Name(s)

Sina S. Astani

Project Number

J1801

Project Title

The Determination of Elastic Modulus with Linear Relationship of Stress vs. Strain

Abstract

Objectives/Goals

The objectives of this project were to determine the Elastic Modulus (Young's Modulus) of materials, which is the stress (force/area) divided by the strain (change in length/ initial length) of materials, and to prove that the stress has a linear relationship with the strain of materials.

Methods/Materials

A mechanism was built that would find the change in length of a material when a given force was applied. These three lines were the materials that were tested: kevlar, copolymer (nylon and other polymers), and copper. Before the testing process had actually begun, the three lines were tied to swivels and then were attached to the mechanism. Then the dial scale was placed beneath the weight platform. The testing process began when five different forces were applied to each line and then the change in length was shown on the dial scale.

Results

The Elastic Modulus of the kevlar had ranged from about 44 Gpa to about 49 Gpa and averaged about 46 Gpa. Kevlar's stress vs. strain graph had been clearly the most linear out of all the graphs. Copolymer's Elastic Modulus went from about 1 Gpa to about 2 Gpa and averaged about 2 Gpa. Its graph was relatively linear but had a sudden upward curve near the end. Copper's Elastic Modulus went from about 24 Gpa to about 38 Gpa and averaged about 30 Gpa. This material's graph was the least linear and had a few upward and downward curves.

Conclusions/Discussion

This project generaly determined Young's Modulus and proved the linear relationship between stress and strain in elastic deformation of materials. In addition it gave me a better understanding of the fundamentals and basics of properties of materials and their strengths. This also gave me knowledge about material behavior when a load is applied.

Summary Statement

The project I had conducted was about the relationship of stress and strain of materials.

Help Received

Father helped me build mechanism. Uncle helped me test materials. Cousin took pictures. Stepfather helped me get materials.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Aaron J. Christensen

Project Number

J1802

Project Title

Wood Truss Design 2

Abstract

Objectives/Goals

To determine if the Warren with post truss is stronger than the Pratt Truss?

Methods/Materials

Wooden box/Test station.
Douglas fir/Glue/Small nails-brads/Weights/Dial Indicator/Hammer/Brad nailer/Sand paper/Exacto knife/Saw/Camera
Procedure
1) Build four different truss designs.
a) Truss 1: Pratt truss design.
b) Truss 2: Warren with Post truss design.
c) Truss 3: Warren with loaded posts truss design.
d) Truss 4: Reinforced Warren with loaded posts truss design.
2) Build a test platform.
3) Test three off each truss design.
4) Draw conclusions and make recommendations for each truss design. Compare test results to the analysis of each truss. Comment on how each truss failed.

Results

I have observed that my conclusions from last years project were not completely correct. Last year the Pratt truss was stronger than the Warren with posts truss. After loading the truss more evenly with the new and improved truss-loading platform, the two trusses are very nearly the same strength. The Warren with posts truss (T2) tested slightly stronger than the Pratt truss (T1). Truss # 3, the Warren with posts truss (minus the posts which do not support weight) tested to be the same strength of the Warren with all posts truss. Truss #4 was very cool. It was built with extra boards at the weak points. It supported a lot more load than the other trusses.

Conclusions/Discussion

My hypothesis was correct. The Warren with posts truss was stronger than the Pratt truss design. The vertical members tied to the diagonal members forming triangles really increased the strength of the trusses. Keeping the trusses rigid made them strong, the triangular configurations of truss members were able to resist the compressive and tension stresses found in the truss members.

Summary Statement

Testing Wood Truss Designs to determine which truss will support the most mass over span.

Help Received

I would like to thank my dad for helping me build my project, my mom for helping me put my board together, Mr. Ajit Randava for his help when I interviewed him, and my teacher for letting me do the project.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Jenny L. Cooper

Project Number

J1803

Project Title

Trusty Trusses

Abstract

Objectives/Goals

The purpose of this project was to find out how strong a truss can be made. With trusses made stronger, buildings and bridges can be made to withstand more weight. This project focused on the shape of the interior supports.

Methods/Materials

In this experiment, balsa wood was used to form trusses made with different polygons as the interior supports. The ratio was found of the load supported to the weight of the truss. The load used was water so it was easy to measure in grams how much it was.

Results

Triangles were found to have the best ratio. As more sides were added to the polygon, the ratio became smaller and smaller.

Conclusions/Discussion

From this experiment, it can be concluded that triangles are stronger and sturdier than other polygons. Using triangles in structural designs will make a strong, efficient structure.

