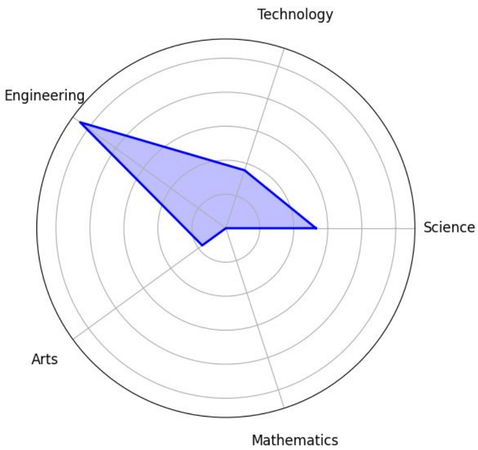
Curricular



INVISIBLE BRIDGES: ENGINEERING WITH A WOMAN'S NAME

Duration	Age	Difficulty
1 hr - 1hr 30min	15-16	Medium
#EXPERIMENTATION #ENGINEERING		

DESCRIPTION

In this activity, students will work in teams to design and build a bridge using simple, recyclable materials. First, they will research two key elements:

1. A real-world bridge structure of their choice.
2. A historical or contemporary **female engineer** whose contributions will inspire the name and symbolic design of their bridge.

Their construction will be tested with weights, and each team will present their design choices—both technical and symbolic—promoting visibility of women in STEAM and the value of collaboration.

ACTIVITY OBJECTIVES

- **Actively research real-world bridge structures and construction principles.**
- **Discover and recognize the contributions of female engineers.**
- **Apply basic engineering concepts through a functional prototype.**
- **Encourage gender equality in technical and leadership roles within the team.**
- **Develop collaboration, creativity, and communication skills.**
- **Justify design decisions using research and hands-on evidence.**
- **Students will be able to design a functional bridge by applying basic engineering principles and symbolizing the legacy of a distinguished female engineer.**

KEY COMPETENCES (EU)

- Numerical, scientific and engineering skills
- Digital and technology-based competences
- Interpersonal skills, and the ability to adopt new competences
- Entrepreneurship
- Cultural awareness and expression

Funded by the European Union

MATERIALS

- Provided by students
- Provided by the teacher/institution
- Downloadable Elements

Scissors

Ruler

Colored pencils / Crayons

Tape

Stopwatch

Paperclips, nuts, or small weights (for load testing)

Paper

Cardboard

Thread or Rope

Optional: Computer with internet connection

Skewer stick

Wood depressors

Glue

Load test record

Optional: program Bridge designer 2016

PREVIOUS PREPARATION

- Organize mixed-gender teams of 3–4 students.
- Ensure internet access and all materials are available in class.
- Optionally prepare links to bridge videos or historical background on female engineers.
- OPTIONAL (if you will do the digital extension): Install the program Bridge designer in the computers that are going to be used and also get familiar with the program, you may see this introductory tutorials: https://www.youtube.com/watch?v=9w9fTC4eh3w - "Bridge Designer 2016 Tutorial"

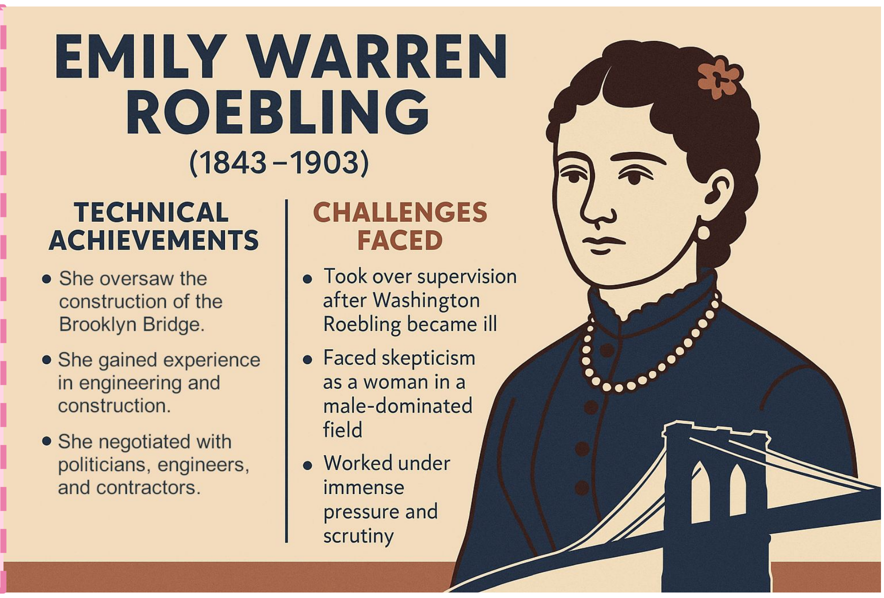
Funded by the European Union

CONTEXTUALIZATION AND ADAPTATION

The history of engineering is full of well-known names... most of them male. But many women have literally built the world we live in. Did you know that **Emily Warren Roebling** led the construction of the Brooklyn Bridge for more than a decade? Despite living in the 19th century, she learned structural calculus, physics, and construction management to take charge of the project when her husband fell ill. Just like Emily Roebling in the 19th century, many female engineers today lead infrastructure projects: for example, Roma Agrawal designed the foundations of The Shard skyscraper in London.

