



## **Introducing Freshmen Engineering Students to Civil Engineering at the University of Florida**

### **Ms. Zhang Lei, University of Florida**

Ms Lei Zhang is the graduate students at University of Florida (UF). She earned her BSCE in 2010 from the Tongji University, in her place of birth, Shanghai, China. After that, she came to the United States and is doing her Master degree in civil engineering. She was the instructor for the STEP-UP program for the College of Engineering at UF and was awarded the most outstanding instructor. She is the teaching assistant for the Introduction to Engineering, Public Works Planning. Lei is also active in professional societies and demonstrates her leadership. She is the member of American Society of Civil Engineering (ASCE), Institute of Transportation Engineers (ITE). She is also the Fundraising Chairman of Women Transportation Seminar (WTS) Student Chapter at UF.

### **Dr. Fazil T. Najafi, University of Florida**

For more than forty years, Dr. Fazil T. Najafi has worked in government, industry and education. He earned a B.S.C.E. in 1963 from the American College of Engineering, in his place of birth, Kabul, Afghanistan, and since then came to the United States with a Fulbright scholarship earning his MS in civil engineering in 1972 and a Ph.D. degree in transportation in 1977. His experience in industry includes work as a highway, structural, mechanical, and consultant engineer and construction manager for government groups and private companies. Najafi went on to teaching, first becoming an assistant professor at Villanova University, Pennsylvania in 1977, a visiting professor at George Mason University, and then to the University of Florida, Department of Civil Engineering, where he advanced to associate professor in 1991 and then full professor in 2000 in the Department of Civil and Coastal Engineering. He has received numerous awards including a scholarship award (Fulbright), teaching awards, best paper awards, community service awards, and admission as an Eminent Engineer into Tau Beta Pi. His research on passive radon-resistant new residential building construction was adapted in HB1647 building code of Florida Legislature. Najafi is a member of numerous professional societies and has served on many committees and programs, and continuously attends and presents refereed papers at international, national, and local professional meetings and conferences. Lastly, Najafi attends courses, seminars and workshops, and has developed courses, videos and software packages during his career. His areas of specialization include transportation planning and management, legal aspects, construction contract administration, and public works.

## Civil Engineering Introduction to Freshman Engineers

**Abstract** – Civil engineering is a professional engineering discipline that deals with the design, construction and maintenance of the physical and naturally built environment, including works such as bridges, roads, canals, dams and buildings.

An Introduction to Engineering (EGN 1002) is a one credit course offered to all engineering freshmen by the college of engineering at the University of Florida. This course introduces students to the eleven departments that offer undergraduate degrees. The class breaks students into groups of 20 and rotates the groups weekly through each department. During the department visit, the students participate in two-or three hour hands-on experimental laboratory classes. The truss bridge laboratory is a part of this one credit hour course offered to the freshmen engineering students by the Civil and Coastal Engineering department. The purpose of the laboratory is to familiarize students with the concept, theory and practical side of the civil engineering and is focused on aiding students in the process of making an informed decision for their futures. This paper is focused on procedure of the laboratory as well as how the resulted data can be utilized in real-life projects. After each team of 4-5 students build their truss, the truss is loaded until it fails. Record of the failure load, score, and final score were kept and the winner team got a prize of Gator pens. The type and the shape of the trusses, location of the failures are kept in a data base for analysis. The results showed that Warren truss types are stronger and most cost effective. Students enjoyed interacting with their team members in building their bridges and learned about civil engineering.

Many international engineering curriculums do not have such a course to provide students at freshmen level gaining early knowledge for deciding what branches of engineering to take for their future career. The EGN 1002 provides engineering freshmen with knowledge of various engineering disciplines in advanced to help them decide their future study. This course also provide multidisciplinary knowledge at early stage of engineering education that should have an international engineering educational values.

**Key words:** Civil Engineering, Education, freshman, Introduction to Engineering

## **Introduction**

Introduction to Engineering ( EGN 1002) is a one-credit hour course aims to expose engineering freshman to eleven departments within the College of Engineering at the University of Florida (UF). These eleven departments include Aerospace, Agricultural and Biological, Chemical, Civil and Coastal, Computer, Electrical, Environmental, Industrial and Systems, Materials Science, Mechanical, Nuclear and Radiological. During each semester, students are required to take one credit hour of EGN 1002 and visit each department within the college of engineering and attend three hours of lecture and conduct experimental work offered by each department relevant to each department curriculum. The goal of EGN 1002 is to help students make decision and find their interests for selecting the major which fits their best interests. Moreover, it also provides multidisciplinary knowledge at early stage of engineering education that should have an international engineering educational values.

