FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF STRUCTURAL ENGINEERING
RESEARCH GROUP SCHOONMEERSEN

FULL DESCRIPTION OF THE PROJECT

3D PRINTED BRIDGE DESIGN CONTEST 2017

Engineering Project (E701028)

Offered in the following programmes in 2016-2017 – Bachelor of Science in Civil Engineering Technology / Bachelor of Science in Chemical Engineering Technology / Bachelor of Science in Electronics and ICT Engineering Technology / Bachelor of Science in Electromechanical Engineering Technology / Joint Section Bachelor of Science in Engineering Technology / Bachelor of Science in Information Engineering Technology

Teaching languages – Dutch

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Course Specifications

Problem Statement

The main goal of this project is to design and build a prototype bridge. There will be 10 teams of 5 students. The design of the bridge will be tested virtually and then printed on an Ultimaker 3D printer. The categories of this year's competition are structural efficiency and cost. The construction should resemble a real-life bridge with an accessible single lane deck. Due to manufacturing constraints, the construction will include multiple segments. Each one of these segments has to fit within a virtual cube sized 20x20x20 cm and is to be printed in PLA. No other materials can be used for the assembly of the different parts and no other reinforcements of the bridge are allowed. Finally, the bridge must be self-supporting and the use of any glued parts is prohibited.

3D Printed Bridge Prototypes [1]

Technical Requirements and Specifications:

The purpose of this competition is to achieve the highest structural efficiency. This means the structural load capacity has to be as high as possible (this is measured by an experimental test on a professional 3-point-bending test machine), while keeping the mass of the bridge to a minimum. Of course, certain design requirements, limitation and constraints have to be taken into account:

1. The bridge must fit within the design domain (440x200 mm) and has to span a distance of 400 mm, from the center of the first pier (support pin) to the center of the next pier.
2. The loading plates will be 50x50 mm in size and will be placed on top of the deck of the bridge.
3. The complete bridge construction must weigh no more than 400 grams.
4. The width of the bridge has a maximum dimension of 90 mm.
5. A car (in cross-section 50x50 mm) must be able to cross the bridge from one side to the other with uninterrupted movement.

Tournament Scoring

As mentioned before the purpose of this student competition is to achieve the highest possible structural efficiency. The teams will physically test their bridge on a 3-point-bending test machine and its structural efficiency will be calculated. This efficiency is computed by dividing the total load by the mass of the bridge. Every team will receive a scoring base on the efficiency of the first ranked bridge construction.

$$\text{Efficiency} = \frac{\text{Total load}}{\text{Mass}} \qquad \text{Scoring} = \frac{\text{Team's efficiency}}{\text{First place efficiency}} \times 20$$

Report

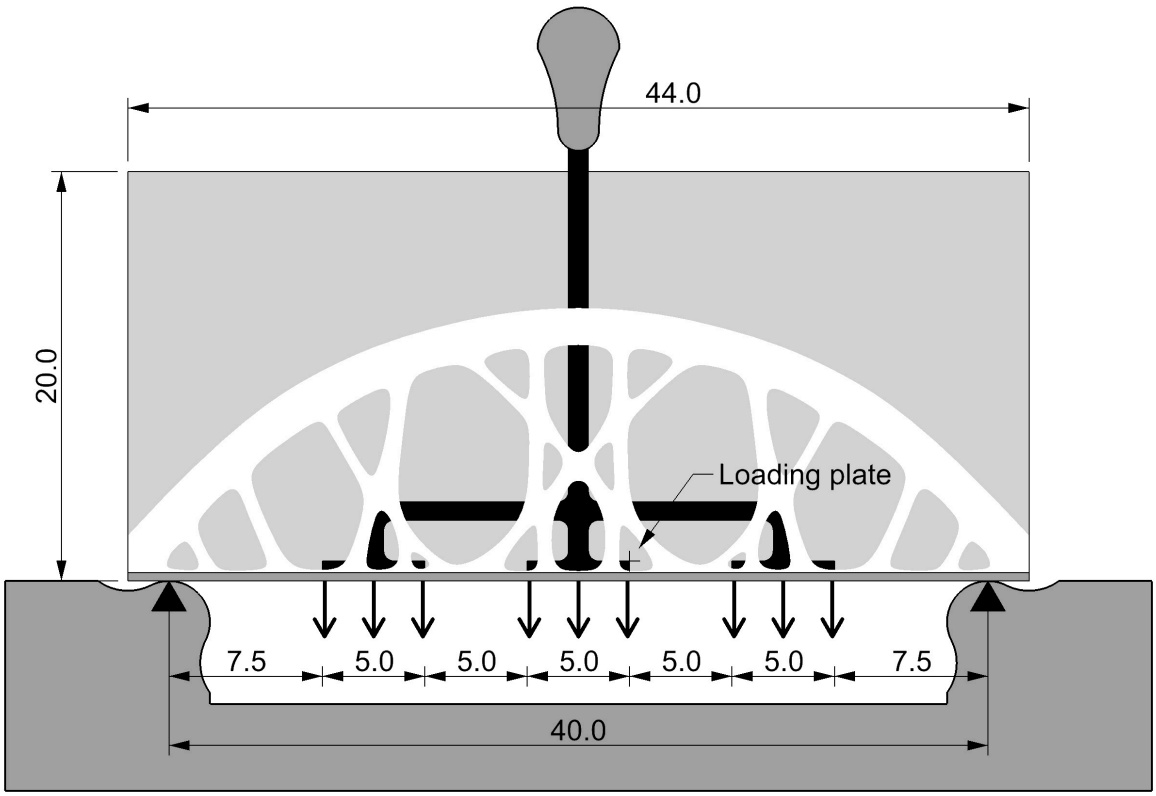
Each team must also submit a *Design document* outlining the key aspects of their project. This document will contain three main sections: Research, Design, and Physical testing and conclusion.