Summary Statement

This project was done to find out what type of polygon would be strongest as interior support in a truss.

Help Received

Mother helped gather materials and took pictures; Dad helped put together test stand;

Name(s)

R. Terik Daly

Project Number

J1804

Project Title

Shake, Rattle, and Roll: In Other Words: The Effect of Shape on a Building's Structural Integrity in an Earthquake

Abstract

Objectives/Goals

The purpose of this experiment is to find out which type of building does better in an earthquake: a cylinder-based dome or a cubic building. I hypothesize that building type will affect how a building performs in an earthquake. I believe that the dome building will do better than the cubic one.

Methods/Materials

My experiment tested the performance of two types of buildings in two different earthquakes. The first is the 1994 Northridge, California quake. The other quake I tested is the 2001 Gujarat, India quake. Each building type underwent the quakes eight times. I based my results on the time to collapse of a building and its score on the Performance Scale, which is a modification of the Modified Mercalli Scale. I used a shake table that simulates earthquake waves in two dimensions to perform my experiment. For my building material, I used sugar cubes to mimic brick and cinderblock construction.

Results

My data indicates that shape has a small effect on a building's performance in an earthquake. The cubic building performed the best.

Conclusions/Discussion

My hypothesis was incorrect. Research shows this is because of the difference in weight distribution in each building. My testing shows that the main difference in building performance is the symmetry of that building. This project has given me a better understanding of the laws that govern architecture, one of the career fields I am interested in pursuing.

Summary Statement

How different building types act under different types of strain.

Help Received

Tech Museum of Innovation provided shake table facilities; Mother and sister helped build buildings; Father helped with videography; neighbor helped with model design and construction

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Natasha M. Darras

Project Number

J1805

Project Title

To Pay or Not to Pay

Abstract

Objectives/Goals

"Is the seam of a $19.99 sewing machine as strong as the seam of a $ 1400 sewing machine?" I wanted to determine whether an inexpensive machine performed as well as the expensive sewing machines, by testing seam strength.

Methods/Materials

Materials : Combination wrench, Environmental chamber, United Calibration unit - Model number STM 10 - Computer System - Printer Utility Wrench Sewing Machine-Bernina - Virtuosa 150 - $1400 - Pacestter by Brother -1250 - $699 - Pfaff - Hobby 1016 - $169 - Sew Smart - $19.99 . Fabrics : acetate 100% cotton, 100% cotton, 100% polyester, 100% silk.

Procedures : A. Follow material procedures. Follow ASTM standards. Follow exact procedures of United Calibration Unit. B. I altered four sewing machines as the variable. Four fabrics were constant with each machine.Silk v. Silk in all trials. C. Sample size was 6 3/8 inches. There were 64 btrials. D. 7 measurements were taken to get to the 6 3/8 inches. Counting of fabrics. Labelling of all test samples.

Results

I learned that my hypothesis was correct. The inexpensive Sew Smart oveall proved to be a durable sewing machine in simple one seam tests. Overall, Sew Smarts seam out lasted the competition. Bernina was also excellent performer. Pfaff and Pacesetter by Brother suprised me with their poor results.

Conclusions/Discussion

In conclusion, the inexpensive machine worked bettnsive ser than its competition. Bernina, the $1400 sewing machine performed very well throughout the testing. Pfaff ($169) and Pacesetter by Brother ($699) were easy to use but did not prove themselvevs. I was especially disappointed with the Pacesetter by Brother. It is a very expensive sewing maachine but had poor test results.

Summary Statement

To determine whether the seam of a $19.99 sewing machine is as strong as the seam of a $ 1400 sewing machine.

Help Received

My mother helped type reports, I used CRT laboratories equipment under the supervision of Mr. Tom Parsons.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Lindsey A. Ellison

Project Number

J1806

Project Title

What Types of Pipe Are the Most Earthquake Resistant?

Abstract

Objectives/Goals

My hypothesis is that PEX pipe will be the strongest and copper pipe will break. I think that this is because PEX pipe is really flexible and you can bend it with your own two hands. So, I think that an earthquake would not have much of an effect on it. I think that copper will break during an earthquake because it is not very flexible, and it is made of metal. There are more fittings required and the tension builds upon itself which could cause a break.