This paper is focused on the civil engineering aspects of the EGN1002, offered to engineering freshman students, a three-hour lecture on civil engineering curriculum and hands-on experiment of building a wooden bridge truss of various types with different configurations. The three hour course agenda include a formal welcome by professor and teacher's assistant (TA). Class begins with a power point presentation by a student representative of the American Society of Civil Engineering (ASCE) student chapter. The ASCE student representative presented the history of ASCE and their professional activities such as building a concrete canoe, a steel bridge and the various activities involved when the student's chapter attended their annual conference held at different states. The TA then presents civil engineering curriculum and a power point presentation of various divisions of civil engineering such as construction, structures, geotechnical, materials, transportation, water resources, public works and environment. The grading for this one credit hour course is based only on attendance. Students need to sign up on the roster at the beginning of the class.

## **Truss Bridge Laboratory**

After the first portion of brief introduction of civil engineering, students will have a brief tutorial on basic civil engineering concepts as they apply to build a wooden truss bridge. Freuler et al (2001) was convinced that incorporating hands-on laboratory experiences can get students involved, excited and motivate them in pursuing engineering as a career right from the beginning of their first semester.

Some basic concepts that are covered include, but are not limited to tension, compression, neutral axis, stress, strain, buckling, and deflected shapes. Some of the concepts can be vividly demonstrated by a foam board such as tension, compression, neutral axis while some of them can be shown by drawing such as stress–strain curve. First, the instructor

conveys the tasks of the hand-on project, which is to design and build truss bridge by given materials including short and long pop-sticks, bolts and nuts. Students were divided into a team of four or five. The team who has the highest failure load and cost ratio (failure load divided by cost) wins. Finally, the main failure modes are discussed in order to help students apply the concepts to design a strong as well as cost-effective bridge.

Thirty minutes is given for students to complete building their wooden truss bridge. The objective of the timing is to encourage them to work in teams efficiently and complete their assigned tasks on time. Besides the time constraints, materials are also limited. Full-size craft sticks should be no more than 27, shorten craft sticks should be less than 29, and a maximum of 20 #7 bolts and matching nuts are given to each team. Different types of materials have different cost; they should be taken into account when students fill in the cost estimate sheet quantifying the cost of the materials as \$0.75 for short craft sticks, \$1.00 for long craft sticks, and \$2.00 per bolt and nut combination. The students are set free to complete their work with the information, material, and time constraints. Figures 1, 2 and 3 represent different frames created by students including warren truss, Howe truss, and Pratt truss. Students are encouraged to be creative and build any types of truss bridge given the materials, and time constraints.

Truss bridges are placed into the Plexiglas which enables their bridge trusses to be loaded. This can be illustrated by Figure 1, Figure 2 and Figure 3. A bucket is attached to the truss bridge where the loads are added into the bucket slowly and gradually until the bridge collapse. Figure 4 presents a bridge created by students ready to be tested under loads.

Figure 5 demonstrates how students place load into the bucket. The loading process will not stop until the wooden truss bridges break and fail. Figure 6 and 7 present wooden truss bridge in the frame before and after loading. Figure 8 shows a typical truss bridge failure outside the frame.



