

CHAPTER

1 

Building the Da Vinci's Self Supporting Bridge

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Abstract: The building of the Da Vinci's self supporting bridge reply was a design handled by a team of students of the fourth semester of the Civil Engineering Course at Pontificia Universidade Católica de São Paulo in combination with the Mechanics of Rigid Bodies course, given in a traditional manner, using the Project Based Learning (PjBL) approach. The project was part of the assessment process in such course. Leonardo Da Vinci was a master of innovation and Engineering. The history notes that he designed four types of bridges. The design of the self supporting bridge was the most simple and ingenious of them. Its design was developed from 1485 to 1487 attending the request of his patron Cesar Borgia, and it was to be of simple assembly by troops without woodworking skills. The design is held together by its own

weight without requiring any ties or connections. When a downward force is applied to the structure the braced members are forced to interlock and tighten together through the structural concepts of shear and bending. This work was carried out in three steps. The first one was a bibliographic research on the issue. In the second step the students set up a prototype of the bridge where test and analysis were made to understand the structures behavior as result of a downward applied force, and presented it to the classmates. In the third and final step the students set up a bridge in real size and shown that it permitted and tolerated the weight of several people passing along the bridge. Each step of the work was recorded in a video, available in youtube, where the students report their opinions on the project and the main concepts, skills and competences acquired along the development of the project.

Keywords: Downward Force, Engineering Design, Project Based Learning, Self Supporting Bridge, Teamwork.

1.1 Background

According to Mills & Treagust (2003)¹, the modern Engineering profession requires skills in human relations as well as technical competence. The Project Based Learning (PBL) is a new approach that several schools of are

implementing around the world. Despite these implementations are growing, they present a lot of challenges and the predominant model of Engineering Education remains like to that put into practice in 1950's. The application of learning systems based on activities that are against theoretical perspectives and practical has been important tools in academic studies last years, used in main Brazilian Universities, Santos et al. (2012)². To adequate to these tendencies the professor of the course Mechanics of Rigid Bodies (MCR) at Pontifical Catholic University of Sao Paulo in the Civil Engineering course proposed the development of a project to put in practice theoretical concepts learned in the classroom. The theme of the project was: "Building of Da Vinci's Self Supporting Bridge". The choice of this theme was because the design of this bridge, developed by Da Vinci from 1485 to 1487, (Bernaroni, Taddei, Zanon)³, was the most simple and ingenious of the four bridge types that Da Vinci designed. Its design was developed to attend the request of his patron Cesar Borgia and it was to be of simple assembly by troops without woodworking skills. The design is held together by its own weight without requiring any ties or connections. When a downward force is applied to the structure the braced members are forced to interlock and tighten together through the structural concepts of shear and bending.

1.2 Purpose

The main objective of this paper was to understand the concepts related to the MCR course carrying out a full study of the Physics aspect and concepts used in the bridges building. In order to carry out this work a bibliographic research on the issue was done and a prototype was built.

1.3 Method

The academic world is changing in its learning concept and new methodologies and approaches are being used to prepare the students for a future where we don't know what must be taught, Campos et al., (2011)⁴. The Project Based Learning (PBL) is an approach that put the student face to a real world developing competences, skills, teamwork and critical thinking. According to Powell & Weenk (2003)⁵ PBL gives to students the opportunity to face a real problem whose solution needs theoretical concepts but the application must be discussed in a teamwork where each member must give a contribution to solve it. In this work PBL methodology was used. The development of this work was made in three steps. The first one was a bibliographic research that give to the students the knowledge of the project under scientific and cultural-history visions. In the second step the students set up a prototype of the bridge where test and analysis were made to understand the structures behavior as result

of a downward applied force. In the third and final step the students set up a bridge in real size and show that it permitted and tolerated the weight of several people passing along the bridge. The choice of the appropriated wood with its special characteristic such as shape (cylindrical), size (1,20 m) and type (eucalyptus) was made using biomimetism concepts.

1.4 Results

The building of the Da Vinci Self Supporting Bridge is very simple and the materials used are cylindrical wood pieces where are made sockets in the extremists of some pieces. Some pieces haven't sockets and they are used only to fit the structure in that with sockets. The simplicity of the bridge is in the fact that there is no nail, screw or stick to maintain the structure stick up. All the steps of our self-supporting bridge building are shown in⁶.

1.5 Conclusions

The building of Da Vinci's Self Supporting Bridge gave to the teamwork a critical and analytical thinking development to apply knowledge to solve a real project. The most important result of this work was the opportunity to work in teamwork facing a real problem where the contribution of each member was fundamental to the project success. In conclusion, the challenges of this

project put the students in contact with a type of problem that they will face as a professional in the civil Engineering area.

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