Methods/Materials

Install Caste Iron, ABS, PVC, Steel, Copper, and PEX pipes into a woodframed wall. Attach eye screws, turn buckles and cable to opposing corners of the wall. Alternate tightening and loosening the turn buckles on eiter side of the wall causing it to sway from side to side simulating an earthquake. Repeat the process until a pipe breaks. Before the test, pressure gauges were installed in each pipe and were filled with air pressure to see when a pipe broke.

Results

My results came out to be a lot like I thought they would be except the copper did not break. PEX pipe was the most flexible and steel was the one to break. Most of the different pipes just bent or tilted and I thought that they would just stay the same. No pipes broke at 3, 4, 5, 6, or 7 inches (or 7.62, 10.16, 12.7, 15.24, or 17.78 cm,) but they got pretty bent out of shape! Finally, I had to get my dad to help me secure and shake it, and that's when steel broke.

Conclusions/Discussion

I found that in the case of an earthquake, all the pipes do fairly well. However, the first one to break would be steel. I think that this is because it is not very flexible, and the fittings don't allow much movement. So, we should make our pipes PEX, and ABS!

Summary Statement

A simulation of an earthquake, testing pipes to see if they are earthquake resistant.

Help Received

Father used skill saw and torch.

Name(s)
Martin R. Geier

Project Number
J1807

Project Title
Architecture vs. Liquefaction: Will Braces Ensure a Building's Survival During Liquefaction?

Abstract

Objectives/Goals
My objective is to determine if a brace added to the structural design of a building will keep it from falling during liquefaction. I believe a brace is needed.

Methods/Materials
Twenty-five different structural designs were drawn and used to construct models of buildings, after interviewing three geologists and a civil engineer. Each design for the model was tested three times. The designs for the models were: seven with no brace; eight of my own made-up designs; one cross-brace; two moment frames; four brace frames; and three pyramids. Each model was constructed of miniature marshmallows and round toothpicks, placed on a 3.78 liter Ziploc plastic bag filled with two liters of water on a cookie sheet, and tested by dropping a book from three centimeters at two-second intervals 15 times on the bag to simulate liquefaction.

Results
Of the un-braced models only 14% succeeded. Fifty percent of the braced models were successful and are categorized as follows: 100% of the pyramids, 100% of the cross-braces, 50% of the moment frames, 50% of the brace frames, and 25% of the made-up designs.

Conclusions/Discussion
In conclusion, the braced models successfully withstood liquefaction in significantly higher numbers than did the un-braced models. My hypothesis was incorrect because not every braced model succeeded; one un-braced model succeeded due to its large base size. Only the pyramid design was completely successful through three stories. This data is applicable to architects and civil engineers in designing structures able to withstand liquefaction.

Summary Statement
My project determined if a brace added to the structural design of a building kept it from falling during liquefaction.

Help Received
Aunt helped with idea, oversaw project, and proofread my work; Uncle helped build display board; Mr. Dee Jaspar, civil engineer, gave me brace ideas; Mr. Karl Gross, Mr. Michael, and Mrs. Darlene Mercer, geologists, gave me information on liquefaction.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Nolan C. Gonzales

Project Number

J1808

Project Title

Concrete Strength

Abstract

Objectives/Goals

I tested to see what comercial concrete additive would make the concrete the strongest. I used three additives a a fast dry, a slow dry, and a flow controle additive.

Methods/Materials

all the concrete was mixed in with 20 Lb. of cement 7.5 and two thirds cups of water was then added and the recomended amount od additive was added also. the 20 pound batches would make 6 samples all samples were one inch thick and in and each saple was in the same size tray. the samples had seven dayes to cure. After the seven day drying period we tested them in a macine that can be set to the amount of weight the abount of weight it brock under was then recorded. after all my test I averaged all my test and came up with my conclusions.

Results

the flow controle additive made the concrete the strongest with an average strength of 5.52kg. Drying accelerator was second with the average amount of 4.43kg. the controle was third with the avrage amount of 2.73kg. The drying retardant was last with the avrage amount of 0.21kg.

Conclusions/Discussion

my results some wht surprised me i thought that the flow controle would be the strongest but i thoght the accelereator would be the weakest instead of the second. I would recommened using flow controle when poring a drive way or side walk i would deffinetly recommened it on colomes and briges too. the slow down would be the worst product to use because it made the concrete crumbaly and it cracked while drying.

Summary Statement

I tested what comercial additive would make concrete the strongest.

Help Received

father helped pour hte cement into the trayes and helped me type the report.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Tyler S. Hand

Project Number

J1809

Project Title

Falling Bridges

Abstract

Objectives/Goals

My objective in doing this project was to test bridge design load capability in an earthquake situation.