Watch video 📽️ - "The Forgotten Architect: How Emily Warren Roebling Saved the Brooklyn Bridge"
"The Forgotten Architect: How Emily Warren Roebling Saved the Brooklyn Bridge"

Note for the teacher 📝
Here we have an infographic about the challenges that Emily Warren Roebling had to face.



Classroom activity 💡

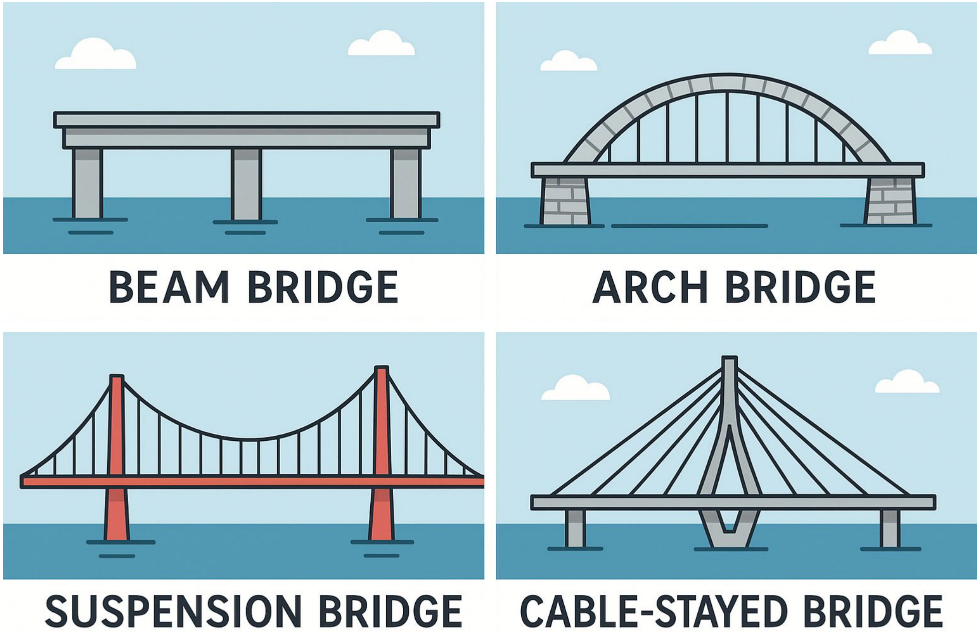
- **Research a type of bridge** (suspension, beam, arch, cable-stayed...) and take notes on how it works, what its benefits are, etc.
- **Research a female engineer** (past or present) in the field of civil, structural, or design engineering.
- Choose her as **inspiration** and **name your bridge** after her or based on a concept related to her legacy.

Guiding questions:

- What is unique about the bridge type you chose?
- What challenges did your chosen female engineer face?
- Why do you think her contributions are not more widely known?
- What type of bridge would best solve a problem in your local community?

Funded by the European Union

Note for the teacher 📝
Here we have several types of bridges, to show the students:



Note for the teacher 📝

Following, we present a few recommendations to have the activity run as smooth as possible and to encourage everyone to actively participate.

Ensure equitable participation
Make sure all team members actively participate in the research, design, and presentation phases. Especially encourage girls to take on technical or leadership roles, helping to break traditional stereotypes. Assign technical tasks on a rotating basis to ensure leadership equity between boys and girls.

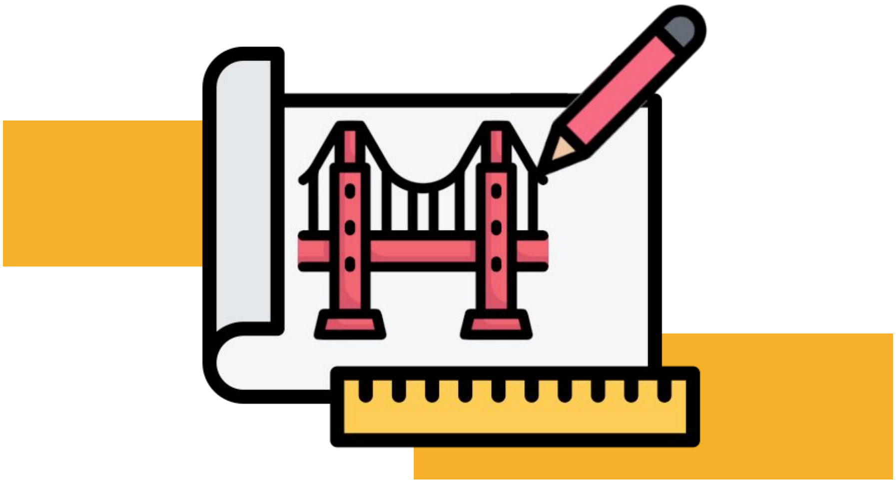
Time management
Clearly mark time phases for research, design, construction, and presentations. Give alerts when half the time has passed or 5 minutes remain to help teams pace themselves.

