Design Project #1

Replacement of Vehicle Bridge over Spring Creek

Centre County, PA

Introduction to Engineering Design

EDGSN 100 Section002

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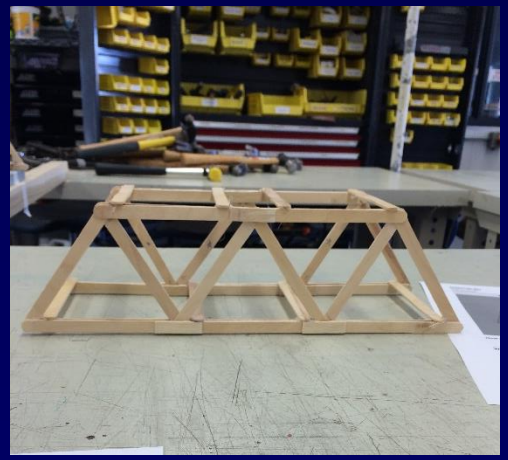

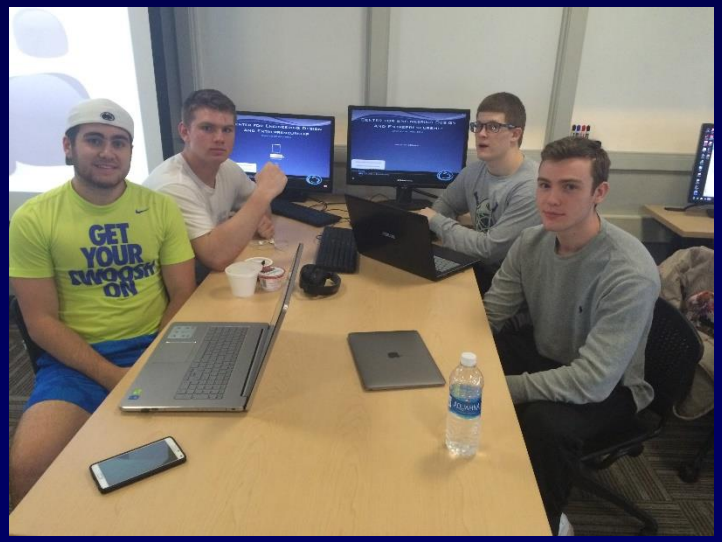

Presented to:

Prof. Berezniak

Spring 2016

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Statement of Problem

A bridge that provides access to Mount Nittany Medical Center has collapsed causing many inconveniences and risks to citizens.

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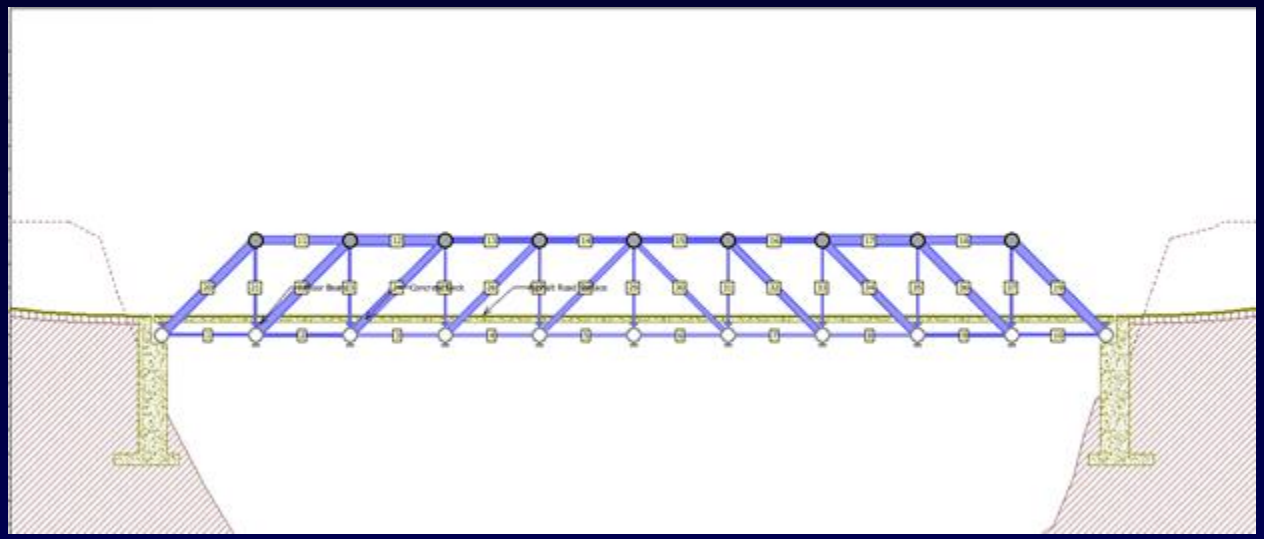
Objective



Pennsylvania Department of Transportation of (PennDOT) Engineering District 2-0 has initiated an emergency project to accelerate the design of a new vehicle bridge over Spring Creek to replace the bridge destroyed by the recent extreme flood event.