Methods/Materials

To do this I built a shake platform that had a motor with a crankshaft and a hinge. Supports were added to the platform so that all bridges contacted the platform in the same way. I built 4 different types of bridges, 3 models of each. Each bridge was put on the shake platform and three pounds were added to the bucket. The bridge was then shaken for 10 seconds. This process of adding weight was repeated until the bridge was broken.

Results

Bridge type 1 failed with the least amount of weight. Bridge type 4 held 3 times as much weight as bridge type 1. Bridge type 3 averaged between bridge type 2 and type 4. Bridge type 2 held the greatest average weight and the greatest single load of 33 pounds.

Conclusions/Discussion

After testing all the bridges and looking at the amount of weight each bridge held, I concluded that bridge type 2 withstood the most weight while being shaken at a verticle frequency. After inspecting the way the bridges broke I saw that all bridges actually failed for the same reason. The main beam for all of the bridges had twisted (rotated) out of position, which then caused the glue joints that attached the truss to the main beam to fail. I then concluded that bridge type 2 held the most weight because its design allowed it to flex more therefore; the load was more evenly distributed over the entire bridge.

Summary Statement

My project determined which bridge design would withstand the greatest load while being shaken at a verticle frequency.

Help Received

I received help on my project from my Dad to build the shake platform. He also participated in testing the bridges. My Mother helped proofread my presentation.

Name(s)

Clint L. Hatayama

Project Number

J1810

Project Title

The Effects of Environmental Factors on the Strength of Wood

Abstract

Objectives/Goals

My project was to determine if various enviromental factors has an effect on the strength of wood when exposed to them.

Methods/Materials

One hundred pieces of identical 12 inch lengths of redwood were cut with an electric saw. Twenty were soaked in salt water (3% saline to simulate ocean water). Twenty were soaked in a vinegar/water solution with a pH of 4.0 to simulate acid rain. Twenty were soaked in plain water and twenty were covered in moist soil. All the wood was soaked or covered for 24 hours then removed and allowed to dry for 48 hours. Twenty pieces were left untouched to serve as control. After drying, weights were attached to each piece of wood in increasing increments until the wood broke. The weight required to break each piece of wood was recorded.

Results

Ocean water had the greatest effect on the strength of the wood with an average of 491.85 ounces required to break the wood compared to the control which required an average of 512.85 ounces. It weakened the wood more than moist soil with an average of 502 ounces, plain water with an average of 512.35 ounces, and acid rain. Acid rain was the least corrosive to the wood with an average of 587.85 ounces required to break the wood.

Conclusions/Discussion

My conclusion is that environmental factors do have an effect on wood and that ocean water and moist soil are the most damaging. The data suggests that any wooden structures like a house, bench, picnic table, or walkway built near a beach exposed to ocean water should be prepared with a preservative to help prevent damage. When building a fence moist soil is probably going to corrode wood exposed to it. You should coat the wood with a preservative or make sure that the wood doesn't come in contact with the moist soil. In my experiment, acid rain almost acted as a preservative, but if I let the wood stay in contact longer it might corrode it. That is something I need to investigate further.

Summary Statement

My project tested to see if wood exposed to acid rain, salt water, moist soil, and plain water was weakened when compared to unexposed wood.

Help Received

Mr. Carl Gong helped clarify my project idea. My parents helped with equipment that I needed and helped with cutting letters and gluing on display board.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Tanner S. Hemphill

Project Number

J1811

Project Title

Rain, Rain, Go Away!

Abstract

Objectives/Goals

Objective: To learn if acid rain would have an effect on building materials.

Methods/Materials

I chose 13 common building materials that would be used in building outdoor structures or used for outdoor decoration. I put one of each of the materials into 2 separate groups: 1)distilled water (control group) or b)acid rain group. I used a 90% water and 10% sulfuric solution to form the acid rain. I first weighed each individual piece of building material and recorded the data. I then took each group separately and individually sprayed each piece with 20 squirts of either the acid rain solution or the distilled water. I then moved each piece back to its predetermined group and location. I did this daily for 1 week. At the end of the week I took each piece, brushed off any residue, weighed it and then continued with the daily spraying process. I continued this process for 4 weeks.