- RESEARCH (10 min)
- DESIGN & CONSTRUCTION (25 min)
- PRESENTATION & COMPARISON (10 min)

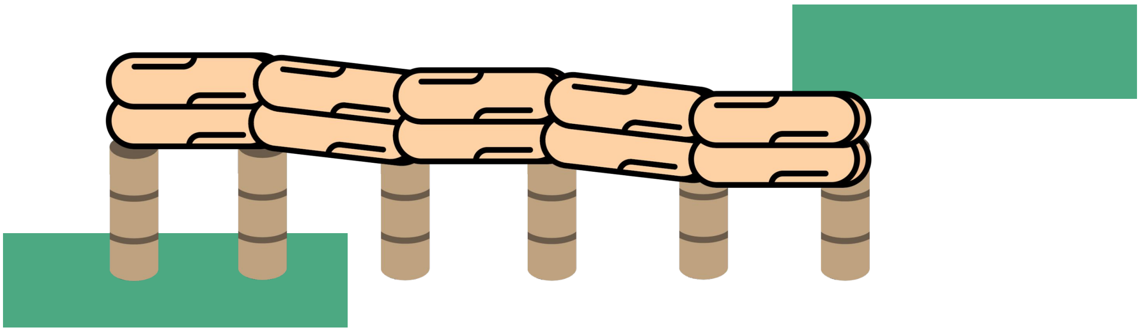
Funded by the European Union

ACTIVITY

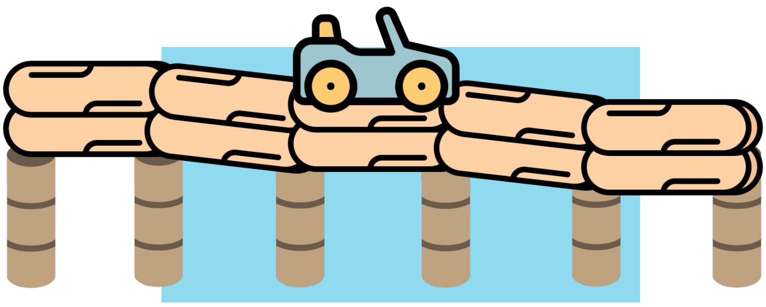
Step 1. Sketch: Design your bridge on paper, applying your selected structure type and considering material limitations. Include additional visual icons such as using colors, symbols, or patterns that represent a female engineer on the bridge.



Step 2. Build: Use the provided materials to construct a bridge at least 30 cm long. It must allow a small object to pass under or over it and hold some weight.



Step 3. Test: Place weights or paperclips gradually at the center to test load resistance.



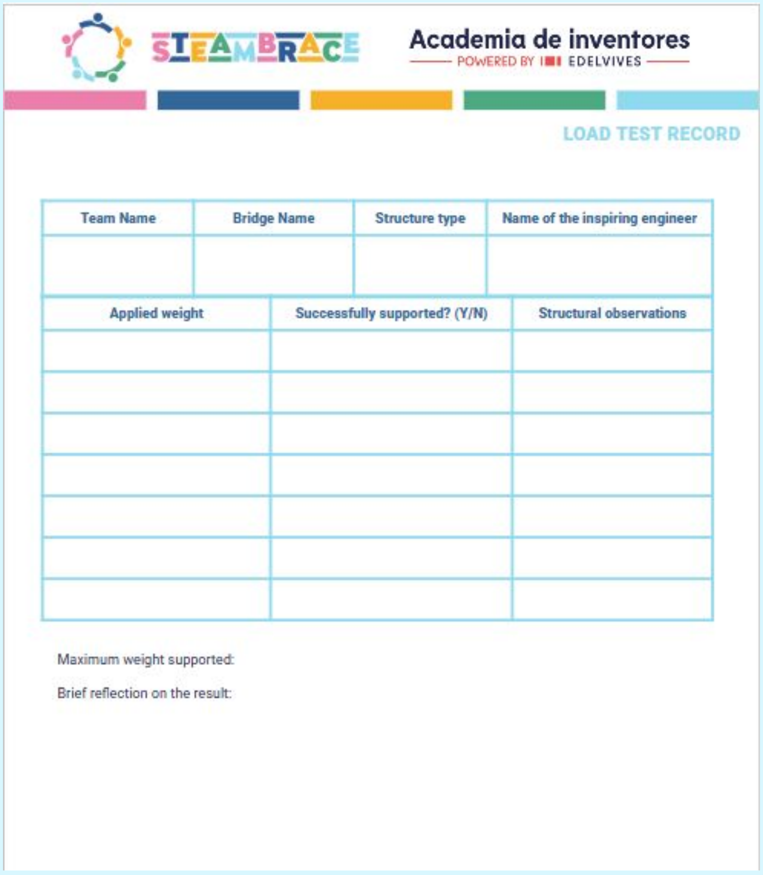
Now, improve your bridge based on what you learned from the load test. What would you change to make it more capable of supporting more weight? You may even try the activity with other materials, for example… could it be possible to make bridges out of spaghetti? Research about possible models like this.