Design Criteria

- standard abutments
- no piers (one span)
- deck material shall be medium strength concrete (0.23 meters thick)
- no cable anchorages and designed for the load of two AASHTO H20-44 trucks (225kN) with one in each traffic lane.
- The bridge deck elevation shall be set at 20 meters and the deck span shall be exactly 40 meters. Both a Warren through truss bridge and a Howe through truss bridge shall be analyzed.

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Technical Approach Phase 1: Economic Efficiency

Howe Bridge

Final Price: $240,332.22

Type of Cost	Item	Cost Calculation	Cost
Material Cost (M)	Carbon Steel Solid Bar	(5643.4 kg) x ($4.30 per kg) x (2 Trusses) =	$48,532.94
	Carbon Steel Hollow Tube	(4637.4 kg) x ($6.30 per kg) x (2 Trusses) =	$58,431.84
	Quenched & Tempered Steel Solid Bar	(1830.6 kg) x ($6.00 per kg) x (2 Trusses) =	$21,967.44
Connection Cost (C)		(20 Joints) x (400.0 per joint) x (2 Trusses) =	$16,000.00
Product Cost (P)	1 - 50x50 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	2 - 55x55 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	2 - 65x65 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	1 - 70x70 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	1 - 75x75 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	4 - 80x80 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	2 - 90x90 mm Quenched & Tempered Steel Bar	($1,000.00 per Product) =	$1,000.00
	3 - 100x100 mm Quenched & Tempered Steel Bar	($1,000.00 per Product) =	$1,000.00
	2 - 110x110 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	1 - 110x110 mm Quenched & Tempered Steel Bar	($1,000.00 per Product) =	$1,000.00
	1 - 140x140x7 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
	1 - 150x150x7 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
	4 - 160x160 mm Carbon Steel Bar	($1,000.00 per Product) =	$1,000.00
	2 - 180x180x9 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
	4 - 200x200x10 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
	2 - 220x220x11 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
	2 - 240x240x12 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
	2 - 260x260x13 mm Carbon Steel Tube	($1,000.00 per Product) =	$1,000.00
Site Cost (S)	Deck Cost	(10 4-meter panels) x ($4,700.00 per panel) =	$47,000.00
	Excavation Cost	(19,400 cubic meters) x ($1.00 per cubic meter) =	$19,400.00
	Abutment Cost	(2 standard abutments) x ($5,500.00 per abutment) =	$11,000.00
	Pier Cost	No pier =	$0.00
	Cable Anchorage Cost	No anchorages =	$0.00
Total Cost	**M + C + P + S**	**$128,932.22 + $16,000.00 + $18,000.00 + $77,400.00 =**	**$240,332.22**