Results

ACID RAIN GROUP: Final results showed that 6 out of 13 pieces had a weight gain with wood and brick having the most significant. 7 out of 13 pieces had a weight loss with limestone, marble and travertine having the most significant recorded loss. 0 out of 13 pieces stayed the same. While most of the pieces had an insignificant weight gain the most significant change in each piece of building material was in appearance with the exception of limestone, marble and travertine that had the most significant weight loss.

DISTILLED WATER GROUP: Final results showed that 10 out of 13 pieces had a weight gain with roof tile having the most significant gain. 3 out of 13 pieces had a weight loss with cement and steel having the most significant loss. 0 out of 13 stayed the same. Most of the pieces had a very insignificant weight loss or gain. There was not a significant change in appearance from any of the building materials.

Conclusions/Discussion

Acid rain does have a definite effect on building materials. Although there was not the significant weight loss that I had anticipated there was a definite effect both visually and with weight alteration in every piece of material. It may take years to see the effect that acid rain will eventually have on building materials but over time there WILL be a definite effect.

Summary Statement

My project is about whether acid rain will have an effect on building materials.

Help Received

Mother helped me type, put my board together and buy supplies. Brother helped me with my graphs and tables. Associated Laboratories made my acid rain solution.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Christina L. Hill

Project Number
J1812

Project Title
Structural Design of Adobe Brick

Abstract

Objectives/Goals
My project was to determine how materials in the design of Adobe bricks effect how much weight a structure could hold.

Methods/Materials
A tray to mold the bricks was built with wood and nails. Dirt, which contained natural clay, was sifted. Equal amounts of sifted dirt and sand were mixed in a large bucket with enough water to hold together. This was then spread 1 inch thick in the tray and dried slightly. Rectangles were cut 3 inches by 1 inch and separated to dry completely in the sun. Then the procedure was repeated with equal amounts of sifted dirt, straw and enough water to hold that mixture together. A fish weighing scale was tied from a ladder and various weights (cement bags, full water barrel) were weighed and recorded. Two other weights used were my dad, Skip and our Honda Accord. A four-walled structure was built on top of a piece of plywood, 4 layers of brick vertical and 9 horizontal, one with sand Adobe bricks and one with straw Adobe bricks. Plywood was placed on top of each of the structures and the weights were put on top until the structure failed.

Results
The straw Adobe bricks never failed, they only cracked slightly. The straw Adobe structure cracked slightly at 781 lbs (without the estimated weight of the car). The sand Adobe bricks showed signs of failure at 262 lbs and failed at 678 lbs.

Conclusions/Discussion
Adobe materials have been used for thousands of years. Many ancient Adobe structures are still around today. My own Navajo Great-Great Grandmother lived in an Adobe Hut in the Arizona desert. The time will come when natural resources used today in building materials such as oil for plastics, wood from our forests and metals from Mother Earth will be gone. We may need to revert to how our ancestors built structures and Adobe bricks could be the answer. The conclusion of my project is that straw fibers, as opposed to sand, in Adobe brick design will make them stronger resulting in a more durable structure.

Summary Statement
The materials used in the design of Adobe bricks, such as straw or sand, will determine how strong and durable a structure will be.

Help Received
Father helped with supplies and weight placement. Mother helped edit report.

Name(s)

Caleb M. Iness

Project Number

J1813

Project Title

A Cure for Concrete

Abstract

Objectives/Goals

The object of my project is to determine which of the different methods of curing concrete gives you the strongest concrete.

Methods/Materials

I made twelve bars of concrete. I cured three samples in plastic, three in burlap, three in sand, and three samples in nothing. I let them cure for twenty-eight days with one misting of water every day. Then I tested their strength by testing how much weight they held untill they broke.

Results

The mean of the weight held by the plastic samples was 1077 N (242 pounds). The mean of the weight held by the burlap samples was 1250 N (281 pounds). The mean of the weight held by the sand samples was 1219 N (272 pounds). The mean of the weight held by the samples with nothing was 1014 N (228 pounds).

Conclusions/Discussion

My conclusion is that burlap is the best way to cure concrete out of the methods tested. I conclude the burlap won because it allowed the concrete to breathe while it also retained the moisture.

Summary Statement

What is the best way to cure concrete?

Help Received

My dad provided me with research, helped me cut forms. Mom helped me glue my paper on my board, and mix and break the concrete. My sister and my dad also helped break the concrete.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

William C. Jordan

Project Number

J1814

Project Title

Are Composites of Wood Stronger than Solid Wood?