Classroom activity 💡

Each team will present:

- The bridge's name and its inspirational figure.
- The type of structure chosen and the reason behind it.
- Test results (how much weight it held) and it's analysis.
- A reflection on how the design represents inclusion and visibility. Explain how your bridge reflects the engineer's cultural background (color, shape, symbols, or layout) or the social theme of your project.
- Create a poster with Canva to highlight the selected engineer's achievements and share it at an exhibition.
- Also teams can research a traditional bridge (e.g., Inca rope bridge) and compare it to their chosen structure. In order to reflect on what modern methods could learn from it.

A template is included in the material for each group to record and display, in a comparative table, the structural resistance data. Teams must record load data in the "load test record" and could create a bar graph showing resistance in kg.



Academia de inventores
POWERED BY EDELVIVES

LOAD TEST RECORD

Team Name	Bridge Name	Structure type	Name of the inspiring engineer

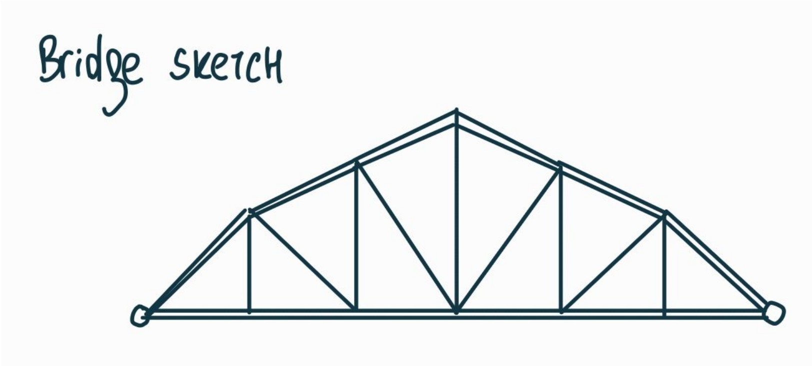
Applied weight	Successfully supported? (Y/N)	Structural observations

Maximum weight supported:

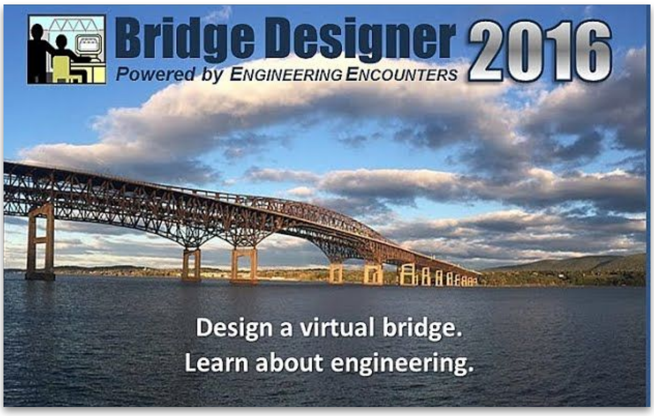
Brief reflection on the result:

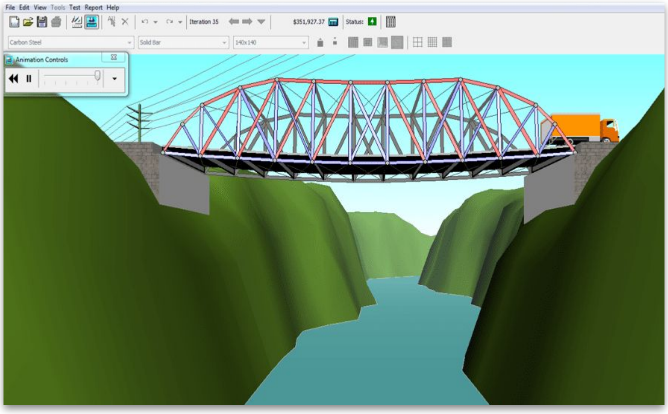
ACTIVITY - OPTIONAL DIGITAL EXTENSION

Step 1. Sketch: Design your bridge on paper, applying your selected structure type and considering material limitations. Include additional visual icons such as using colors, symbols, or patterns that represent a female engineer on the bridge.



Now, we will recreate this bridge model in the program Bridge Designer 2016:





This app will allow us not only to recreate our model digitally but also to test it out with different real weight such as transport, how does it work with different materials and also, how much it costs!