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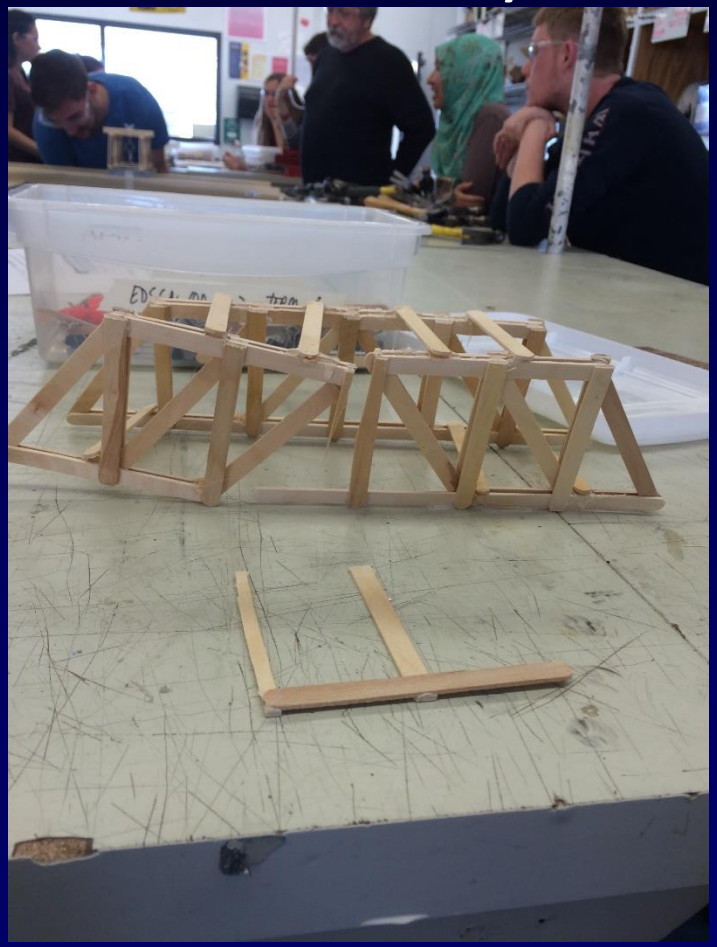
Technical Approach Phase 2: Structural Efficiency

Howe Bridge

Bridge Weight: 80.8 g

Load at Failure: 66.7lbs

Structural Efficiency:375



Results Phase 1: Economic Efficiency

Warren Bridge

Final Price: $ 249,468.24

Table 4:

Type of Cost	Item	Cost Calculation	Cost
Material Cost (M)	High-Strength Low-Alloy Steel Solid Bar	(16542.8 kg) x ($4.30/kg) x (2 Trusses)=	$142,268.24
Connection Cost (C)		oints) x (400.0/joint) x (2 Trusses)=	$16,800.00
Product Cost (P)	- 55x55 mm Carbon Steel Bar - 60x60 mm Carbon Steel Bar – 65x65 mm Carbon Steel Bar – 70x70 mm Carbon Steel Bar – 75x75 mm Carbon Steel Bar – 90x90 mm Carbon Steel Bar – 100x100 mm Carbon Steel Bar – 110x110 mm Carbon Steel Bar – 120x120 mm Carbon Steel Bar – 130x130 mm Carbon Steel Bar – 140x140 mm Carbon Steel Bar – 160x160 mm Carbon Steel Bar – 170x170 mm Carbon Steel Bar	(%s per product)=	$1,000.00
Site Cost (S)	Deck Cost	(10 4-meter panels) x ($4,700.00/panel)=	$47,000.00
	Excavation Cost	(19,400 cubic meters) x ($1.00 per cubic meter)=	$19,400.00
	Abutment Cost	(2 Standard abutments) x ($5,500.00/ abutment)=	$11,000.00
	Pier Cost	No pier=	$0.00
	Cable Anchorage Cost	No Anchorages=	$0.00
Total Cost	**M+C+P+S**	**$142,268.24 + $16,800.00 + $13,000.00 +$77,400.00=**	**$249,468.24**

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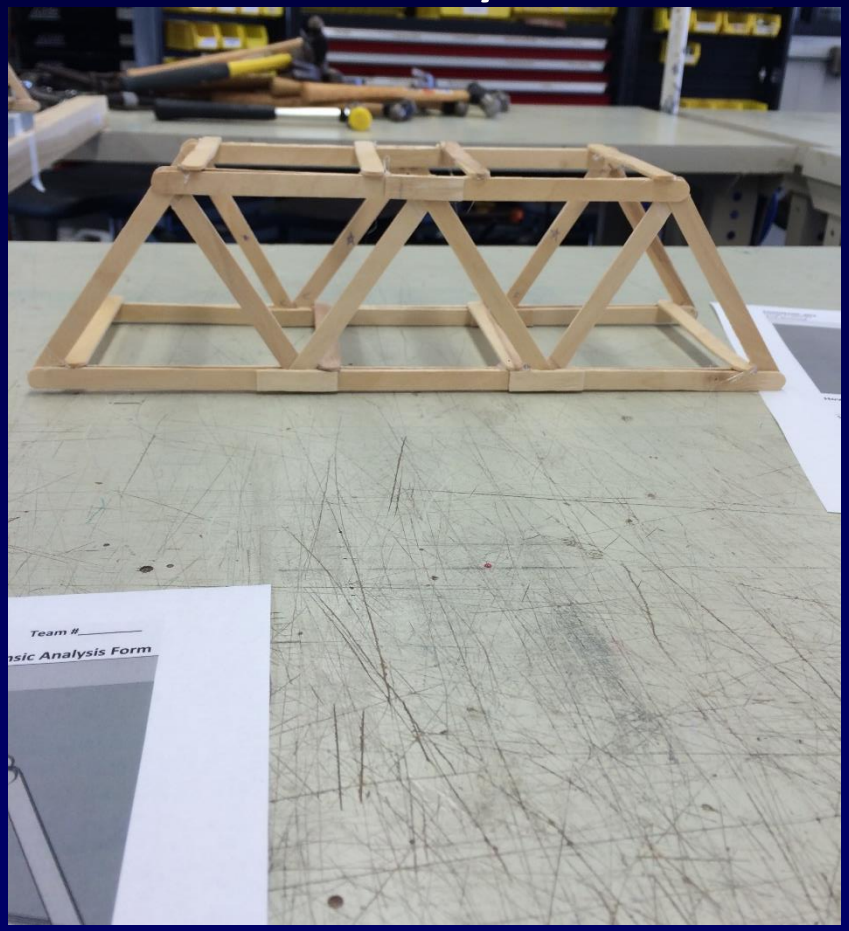
Results Phase 2: Structural Efficiency