Abstract

Objectives/Goals

I believe that solid wood will have greater torsional resistance (twisting) and drop resistance (bending) than a comparable piece of composite wood. In my experiments I will compare Douglas Fir, which is, used in for structural support in construction to various composite woods.

Methods/Materials

We conducted tests on solid wood vs. three kinds of solid wood to determine which was stronger. The types of wood used were: solid wood # Douglas Fir; Composite panel material # plywood, MDF, and OSB. Two types of experiments were conducted: twisting and bending. For the twisting test weight was applied to a wire fishing line from a 4-inch arm to cause the test bar to twist. The degree of twist was measured for each increment of weight applied until the wood sample broke. For the bending test the test bar was held at one end, and a predetermined amount of weight was applied at the opposite end. The amount of deflection was measured for each increment of weight applied until the wood sample broke.

Results

The arc of twist and the amount of bending for each sample were proportional to the weight applied for both the solid wood and the composite woods. More torque was required to break the solid wood than the composite woods. The solid wood broke into two pieces at a smaller arc of twist than the composite woods. More weight was required to break the solid wood than the composite woods.

Conclusions/Discussion

The solid wood proved stronger in both tests than the composite panel materials, which supports my hypothesis. I believe I got these results because the long, continuous fibers going in the same direction in the solid wood hold together better than the manufactured composite wood held together by resins. However, I learned in my additional research that there is a category of composite wood engineered beams. These beams are stronger and can be manufactured longer than solid wood beams. I learned that in construction solid woods and composite woods (composite panels and engineered beams) have specific applications ranging from decorative to structural support.

Summary Statement

To determine if a wood composite has a greater torsional resistance and drop resistance than a comparable piece of solid wood.

Help Received

My parents helped me build the testing apparatus.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Justin J. Kim

Project Number

J1815

Project Title

What Kind of Foundation Is the Best for an Earthquake?

Abstract

Objectives/Goals

In many places around the world there have been very powerful earthquakes, but the damage repair costs varied a lot. In Prince William Sound, Alaska the damage repair cost was about $311M with a 9.2 magnitude earthquake in 1964, but in Kamchatka, Russia the cost was only $2M with only a slight difference in the magnitude, 9.0, in 1952.

In this project, I am trying to figure out what foundation for a building is the best (shakes the least) during different sized earthquakes. I am going to use three foundations, a fixed foundation, a hinged foundation on rollers, and a free on roller foundation. Two hypotheses were made: 1) a building will move the least on a fixed foundation but 2) objects in the building are going to move the least on a free foundation.

Methods/Materials

An earthquake simulator has been constructed using a toy car, wooden balls for rollers, and springs, etc. to measure building movements and object movements in the building on three different support methods (fixed, hinged on rollers and free on rollers). Each of the support methods was measured four times at three different strengths of earthquakes.

After all measurements were collected, they were averaged for each support type at each quake strength. Then a shake ratio between the number of grids and the length of each line of the building and the in-building object was calculated to figure out how violent the building or the in-building object was.

Graphs were drawn for the average length of the farthest point, average number of grid counts the line went through, and the average shake ratio. Then the comparison was made for the three graphs of the building foundation and for the three graphs of the in-building object to see which supporting method was the best.

Results

The object movement is least and safest with the free-on-rollers supported building. However, the building movement is the greatest with the free-on-rollers support. The object movement in the hinged supported building is the safest because it responds with a marginal movement and the building itself does not move a lot or violently.

Conclusions/Discussion

My hypothesis about the building was wrong, but the second hypothesis about the object movement in the building was correct. The further experiment can be done to determine how to secure in-building objects to the building and how to construct a building in order to minimize the earthquake damage.

Summary Statement

The project is about determining the best building support method to minimize the earthquake damage of a building and objects in the building.

Help Received

I would like to thank my teacher, Mr. Lenker, the science fair coordinator from my school, Ms. Francis, my mother for buying materials for me, and my father and brother for helping me build an earthquake simulator.

Name(s)
Kacey Marton

Project Number
J1816

Project Title
How Do Heat and Hydration Affect the Tensile Properties of Human Hair Fibers?

Abstract

Objectives/Goals
(1) Study a full spectrum of tensile properties of keratin-based fibers (human hair), beyond simple tensile strength (e.g., generate full stress/strain curves).
(2) Explore how heat & hydration, which alter protein structure, act to affect the tensile properties of individual keratin-based fibers.
(3) Key is to successfully design and build a practical, inexpensive, and accurate mechanism that can generate full stress/strain curves for single fibers, and to make a time-effective methodology that overcomes the problem of high variability between different hairs.