1 Research
In this section, the teams will use the internet and other sources to search for information about different bridge structures and formulate answers to a number of important design decisions. It gives an answer to questions such as: What makes a good bridge? What are the benefits/limitations of different bridge structures? What roles do compression and tension play in a bridge structure? [2]

2 Design
This section of the document will include drawings and specific information about the final bridge construction. This includes dimensions and arrangement of the segments, and includes drawings or sketches of the different design stages. This part will also explain how the final design originated and what modifications were made to improve the structural efficiency of the structure.

3 Physical testing and conclusion
The final section will describe what kind of failure occurred during the final testing of the bridge and will offer an appropriate interpretation. One or more pictures of the broken bridge should be included and a suggestion for some future changes must be given in order to increase the strength and prevent repeated failure.

Design domain



- Light gray area: Design domain
- Dark gray area: Base of the testing machine
- Black triangles: Support pins
- Black rod: Loading pin + plates
- White structure: Example bridge design

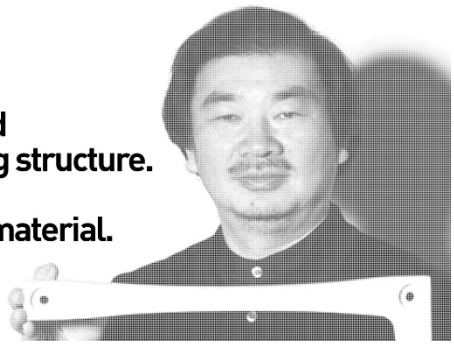
References:

[1] M. Traczyk, "First Design Contest for 3D Printed Bridge Prototypes", ZMorph Blog - articles, case studies and news on 3D printing, 2016. [Online]. Available: http://blog.zmorph3d.com/3d-printed-bridge-prototypes/. [Accessed: 20- Dec- 2016].

[2] "How 3D Printing Will Change Your Engineering Degree | StudyLink", 2016. [Online]. Available: http://studylink.com/blog/3d-printing-will-change-engineering-degree/. [Accessed: 20- Dec- 2016].

I believe that the material doesn't need
to be strong to be used to build a strong structure.
The strength of the structure
has nothing to do with strength of the material.