Warren Bridge

Bridge Weight: 57.6 g

Load at Failure: 54.1 lbs

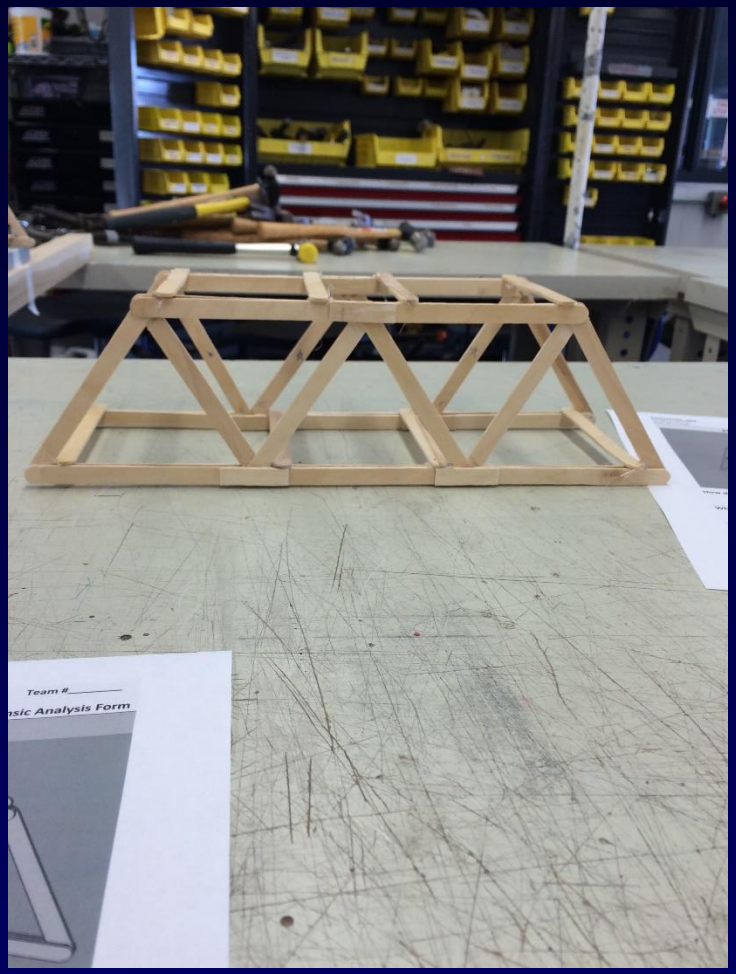
Structural Efficiency: 427



Best Solution

When comparing the two types of bridges, the Howe truss bridge has a greater economic efficiency. The overall cost of the Howe bridge is $240,332.22. The price of the Warren truss bridge is approximately $9,000.00 more expensive than the Howe truss bridge with a total cost of $249,468.24.

Warren has greater structural efficiency—427 vs 375



Conclusions

Conclusions and Recommendations. The design team has come to the conclusion that the Warren truss bridge should be the bridge to replace the fallen bridge in Centre County, PA. Despite the greater cost, it is worth the greater structural efficiency.