Study model of different types of bridges
The test bed "type bridges" provides several types of bridges.

The platform is too flexible to carry a light load.

The different elements contained in the box test bed can make several types of maintenance of the deck. Example with the bridge girder.
SUMMARY

Preparation of the test bench comes as a kit 02 and 03

Presentation 04

Educational use - General 05

Activity 1:
How to support the deck of a bridge? 06-08
Presentation of the activity for the teacher 06 and 07
Student sheet 08

Activity 2:
Classification by types of bridges 09

Activity 3:
Where those efforts? 10-13
Presentation of the activity for the teacher 10
Student sheet 11
Sample corrected 12
Synthesis example 13

Activity 4:
integration into a site 14-20
Student sheets 20 and 21
Examples of fixed 16-18
Synthesis example 19
Resource schedule 20

This booklet may be copied for students for internal school use* * This booklet may be copied as many times as necessary within school establishments for educational use only, on the condition that the publisher’s name is included: A4. Copying or distribution for commercial use is not permitted without agreement from A4. Any copying or distribution of all or part of this booklet outside of school use is not permitted without agreement from A4.
Preparation of test bench comes as a kit 1/2

Exploded view of the support comes as a kit of parts to assemble

White pieces are the support component of the test rig floor

Red pieces to make different types of bridges

Stay cables x4
Preparation of test bench comes as a kit 2 / 2

Stand assembly
Directed by embedding parts and maintenance by screws. The bonding is not necessary.

1 - Mounting the abutments on the base
Position and fix the abutments using TF 4 screws 3x13.

Attention
Tighten the screws well TF 3x13 for which do not exceed under the base.

2 - Installation of Tower on base
Position and secure the towers with 4 slotted screws 3x13.
Learning objective: to discover the different types of bridges

The function of a bridge crossing a barrier.
The deck covering the roadway must allow passage of pedestrians or vehicles.
In most cases, the apron is not strong enough to support loads without being itself supported.
The purpose of this testbed is to allow the comprehension of different types of structures holding the deck.
The student will speak on the test bench to mount and test different ways to support the deck.
The proposed classification:
- The bridge girder
- The bridge piers
- The Bridge on crutches
- The arch bridge
- The cable-stayed bridge or suspension

Note:
- This list does not pretend to be exhaustive but to group the most frequent types.
- We will see later in the case, students are encouraged to discover that most bridges are often hybrids (Example: apron, supported on a beam, itself supported by pillars which rest on a vault).
- The suspension bridge is classified in the same family as the cable-stayed bridge. The testbed would allow the proposed mounting of a suspension bridge but it would be tricky with lots of little strings to adjust.

The test bed
It consists of:
- A pedestal onto which are fixed the two bridge abutments,
- An apron / pavement material very little hard (PVC foam 2 mm)
- Interchangeable elements keeping the deck (red + PVC cords).

The test stand Item code: 560-775
It comes in a cardboard boxed kit of parts and requires assembly.(assembly time 5 ’).
See pages 04 and 05.

Weighing 300 g in a truck Item code: 560-776
This is an optional item which is sold separately. (You may use any load).
Educational interests
The testbed will allow, from simple observation and manipulation to gain knowledge in the following areas:
- Different ways to support bridges, beams, pillars, stands, arches, cables.
- The various materials used in bridge construction.
- Different configurations of bridges by material used, lattice girder, box girder, etc.
- It is often observed that a bridge is supported by a combination of means. Indeed, except in arch bridges, Stone, the deck is usually coupled with a beam, itself supported by various means.

Examples:
- Depending on the time and the need, types of support are more or less common:
- Antiquity: for books inexpensive and quickly built: the use of wooden pillars and beams.
- Antiquity: books made to last: the use of stone for the batteries + beam of wood or stone arch.
- Middle age bridges of wood or stone.
- Renaissance: The bridges are usually built with stone arch.
- Industrial Revolution: the appearance of iron-frame structures.
- Contemporary World: assortment material concrete box girder, suspension bridges, concrete and steel composite bridges.
- Reading and analysis of drawings. Production sketches and drawings.
- Technical solutions: research and investigation around solutions that can overcome an obstacle.
- The transfer of forces through a structure: Students will look on different types of bridges that are efforts and where the bridge supports on the ground.
- Integration into the landscape: comparing different types of bridges and discuss their boundaries on the landscape.

The proposed activities and questions

1) What are the ways to support a bridge?
The test bench (ref. BE-PONA) allows students to assemble five types of bridge: girder bridge, bridge piles, Bridge on crutches, arch bridge, cable-stayed bridge.

A - Try different ways to support the deck of the test bed using the information provided.
We start by testing the bridge with a load without having established a system for holding the deck.
There is the need for the deck is supported and we test the various possibilities offered by the testbed.

B - Diagram and discuss the different ways of maintaining

2) Can we make a classification by types of bridges?
Bringing maintenance types tested (and diagrammed) photos of real bridges collected here and there (books, internet, personal photos, ...).
Make a classification in a table with pictures of various bridges.
Here is a very useful link to the site Structurae: http://en.structurae.de/structures/stype/index.cfm?ID=1

3) What efforts are exerted?
PVC deck is sufficiently flexible to amplify the distortions caused by the passage of a load.
For each solution keeping, we ask students to show the points where the exerted efforts and understand and there is a charge transfer in the structure of the book. The student manipulates the bench and produced diagrams.