Shigeru Ban



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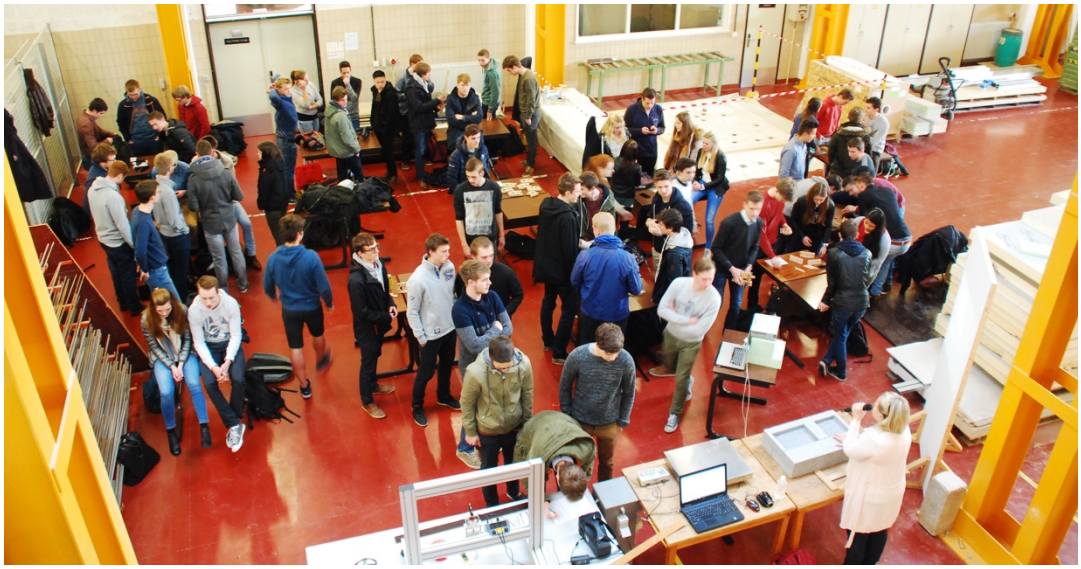
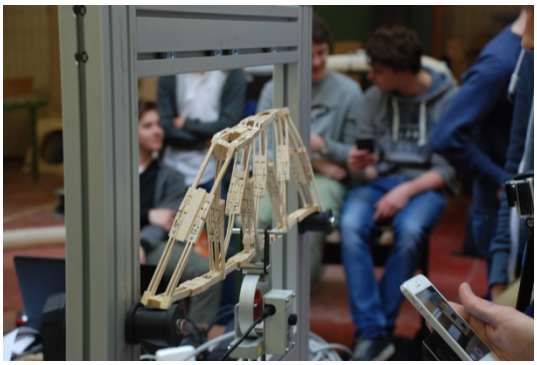
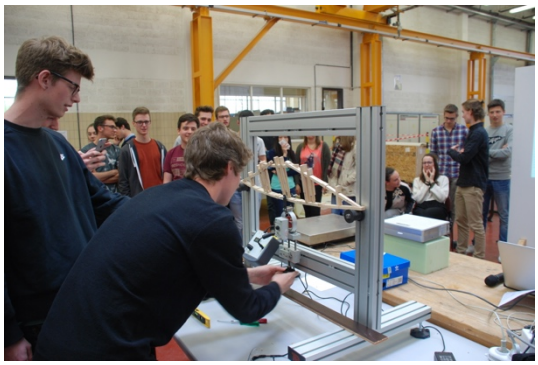
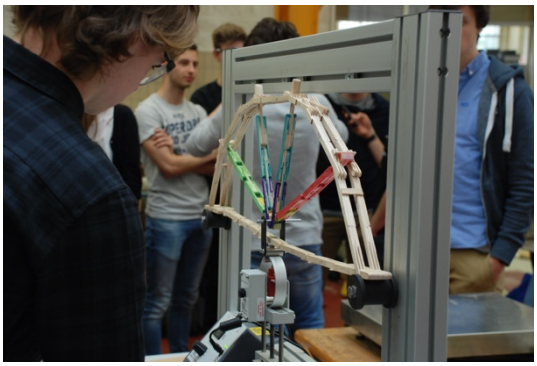
ADDITIONAL DOCUMENTATION