Figure 1 Warren Truss Bridge

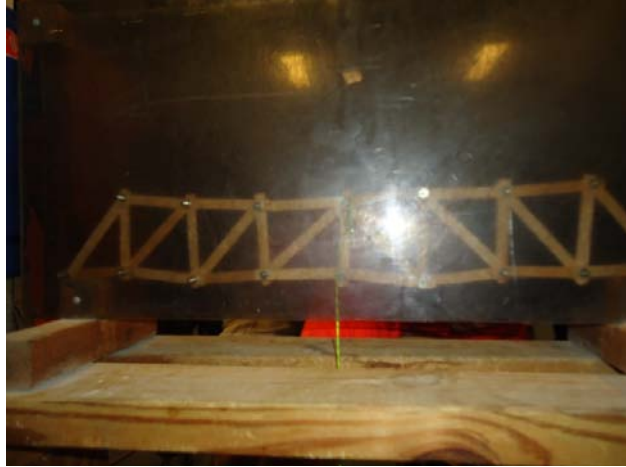


Figure 2 Howe Truss Bridge



Figure 3 Pratt Truss Bridge



Figure 4 Creative Truss Bridge



Figure 5 Loading of truss bridge

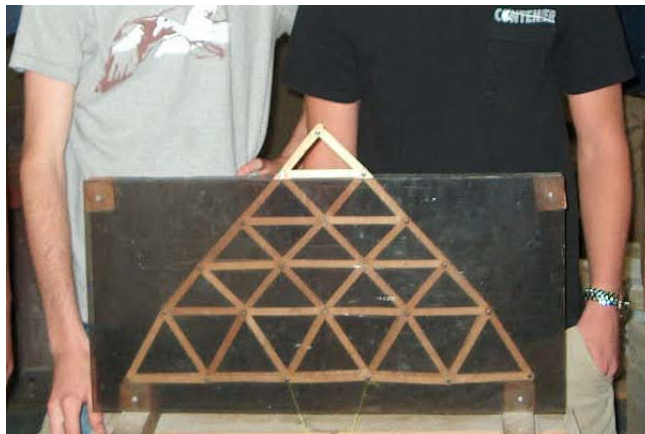


Figure 6 Before Loading



Figure 7 After Loading.



Figure 8 Typical Truss Bridge Failure

Scores for the wooden truss bridge can be calculated using equation 1,

$$\text{Score} = \frac{\text{Truss Bridge Failure Load}}{\text{Truss Bridge Cost}} \times 100\% \quad (1)$$

Engineer's job is to provide adequate services with the minimal cost. The score can help students understand negative effects between performance and costs.

Table 1 show scores collected from students during summer and fall semester of 2012. It can be seen in Table 1 that wooden truss bridge in warren frame built by students has the lowest cost and the second highest failure load. It can be noticed in the same table row 2, that the bridge designed by students' creation (Figure 4) had the highest cost; however, it is the strongest truss bridge. Thus creative type bridge ranks the second.

Table 1 Average Score from Wooden Truss Bridge

Rank	Type	Truss Bridge Cost (\$)	Truss Bridge Failure Load (lb.)	Score
1	WARREN	50.21	31.61	63.66
2	CREATIVE	55.77	33.36	59.65
3	PRATT	50.43	29.11	58.22
4	HOWE	51.75	28.21	55.23

### Laboratory Demonstrations

Following the wooden truss bridge project, two laboratories, hurricane simulation and concrete compression testing are also demonstrated to students. Both tests are designed to help students understand material strengths and how to determine the strength. Moreover, they also aim to arouse students' interests in civil engineering.

## Conclusion

The Department of Civil and Coastal Engineering curriculum is effective. The civil engineering aspects of the EGN1002, offered to freshman engineering students, a three-hours lecture on civil engineering curriculum and hand-on experiment of building a wooden truss bridge of various types with different configuration. Basic concepts and principles are discussed including tension, compression, neutral axis, stress, and strain. The objective of this class is to help students make decision and find their interests for selecting the major which fits their best interests. Student's evaluations of this class have been always very high. Both hand-on project and laboratory demonstrations stimulate students' interests in civil engineering. Even quite a few students have decided to switch their major to civil engineering.

Recently the Civil & Coastal Engineering program at UF was reviewed by the ABET team. After thoroughly review and evaluation of the entire academic program, the team was happy and gave the ABET approval for another six years, indicating the soundness of the academic program. Moreover, the enrollment at the Department of Civil and Coastal Engineering at UF is stable. However, according to 2011 US News and World report, the UF College of engineering ranking stands pretty good. (Table 2). It can be seen in Table 2, row 5 the 2011 overall ranking of the civil engineering is 31 and among all U.S. public schools, the ranking stands at 20. This is considered pretty good which reflects the soundness of the curriculum offered by the civil engineering department.

Table 2 UF Graduate Engineering Specialties Ranking

Specialty	2011 Edition (April 2010)			2010 Edition (April 2009)		
	Overall Rank	Public Rank	# of schools	Overall Rank	Public Rank	# of schools
Aerospace	19	13	55	21	13	
Agricultural	7	6	28	7	6	
Biomedical			94	47	25	
Chemical	23	15	125	22	14	
Civil Engineering	31	20	141	25	16	
Computer Eng.			NR	43	25	
Electrical	35	20	173	32	18	
Environmental	28	17	95	28	18	
Industrial	15	10	74	14	10	
Materials	8	5	92	10	7	
Mechanical	26	15	163	27	16	
Nuclear	9	8	27	8	7	

Source: U.S. News and World Report, America's Best Graduate Schools, Graduate Engineering specialties, ranked in 2012.

It is recommended that international engineering schools should consider the one credit hour EGN 1002 in their engineering curriculum and such course should be offered to



freshmen engineering students. Furthermore, this is only an example of a civil engineering, similar examples should be developed relevant to the curriculum of mechanical, electrical, agricultural and many other branches of engineering.

## **Reference**

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