💻 What students can do with the app

1. **Digitally recreate their bridge** using the truss templates and tools inside the program.
2. Experiment with **different materials** (steel, bars, cables), modifying the type of joints and member dimensions.
3. Simulate the behavior of the bridge under **moving or fixed loads** and analyze which elements fail or succeed.
4. **Calculate costs and material efficiency**: How much does the bridge cost? Could it be cheaper and stronger?
5. Compare outcomes to their **physical model** and discuss which design choices were most effective.
6. Save screenshots or data and include it in their presentation or final reflection (e.g., a poster created in Canva).
7. Use the app to test your bridge virtually and compare weight tolerance and cost with your physical design.

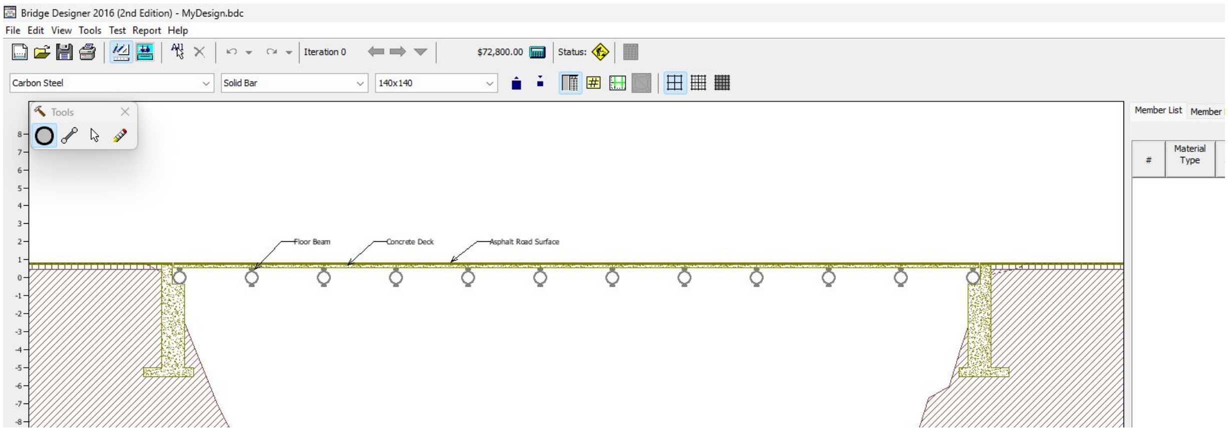
You may see first this tutorial on how to use this app:

https://www.youtube.com/watch?v=9w9fTC4eh3w

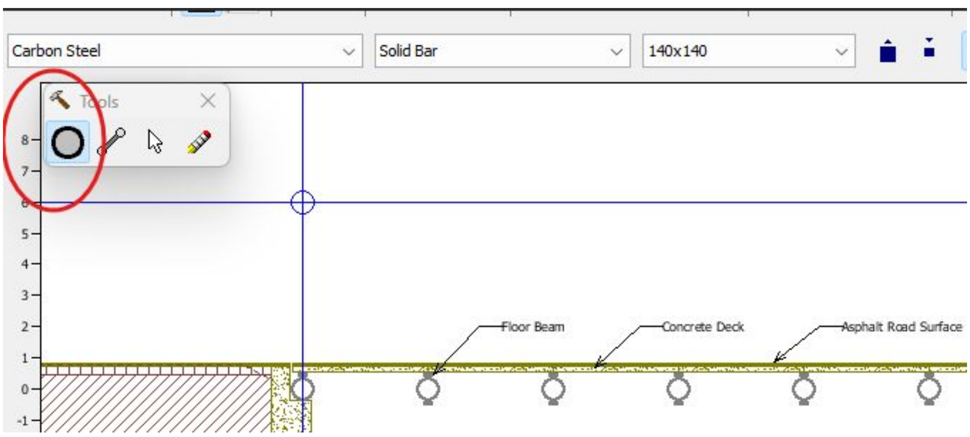
You will notice that the app is built around three key components:

- The ability to place beams made of different materials,
- The cost calculation of the design, and
- The bridge model itself.

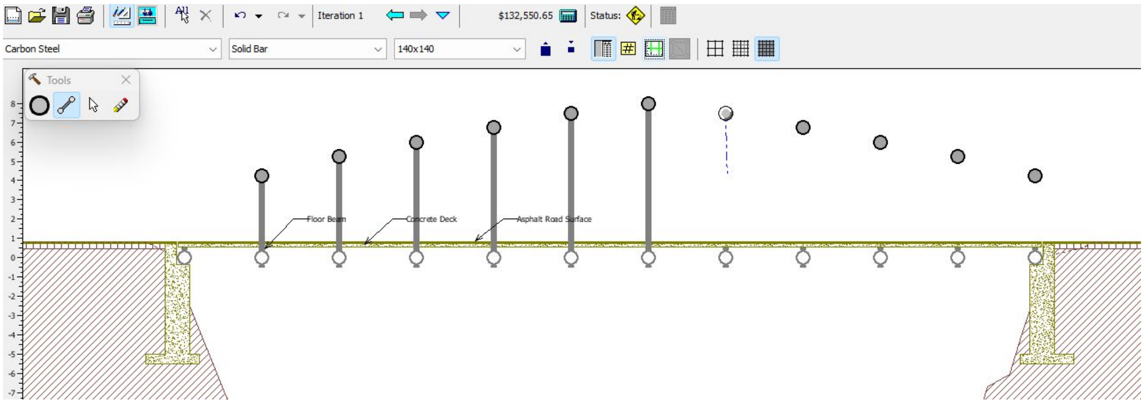
Below, we show a very basic bridge without any preloaded structure. However, the app allows you to start from one of several predefined templates available when creating a new file:



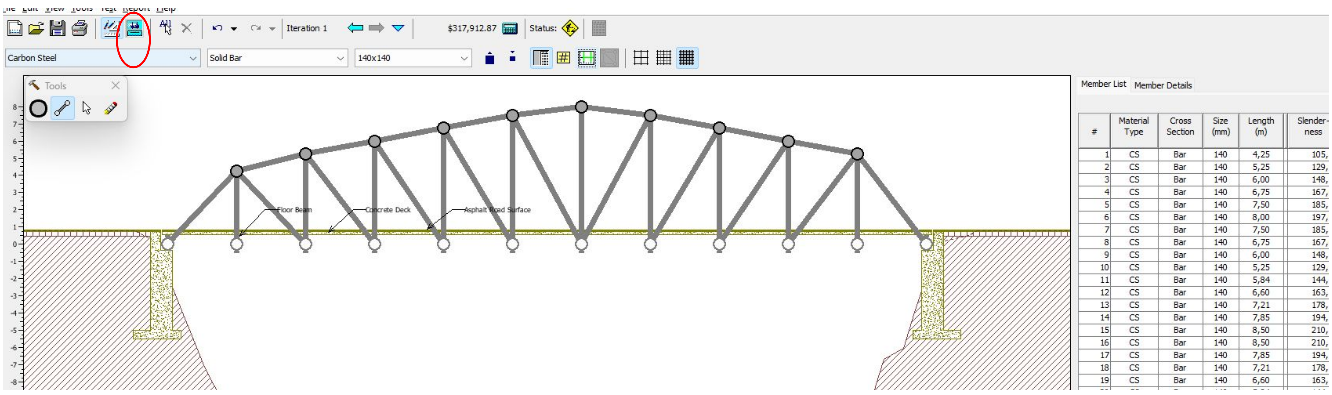
Next, we're going to build a structural design based on the diagram we sketched earlier, and test how well it works as a real bridge. To do this, go to the "Tools" menu and make sure only the "Add Members" option is selected. As you'll see, the app also allows you to choose the material type and whether each beam is solid or hollow:

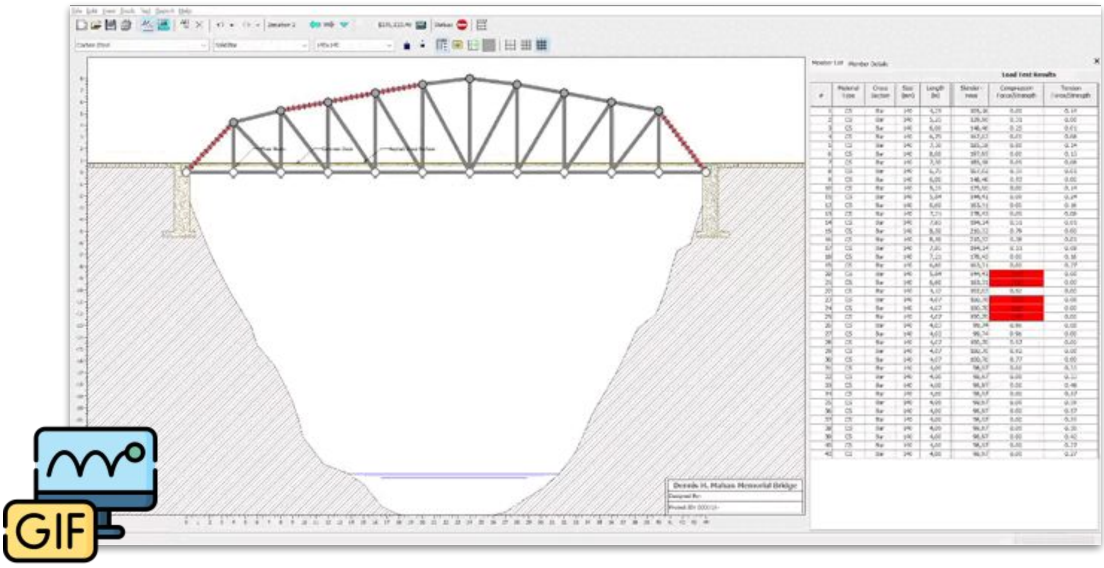


Next, to create the joints, simply select the "**Member Tool**" and click, drag, and release to draw the beams, just as shown in the image below:



Then, select the option to **test your bridge using the animation mode**:



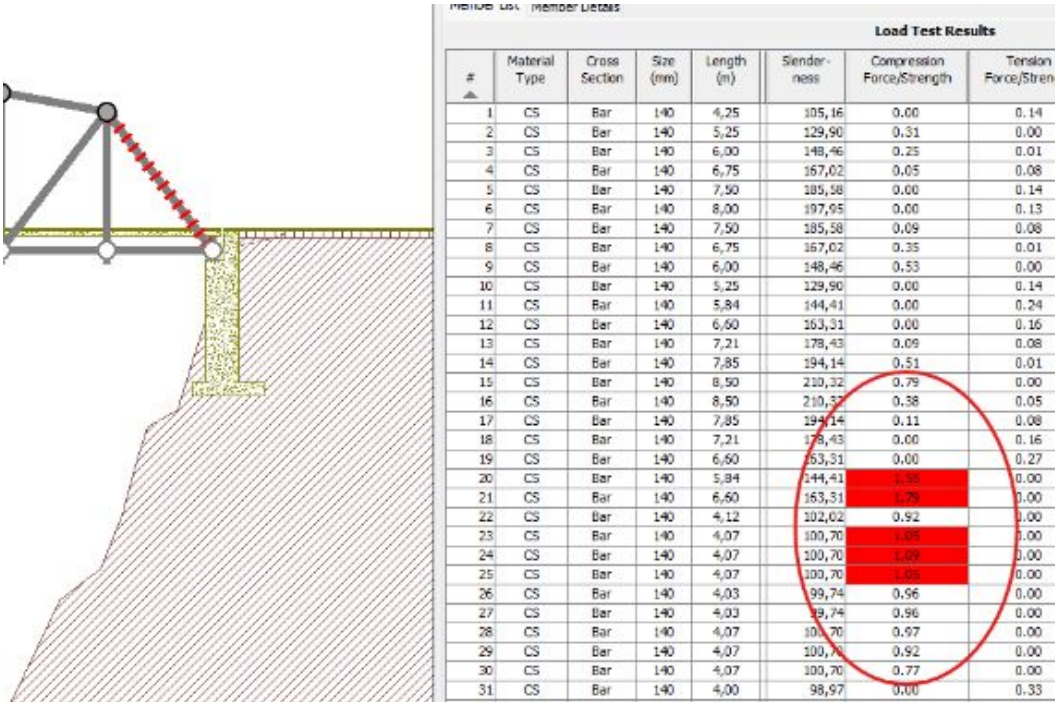


As you can see, this is not exactly the most effective bridge design...

So now, let's explore how we can improve and strengthen it:

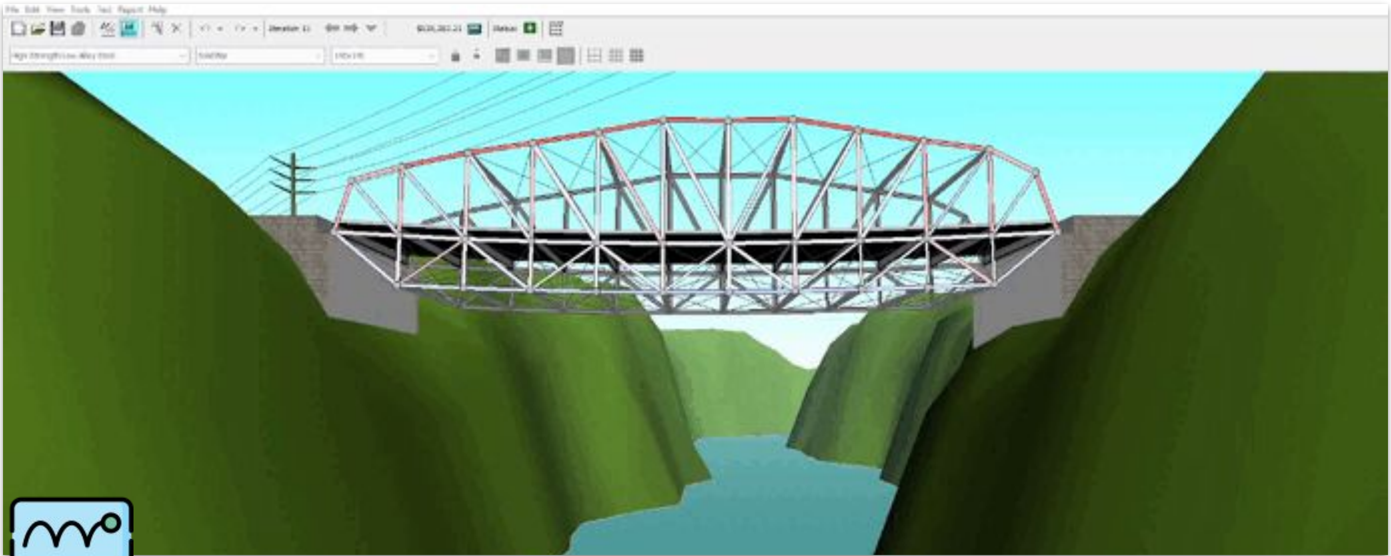
Funded by the European Union

If we look closely at the **tables on the right**, they show us **where our design is failing in terms of structural resistance**:



#	Material Type	Cross Section	Size (mm)	Length (m)	Slender-ness	Compression Force/Strength	Tension Force/Stren
1	CS	Bar	140	4,25	105,16	0.00	0.14
2	CS	Bar	140	5,25	129,90	0.31	0.00
3	CS	Bar	140	6,00	148,46	0.25	0.01
4	CS	Bar	140	6,75	167,02	0.05	0.08
5	CS	Bar	140	7,50	185,58	0.00	0.14
6	CS	Bar	140	8,00	197,95	0.00	0.13
7	CS	Bar	140	7,50	185,58	0.09	0.08
8	CS	Bar	140	6,75	167,02	0.35	0.01
9	CS	Bar	140	6,00	148,46	0.53	0.00
10	CS	Bar	140	5,25	129,90	0.00	0.14
11	CS	Bar	140	5,84	144,41	0.00	0.24
12	CS	Bar	140	6,60	163,31	0.00	0.16
13	CS	Bar	140	7,21	178,43	0.09	0.08
14	CS	Bar	140	7,85	194,14	0.51	0.01
15	CS	Bar	140	8,50	210,32	0.79	0.00
16	CS	Bar	140	8,50	210,32	0.38	0.05
17	CS	Bar	140	7,85	194,14	0.11	0.08
18	CS	Bar	140	7,21	178,43	0.00	0.16
19	CS	Bar	140	6,60	163,31	0.00	0.27
20	CS	Bar	140	5,84	144,41	1.55	0.00
21	CS	Bar	140	6,60	163,31	1.79	0.00
22	CS	Bar	140	4,12	102,02	0.92	0.00
23	CS	Bar	140	4,07	100,70	1.05	0.00
24	CS	Bar	140	4,07	100,70	1.09	0.00
25	CS	Bar	140	4,07	100,70	1.05	0.00
26	CS	Bar	140	4,03	99,74	0.96	0.00
27	CS	Bar	140	4,03	99,74	0.96	0.00
28	CS	Bar	140	4,07	100,70	0.97	0.00
29	CS	Bar	140	4,07	100,70	0.92	0.00
30	CS	Bar	140	4,07	100,70	0.77	0.00
31	CS	Bar	140	4,00	98,97	0.00	0.33

Based on that information, we can modify our bridge model and run the test again to see if the changes improve its performance:



It could be also an interesting challenge for teams to identify a real bridge need in their city and propose their solution accordingly. This could be achieved using google maps in the satellite 3D news and for them to review bridges in their areas or places that are lacking one. If this bridge were built in your community, who would benefit? What environmental risks would you need to address?

Funded by the European Union

CONCLUSION AND SHARING

Suggested final questions:

- What was the biggest challenge in designing or building the bridge?
- What recyclable materials would you use for a more beautiful and eco-friendly design?
- Why is inclusion important in teamwork and technical projects?
- Who was in charge of the technical design? Why? Did we divide the roles fairly?
- What kind of bridge would help your community today?
- Should all engineering projects ensure cultural or gender representation? Why or why not?
- Remember, every design tells a story. Which one does yours tell?

After all teams present, analyze: Which structure held most weight? What patterns do we see in results?

Don't forget to take a photo of your experience and share it with us!

LinkedIn Instagram X

BIBLIOGRAPHY AND REFERENCES

If needed, you may use this part to cite references and bibliography when data or information is used in the activity contextualization, example:

Information and videos about Emily Warren Roebling
https://en.wikipedia.org/wiki/Emily_Warren_Roebling
https://www.youtube.com/shorts/KF2-FKKMYek

Currently, a prominent figure for women in engineering is Roma Agrawal.
https://www.youtube.com/watch?v=CJf8vkyJq-o

Funded by the European Union

PROJECT EVALUATION

Activity Objectives	Key Competences (EU)	Evaluation Criteria
Actively research real-world bridge structures and construction principles.	Numerical, scientific and engineering skills	The student demonstrates understanding of bridge types and applies structural principles in a design sketch.
Discover and recognize the contributions of female engineers.	Cultural awareness and expression	The student identifies a female engineer, explains her contributions, and integrates symbolic elements representing her legacy into the project.
Apply basic engineering concepts through a functional prototype.	STEM competence	The student builds a structurally sound bridge prototype using provided materials, meeting criteria for length and load capacity.
Encourage gender equality in technical and leadership roles within the team.	Interpersonal skills and the ability to adopt new competences	The student engages in teamwork with equitable role distribution, actively participating in both creative and technical tasks.
Justify design decisions using research and hands-on evidence.	Entrepreneurship	The student explains design choices based on testing results, proposes improvements, and reflects on the practical application of their prototype.

Funded by
the European Union