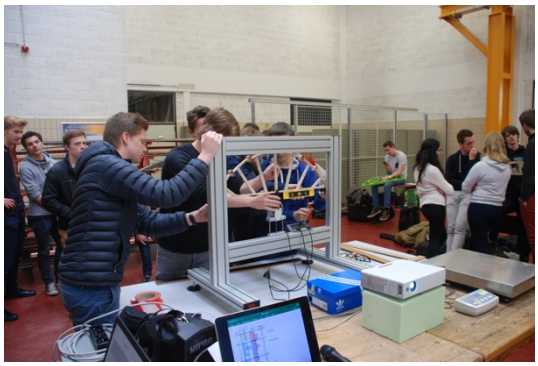
Bridge Design Contest 2016











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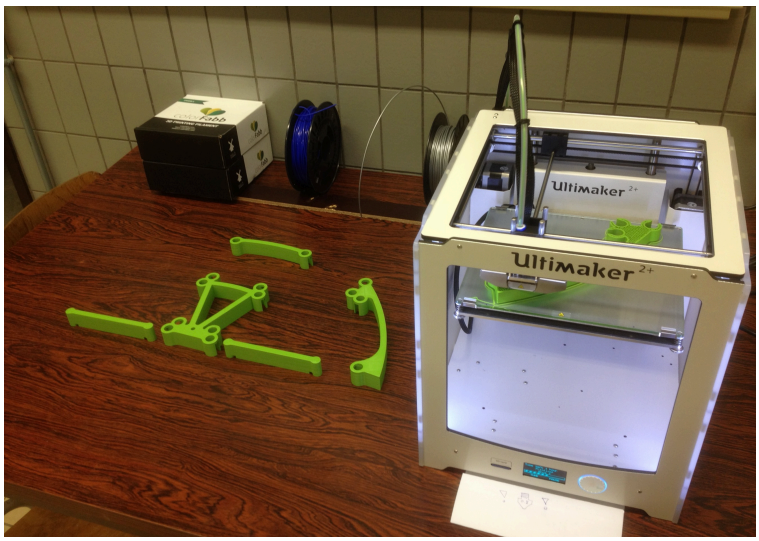
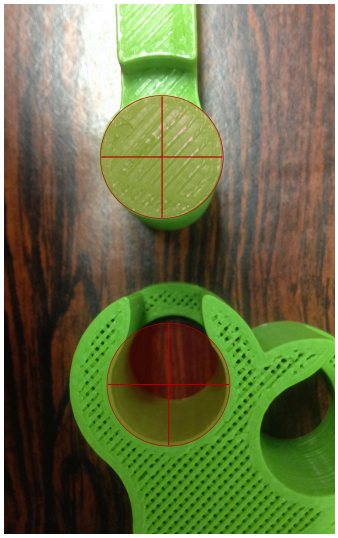
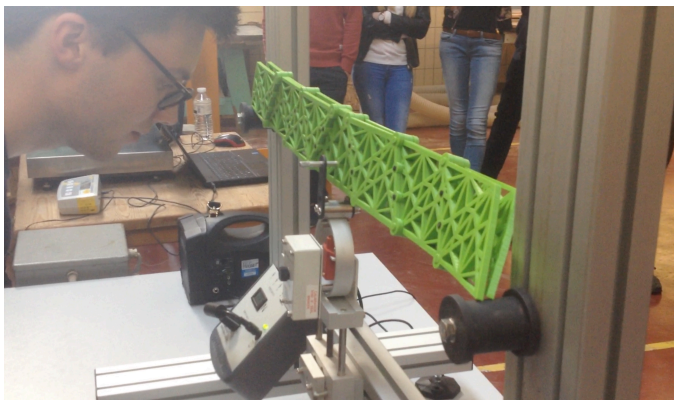
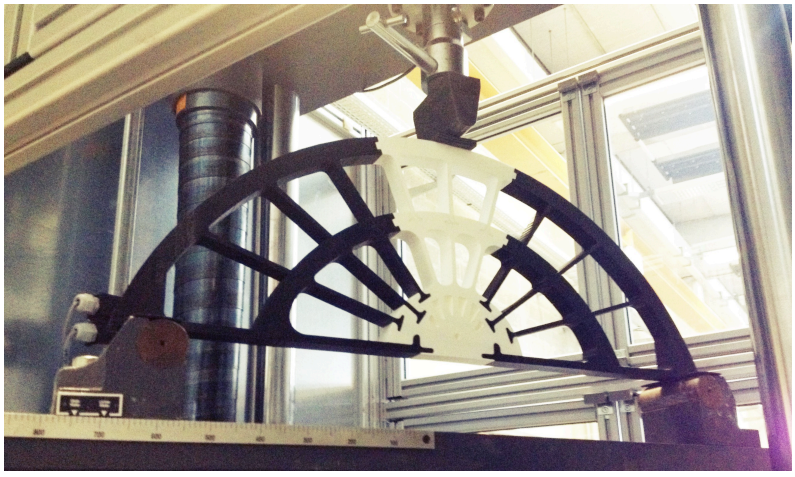
Bridge Design Contest 2016 – 3D Printing Test Phase









