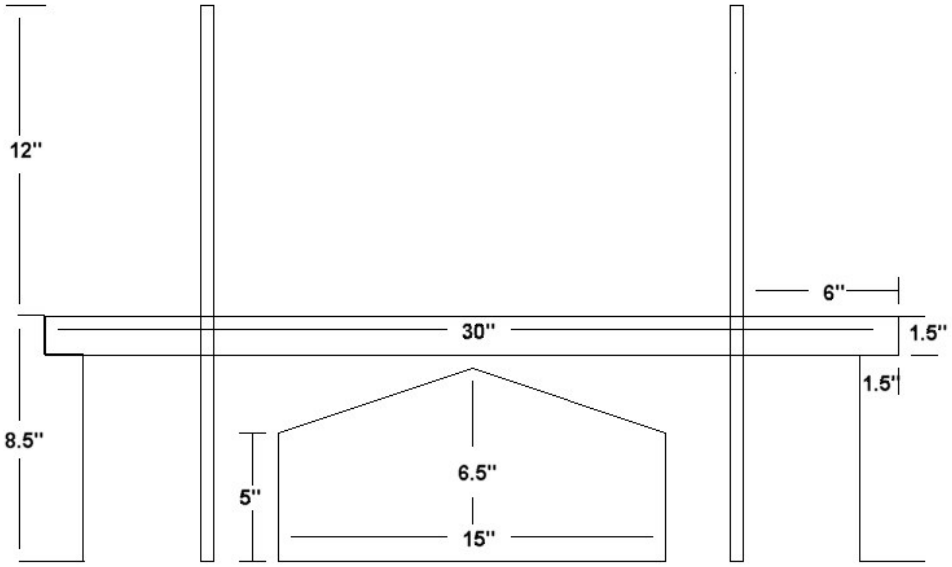
Spaghetti Bridge Project

Situation

Core E. Gated, a local engineering firm, is in the middle of a labor shortage. Engineers at the firm have been overwhelmed by the amount of structures that they must design. One of the projects is a design for a new bridge. The owner, Mr. Gated, needs the design to keep his firm running and believes that the engineers need some help with the design ideas for the firm to meet the deadline. In an effort to meet the deadline, Mr. Gated has asked the physics students for assistance with the design. To complete the project, he has asked that the students research, design, and build several options for the bridge based on the specifications provided. In addition to designing the bridge, the company has asked for a scale mode, proof of its integrity and profitability. To test the strength of the design, Mr. Gated has asked that models be built out of store bought pasta and tested until structural failure.

Design Requirements

1. The model must be made entirely from any store bought pasta, except lasagna, and string or thread.
2. String can only be used as a suspension system; it can not be used to hold pieces of pasta together.
3. Only hot glue or white glue may be used to attach pasta together.
4. The model must have an area in the middle center to fit the 8” x 4” x 1” load testing support. A ½” hole must also go through the bridge center to accommodate the bolt that will hold the weight.
5. The roadbed of the bridge must be even with the existing road which is 8.5” above the ground below.
6. There are two side support areas, one on each side measuring 1.5” x 1.5”.
7. If vertical supports are used, there must be no more than 6” from the support to the edge of the bridge.
8. There must be enough space below the bridge to allow a 15” x 6.5” block to pass through. (See diagram)
9. The bridge height may not exceed a distance of 12” above the existing road.
10. The maximum width of the bridge may not exceed 6”.



Documentation/Presentation

1. To insure the reliability of the design, the firm requires that the design of the bridge be well documented and the integrity of the bridge must be tested. The documentation should show the progression of ideas leading to the final design.
2. As a final step to creating the bridge, you will present your design concept to the company in the attempt to sell the design to the company. This presentation must use Microsoft PowerPoint.

Commission for Designs (Grading)

If any of the design requirements are not met, the company has no use for the design. ***Therefore, any design not meeting any of the above design requirements will not receive any credit.***

Bridge Construction (30 points - 50% of total)

Strength / Mass Ratio (10 pts)
Points will be given based on the performance of the bridge. The bridge must at least hold its own weight to receive 5 points. The total mass held by the bridge will be divided by the mass of the bridge to determine the strength to mass ratio. All bridge ratios will be calculated and ranked to determine the number of additional points that will be awarded.