Methods/Materials
An inexpensive stress/strain assessing mechanism (SSAM) was designed to precisely apply stresses to single fibers and measure resulting strains. It uses a Hookes law ideal spring & a camcorder to capture data on-the-fly for later analysis. A fiber has each end threaded in a needle, tied, and glued. Needles are clamped into the SSAM. Tensile properties of 32 normal hair fibers were studied to refine and prove the SSAM. Stress/strain curve analysis successfully gave 7 measures for each: Youngs modulus (stiffness) pre-yield, yield stress & strain, post-yield modulus, pre-breakage modulus, and breakage stress & strain.

Results
Tensile properties varied greatly between hairs, so paired internal controls were developed. A hair is divided, one half used as control for its twin, reducing variability. Heat, 95-100 °C, 2-3 hrs, was applied to one half of each of 15 hairs. Heated fibers showed less elasticity over a longer range of stresses than their unheated twins. Many yield points nearly disappeared. Hydration at 40-45 °C, 2-3 hrs, was also studied on 21 fibers. Water increased elasticity & reduced yield stress, compared to their dry twins. Finally, stretching & releasing fibers showed fibers return to their original length if strain is low, but they lose an ability to recover (even overnight) if strained past the yield point.

Conclusions/Discussion
My new SSAM & procedures worked well to make single fiber stress/strain curves, and internal controls overcame variability problems. High heat makes keratin fibers stiffer and hydration raises elasticity & eases yield. Interestingly, keratin fiber stress/strain curves seem counterintuitive: When stretched, they are first stiff, then loose, then stiff again, before breaking. A model with a spring-like structure having cross-links is proposed to account for this behavior.

Summary Statement
This is a study to find a way to do detailed studies of keratin-fiber tensile properties, and to then use that methodology to explore the effects of heat and hydration on single human hair fibers.

Help Received
Father assisted with power tools in constructing the SSAM, and with the circuit design for the motor controller.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Cameron F. Matthew

Project Number

J1817

Project Title

Concrete Reinforcements

Abstract

Objectives/Goals

My objectives are to determine how much stronger does reinforcement make concrete, and which types of reinforcement makes concrete stiffer compared to other types.

Methods/Materials

The materials I used for this project are; (2) 50 pounds bags of concrete mix, (2) 3/8-inch diameter wood sticks as a type of reinforcement, (2) 3/8-inch diameter steel bars as a type of reinforcement, (1) one pound bag of 1-inch long fiberglass material as a type of reinforcement, (5) 2-inch diameter by 60-inch long PVC tube to hold the concrete in, a mixer to mix the concrete, (2) 5-gallon buckets to hold sand that I used for weight, a dial indicator instrument to measure the bending to 1/1000th of an inch displacement.

Results

The PVC tube with no concrete took 72.4 pounds to bend 0.964 inches. This is 75 pounds per inch stiffness.

The PVC tube with concrete only took 87.2 pounds to bend 0.915 inches. This is 95 pounds per inch stiffness.

The PVC tube with concrete and wood took 103.8 pounds to bend 0.970 inches. This is 107 pounds per inch stiffness.

The PVC tube with concrete and fibers could not be tested because my Dad sawed open this tube by accident, instead of the spare concrete only tube.

Conclusions/Discussion

The steel reinforcement was the strongest and the stiffest. The PVC tube only was the weakest. The concrete with wood was the second strongest, and the concrete only tube was the second weakest. This means that the stronger the reinforcement, the stronger the tube was.

I also discovered that as you add weight to the tubes with concrete in them, the stiffness goes down as the weight goes up. This must mean that the concrete inside the tube is breaking. The PVC tube alone was about the same stiffness for all the wieghts.

I found out that the total stiffness of a tube is equal to the PVC tube stiffness plus the stiffness of the concrete and reinforcements inside of the tube.

Summary Statement

This project helps to determine the strength of concrete with different types of reinforcement

Help Received

My dad bought the materials and showed me to mix concrete and help me make the graphs

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

David M. Mikulka

Project Number

J1818

Project Title

Trusses: An Angle on Stress

Abstract

Objectives/Goals

The intent of this project is to examine whether different angles change the strength of a truss during an earthquake. The hypothesis is that trusses formed of 60º angles will last the longest during a simulated earthquake.