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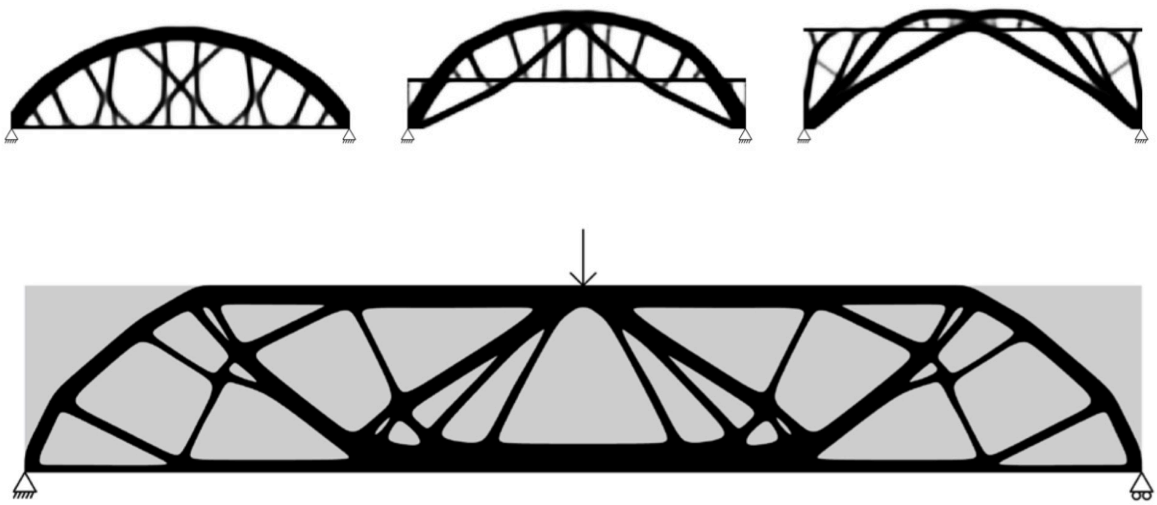
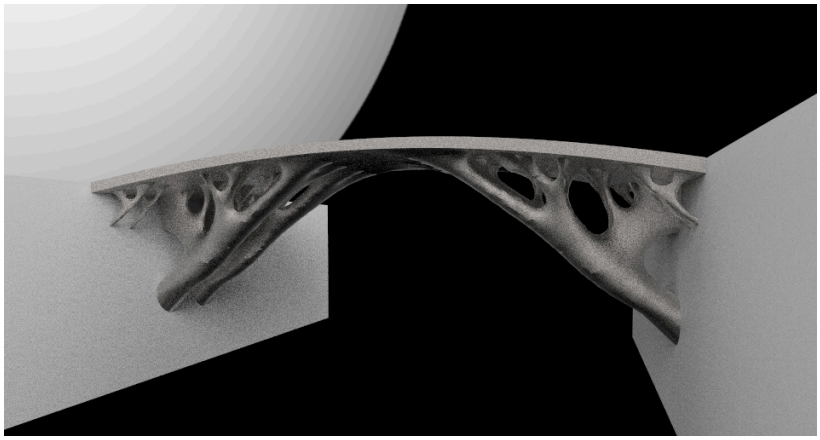
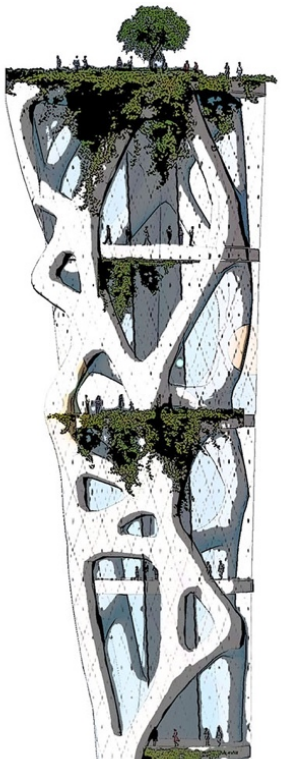
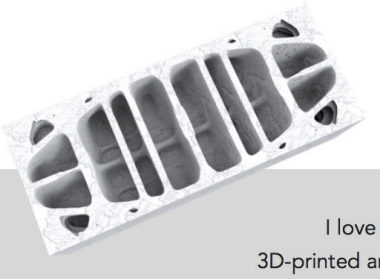
Topology Optimization – Bridge Design









I love architecture, design,
3D-printed and high-tech gadgets – The
impossible futurist – Science-lover

Additional information can be found at my personal website:
gieljan.wix.com/gieljanvantyghem