used. Bricks contained silica sand #18, silica sand #30 or both silica sand #18 and #30.

Results

In the compression test, it turned out that the coarse sand bricks containing the silica sand #18 was stronger than the silica sand #30, the finer sand bricks. In the durability test, the bricks containing the silica sand #30 had more broken pieces then the bricks containing the #18 silica sand.

Conclusions/Discussion

In conclusion the bricks containing the silica sand #30 was the weakest and the bricks containing the silica sand #18 was the strongest. As for the bricks with both the silica sand #18 and #30, it was in between. The silica sand #18 may have been stronger because during the curing process the bricks didn#t dry as quickly as the bricks with the finer sand (#30).

Summary Statement

I made concrete bricks using fine sand and coarse sand to see which silica sand size would make a concrete brick stronger.

Help Received

Ms. King provided this opportunity and materials needed, Don Phillipe to helped make bricks, Skip for information, San Diego Equipment Rentals INC. rented equipment needed, RCP the wood needed, The Freeform Company for information, Home Depot the silica sand

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Cody A. Graf

Project Number

J1808

Project Title

Under Pressure

Abstract

Objectives/Goals

There is a guide that states that the strongest beam is the shape with the greatest amount of material away from the axis. I want to see if it applies to tunnels as well.

Methods/Materials

I used poster board, cardstock, and construction paper to build tunnels. I tested by placing either washers, checkers, or gram blocks on a board placed on the tunnel. I decided that I would use cardstock and washers to test the strongest shape.

Results

The engineering guide for beams did not apply to tunnels because the shape the guide predicted would be the weakest was actually the strongest.

Conclusions/Discussion

I have a better understanding of structural shapes after this experiment. Triangles have strong bases, letting the pressure be dispersed over the larger area, so they make good supports on large buildings. Circles and arches have curved tops, allowing pressure to be evenly distribute on them and the ground, so they are found as tunnels and pipes. Squares are sturdy so they can support a lot of weight from the inside, but none from the outside.

Summary Statement

Does an engineering formula for beams apply to tunnels?

Help Received

Mother typed some of project, Mr. Larson helped with math, Mrs. Dolan and Mrs. Flatt helped with numerous ideas and helped ready the project for each fair.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Gregory P. Schuster

Project Number

J1809

Project Title

Truss Analysis: A Study in Engineering Practices

Abstract

Objectives/Goals

"Can you combine member strength analysis and static analysis to form a predictive model for craft stick truss bridge failure?" My project applies engineering practices to a craft stick truss bridge by examining materials and loads. My predictions are based on data I collect through my own member tension, compression, and buckling tests and which then is combined with my static analysis of a particular truss. Then I will build the truss and apply a mid-span point load until the truss fails. My Variable: Truss Type, will have three study values to be sure that my predictive model works with more than one truss type and I will build three of each type.

Methods/Materials

My trusses were constructed out of craft sticks, wire pins, and joint plates. I prototyped the joint plates, to asuure stability, without providing structural support. Using my tension, compression, and buckling fixtures, I tested the craft stick member's strengths, for both long and short sticks. Combining the data collected from these member tests with the static analysis of each truss type, I made predictions on the failures of the three trusses. I set Variable: Truss Type, with three study values: #1: Warren Through-Truss; #2: Howe Through-Truss; #3: Pratt Through-Truss. Building and testing conditions for all trusses were the same. On each truss, I applied a mid-span point load using a bucket of weights. When the truss failed, the weight was recorded with the member name where the truss failed. I compared the actual failure weight and member location with my predictions.

Results

The Howe Truss was the most accurate prediction, breaking within 2 lbs. of my prediction. The Pratt Truss also had good results. I estimated a small range (71.7 lbs +/- 6.3 lbs) of failure. The prediction was 104% of the average. The Warren Truss prediction was incorrect. I attribute this to using only the compression test. Since I performed a buckling test later, the Warren truss prediction would be somewhere between the buckling and compression averages, which would have been correct. In every case, I successfully predicted which member would fail.

Conclusions/Discussion

My hypothesis was correct; combining static analysis and member strength testing, I was able to accurately predict when the truss would fail and which member would fail. The member strength test results for compression and tension were very accurate.

Summary Statement

Combining member strength tests and static analysis, I found that I could make a predictive model of truss bridge failure by testing three truss types.

Help Received

My father taught static analysis, aided with experimentation, & building apparatuses.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Stephen J. Steckbeck

Project Number

J1810

Project Title

Fender Bender Damage Resistance

Abstract

Objectives/Goals

The objective of this project is to determine which material will resist low speed automobile collision impact damage the best and potentially meet the Highway Transportation requirements.