Methods/Materials

The materials used in this project are as follows; an earthquake simulator and enough wood to build 60 trusses(I used 3mm by 3mm wood.) You will also need super-glue, corkboard and wax paper for making the trusses. Pins are very helpful for holding the joints together while the glue dries. A stopwatch/timer is also needed to time how long a truss lasts. A table saw capable of cutting at various angles is also needed. The testing procedure begins, after manufacturing the actual trusses, with placing a truss on the P-wave simulator. The simulator is then activated. Once the simulator is activated, a timer is set. Once the truss breaks, the timer is stopped and the time recorded. This process is repeated with half of all trusses, 10 of each type. Once all P-wave testing is finished, S-wave begins. The second half of the trusses are used, and the procedure is the same as for the P-wave testing.

Results

The results of this experiment are that the 30º trusses perform the best under S-wave testing, but the worst under P-wave testing. The 45º trusses perform the best under P-wave testing but the worst under S-wave testing. The 60º trusses, however, perform better overall. They are slightly lower than the 30ºs in the S-wave testing, and slightly below the 45ºs in the P-wave testing. Since an earthquake consists of both P- and S-waves, withstanding both is crucial.

Conclusions/Discussion

The findings show that while the 60º trusses are not the best at either type of wave, they are the best for the entire earthquake, which consists of both waves. This proves the hypothesis that an equilateral truss, or 60º truss, will perform the best during a simulated earthquake. This means that trusses(either in roofs or bridges)built in earthquake prone areas shoul be made from 60 degree angles.

Summary Statement

My project is whether angle change how earthquake resistant a truss is.

Help Received

Father helped to build earthquake simulator, neighbor helped manufacture trusses.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Todd M. Schenk

Project Number

J1819

Project Title

Breaking Bricks and Building Better Ones

Abstract

Objectives/Goals

This experiment was to determine if it is possible to make a lighter yet stronger brick than one made of ordinary concrete. My goal was to modify the curing technique and the ingredients of the bricks to determine if less weight per brick could be achieved while improving tensile strength. I used cost analysis to show the price of making the bricks better.

Methods/Materials

Four batches of bricks were made. The first batch was ordinary dry cured concrete that served as my control group. The second batch was ordinary but water-cured concrete. The third was made of cement, Perlite, and fiber. The fourth was made of cement, Perlite, fiber, and metal rods to serve as rebar. Every brick was weighted and then broken on my "Brick-Breaker." A 2000lb forklift pallet scale was used to measure the breaking strength of each brick.

Results

Water curing doubled the strength of the concrete bricks but did not reduce weight. Substituting Perlite and fiber for the coarse aggregate and sand of concrete significantly reduced the weight of each brick and substantially improved each brick's tensile strength. Adding rebar increased the strength of each brick even more, with almost no increase in weight.

Conclusions/Discussion

By modifying ingredients combined with cement to make bricks, lighter and stronger bricks can be achieved. These better bricks greatly improve structures and help save the backs of masons everywhere. Even though these improvements are more expensive, they are well worth the investment.

Summary Statement

My project was to see if it is possible to make a lighter and stronger brick.

Help Received

Uncle supervised me building my breaker and brick forms.

Name(s)
Nathaniel S. Sekula

Project Number
J1820

Project Title

Improving Buildings' Resistance to Earthquakes May Be as Simple as Using Reinforced Sheetrock

Abstract

Objectives/Goals
My objective was to determine if by reinforcing sheetrock with plywood, a superior usable building product could be produced. I believe that reinforced sheetrock will have greater strength and will help structures withstand natural disasters.

Methods/Materials
I constructed reinforced sheetrock by laminating sheetrock and plywood in a hydraulic hot press. This I named S-ROK. I then ran a series of tests to compare the horizontal, vertical, and shear strength of the S-ROK vs. conventional sheetrock. Additionally, I compared the weight and cost of the two products as well as tested for impact resistance and soundproofing qualities.

Results
S-ROK (the reinforced sheetrock) proved to be greatly superior in strength, impact resistance, and soundproofing. It's drawbacks are in higher cost and weight.

Conclusions/Discussion
My conclusion is that S-ROK would add remendous strength and durability to buildings, particularly those in earthquake prone areas. Decreasing damage would more than offset the higher costs to produce and install reinforced sheetrock.

Summary Statement
My project is comparing conventional sheetrock to a reinforced sheetrock product that I created, testing to see which has superior strenth and durability for earthquake resistance.

Help Received
Father helped with construction of material, supervised cutting of material, assisted with testing and autocad drawings for charts and graphs. My Mother helped with typing and board presentation.