Strength / Cost Ratio (10 pts)
Points will be given based on the performance of the bridge. The bridge must at least hold its own weight to receive 5 points. The total mass held by the bridge will be divided by the cost of the bridge to determine the strength to cost ratio. All bridge ratios will be calculated and ranked to determine the number of additional points that will be awarded.

Aesthetics/Originality (10 pts)
Each bridge will be judged on the construction and design quality of the bridge. Overall appearance and design, neatness of construction, construction techniques, and attention to detail will be considered during the evaluation in this category.

Documentation / Presentation (30 points - 50% of total)

Design Documentation (10 pts)

Each group will document the design process of the bridge. This is a dated journal documenting each meeting of the design team. Each meeting should be summarized to describe the purpose of the meeting and the progress of the design process. The summary should include the date, time, and team member attendance. The summary should also include a log of the ideas considered in the design process. In addition, the reasons for choosing the actual designs over the other ideas should be explained. During the design process, the team should construct small models to test design concepts. Pictures (digital, Polaroid, 35mm, etc) of these models and of the design/construction process should be included in the documentation, including a picture of the finished bridge.

Research (10 pts)

Each group should complete thorough research on bridge types and structures. While completing the research, each group should complete a "Bridge Characteristics Data Sheet" for each of the four major bridge types. A bibliography of the books and web sites from which ideas and information was taken should be turned in with the research. A minimum of 10 books and/or websites should be used and recorded in the format shown in *Writing Lancer Style*.

Proof of Profitability (5 pts)

Each group should carefully use the given material prices to approximate the overall cost of the design. Then based on the average traffic projections, yearly maintenance cost, and maximum toll that can be charged for crossing the bridge, determine the number of years it will take to pay for the bridge.

Presentation (5 pts)

The presentation should convince the Core E. Gated company that they should purchase the group's bridge design. The presentation should be a brief sales pitch (approximately 10 minutes) to convince the company to purchase the bridge design. Points that should be covered in the presentation include: design considerations based on research, any structural test that was done, production cost, and profitability. The presentation should be given with the understanding that it is being given to a panel from Core E. Gated, not a room full of classmates. A printout of the final presentation must be turned in the date the bridges are brought to school.

Bridge Characteristics Data Sheet

Name of Bridge Type:

Graphic representation (hand drawn or actual picture) of bridge showing basic shape and structure

List two advantages of this bridge type:

1.

2.

List two disadvantages of this bridge type:

1.

2.

What parts of this type of bridge might you incorporate in your design and why?

Cost calculation sheet

Material Costs:

Cost for initial 454 grams of pasta:$177,500,000
Cost for additional mass: $400,000 per gram
Pasta used for roadbed: Additional cost of $7,500 per square inch
String: $1,200 per centimeter

Refunds:

$440 will be refunded for every gram under the initial mass of 454 grams.

Yearly data:

20 million vehicles will cross the bridge each year.
Maximum toll charge: $2.00
Annual cost to maintain the bridge is estimated at $1.6 million.

Sample Calculations for Cost of Bridge:

Initial pasta cost =	$177,500,000
Additional construction cost	
((Total mass - 454 grams) x $440,000)	
((750 grams - 454 grams) x $440,000) =	$130,240,000
Additional cost for roadbed	
Area of roadbed x $95,000	
(30” x 6”) x $95,000 =	$17,100,000
String	
Centimeters of string used x $12,000	
(1375 centimeters) x $12,000 =	$16,500,000
Refunds	
((454 grams – total mass) x $440) only if total mass is less than 454 grams	
((454 grams - ___N/A___ grams) x $440) =	$0
Total Cost of Bridge =	**$341,340,000**

Sample Calculations for Determining the Time Needed to Pay for Bridge

Total Cost + (Time Needed x Yearly Maintenance Fee) – (Number of Cars per Year x Maximum Toll x Time Needed) = 0

$180,990,240 + (Time Needed)($1,600,000) - (20,000,000)($2.00)(Time Needed) = 0

Solve for Time Needed = **Approximately 8.89 years**