Methods/Materials

The researcher used four materials with the same thickness and size. Each material was formed into a U-shaped channel to simulate a bumper of an automobile. Each bumper was impacted by an 18.18 Kg weight at 34.9 Km/Hr which simulates the kinetic energy of a 1364 Kg car travelling at 4 Km/hr. The 34.9 Km/Hr was achieved by dropping the weights down a chute from 4.8 Km high. the dent in the bumper was measured after each impact.

Results

Titanium had the least damage with a dent of only 2.0 mm. The remaining materials had an average depth of 104.6 mm for aluminum and 50 mm for stainless steel. Plexiglas was also tested but shattered upon impact.

Conclusions/Discussion

The researcher's conclusion is that titanium resists low speed automobile impact damage better than any of the other materials tested.

Summary Statement

The project is about discovering a material that won't dent in a low speed automobile collision.

Help Received

Grandmother's neighbor owns a sheet metal shop and supplied most of the material and formed all of the test specimens; Father helped me pour the foundation, build the wooden chute, and drop the 18.18 Kg weights during the testing; Grandmother allowed use of her back yard and garage for testing.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Cheyenne Waldman

Project Number

J1811

Project Title

Comparing the Strength Characteristics of Two Styles of the Warren Truss Bridge

Abstract

Objectives/Goals

My project's objective is to determine the percent of additional strength of the modified Warren Truss when verticals are inserted.
My original hypothesis was that the modified Warren Truss would be 50% stronger than the standard modified Warren Truss.

Methods/Materials

In my project I used balsa wood to crate the six bridges for testing, three of each style. I glued, pinned, and bound the joints to make them strong, to ensure that the tests were valid.

Results

My results surprised me, the verticals only made the bridge 28.5% stronger, only a little only half of my hypothesis. They mostly added stiffness.

Conclusions/Discussion

I feel that my project is pertinent to modern day life because trusses are used in many structural applications, and the correct truss design is critical to each unique situation.

Summary Statement

Testing the additional strength of verticals in the Warren Truss.

Help Received

Father helped me pin and bind the joints of the bridges.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Nolan A. Witowich

Project Number

J1812

Project Title

Can the Strength of Concrete Be Increased Without Adding Cement?

Abstract

Objectives/Goals

My goal was to increase the final strength of concrete by adding aggregates. I had no odjectives.

Methods/Materials

The experimenter mixed pre-packaged concrete mix with water and filled three plastic test cylinders for the control group. Steel fibers were added to an identical batch of concrete at 2% of cement volume weight. Three cylinders were filled with this concrete referred to as the steel batch. Fibermesh was added to a second variable batch,and an additional three cylinders were filled. these cylinders are refferd to as the fibermesh batch. A thrid variable batch was mixed, adding plastic at 2% the cement volume weight, and three more cylinders were filled. This batch is referred to as the plastic batch. All the cylinders were allowed to damp cure at a temperature of 22.2C.

1. Eight 40.5 Kg bags of pre-mixed Quikrete concrete mix
2. Three plastic test cylinders
3. Fifty-six grams of fibermesh.
4. Three kilograms of steel fibers.
5. Three kilograms of high impact plastic particles.
6. One Imer cement mixer.

Results

The concrete batch produced three cylinders that tested 31.50 MPa or higher at twenty-eight days of curing. This exceeds the manufacturer's design for strength. The plastic batch produced one cylinder at 31.33 MPa, one cylinder at 31.50 MPa, and one cylinder at 31.67 MPa. The fibermesh batch cylinder were all above the control batch average. They tested at 32.29 MPa, 32.15 Mpa, and 32.22 MPa. The steel batch was the strongest concrete, testing at 32.91 MPa, 34.00 MPA, and 32.74 MPa. Eight of the nine variable cylinders equaled or exceeded the strength of the standard concrete cylinders.

Conclusions/Discussion

The fibermesh and steel batches all produced concrete that exceeded the strength of standard concrete. Two of the three plastic batch cylinders met or exceeded the strength of standard concrete. Inert materials can be added ta standard concrete to increase the final strength of the mix.

Summary Statement

My project is to see if concrete can be strenghtened without adding extra cement.

Help Received

Father helped in experiments; John Johnson provided lab and equpment; John Rodriguez gaved mixed designs and suggested ratios; Tyler Collins provided capping compounds and other testing materials; Al White cut finished test cylinders for display; Paz Espinosa provided plastic cylinders and cement mixer