4) What can one say of the various types of bridges in relation to their integration into a site?
The observation of various types of place in a landscape should encourage students to reflect and compare the integration of different types of work in the geographical environment:
- We have already seen where some forces raise the question of soil strength;
- We observe the passage left free under the bridge, according to its type;
- You will comment on the influence on the landscape in terms of look.
Activity 1 - How to support the bridge deck? Teachers Notes 1 / 2

A - Try different ways to support the deck of the test bed using the information provided.

The test bench (ref. BE-PONA) allows students to assemble five types of bridge: beam bridge, bridge piles, Bridge crutches, arch bridge, cable-stayed bridge. Students will “read” the various parts and shapes to create assemblies.

1 - Test with a load, maintenance-free deck.
There is the need for the deck to be supported.

2 - Maintaining a beam -
The beams can be lattice box type, shaped, ...
They can be metal, concrete, wood, ...

3 - Retention by pillars

4 - Retention by crutches

5 - Maintain a vault
Whatever the material, concrete, metal, wood, stone, ...

6 - Maintain cable can be classified in the same class suspension bridges and cable stayed
Activity 1 - How to support the bridge deck?  Teachers Notes 1/2

B - Diagram and name the different method of restraint
The student performs sketches or diagrams to explain the various solutions discovered during the activity.

Examples of sketches of students

Subsequently, when we will require a classification of bridges real (file photos), students will be encouraged to discover that usually decks are hybrid (eg apron reinforced beam, itself supported by pillars that bear on a vault).

We will see later that the type of maintenance is not associated a given material. Example beams that can be metal, wood or concrete, solid or mesh.
Discoveries of coins.
The test bed "type of bridge" consists of:
- An appliance that represents both sides of the bridge (pillars or "abutment")
- A flexible floor or apron (white plastic)
- Various elements that go to support the floor (Plastic parts red + cables).

Problem: What are the possible solutions to support the deck?

- Start by mounting the deck and put a load on it.
- What do we see?
- Using the testbed, find and test different ways to support the deck.
- Represent by diagram each of the solutions for the maintenance of the deck.
- Identify each principle of maintaining and possibly adding comments.

Example:

With a beam
Activity 2 - Classification by types of bridges

Different possible classifications
We could make different rankings according to different criteria:
- The time of construction,
- Materials,
- The scope,
- Function (aqueduct, viaduct, ...),

The criteria of classification will be retained here is the type of maintenance:
- By beam (s)
- By pillar (s)
- By crutches
- Per arch (s)
- Cable,
- For mixed systems .*

* In fact, the student will quickly discover that the more often a bridge is supported by a combination of means. Except in the stone arch bridges, the deck is usually coupled with a beam, itself supported by various means.

Examples:

- Apron + Beam + Pillars
- Apron + Cable
- Apron + Beam + Legs
- Apron + Ark
- Apron + Beam + Pillars
- Apron + Beam + Pillars

Work required
Make a classification by type of bridge deck maintenance.
To do this, based on:
- The activity previously carried on the test bench "type bridges"
- Search for documents, drawings, diagrams or photos.

Students will observe and photograph the real bridges, open encyclopedias, undertake research on the internet ...
Here is a very useful link to the site Structurae: http://fr.structurae.de/structures/stype/index.cfm?id=1
You can request a table with patterns (or pictures pasted) and comments. Like most bridges are "mixed", he will choose for each bridge type it is rather "beam" or Type "Ark" or another. It could for example mean that the bridge will be classified into the type that matches the primary means of its retention.

For example, an arch bridge with small batteries will be classified as "ark". Whatever the choice to be made in cases of "contentious" what matters is the argument put forward by the student. The goal is to get students to observe and comment on technical subjects (Different ways of supporting structures) and develop a spirit of synthesis. We will see that two bridges are alike rarely and that we could classify them according to various criteria.

Work expected - Booklet
We will not here “corrected” or “an example of the student book” for this suggestion of an activity not directly related to the use of test bench and that depends largely on the resources documentary which everyone can have.

The main purpose of this issue is the use of test bed "type bridges" (ref BE-PONA).
Activity 3 - Where are exerted efforts?

You can lead students to reflect on the forces in a structure.

The test bed "type of bridge" allows manipulations that can help answer simple questions like:
- What efforts a bridge support given to it,
- Where (which part of the bridge or road) exerted efforts,
- To what (s) direction (s) efforts practice?

Example:

Analysis of the transmission diagram of the load on

The teacher may ask students to repeat each configuration on the testbed and supporting (or move load) in different parts of the deck to locate where the bridge rests.
We will resume the patterns that represent each "big guy" and complete deck or use the student sheet below (page 11).

NOTE
The test bed "type of bridge" is not subject to tests of strength of materials. It is not used to quantify forces or to compare the resistance of a bridge over another. Indeed, how to compare for example the beam and the ark of the test bed that are neither mass nor even of the same material, nor even really a material used to build bridges. This testbed allows simply to observe the deformations induced by a load, see where the bridge rests and what direction are oriented efforts.

For investigations and tests around the comparative strength of different materials or structures, see the benches specialized testing that we offer.
Activity 3 - Where are exerted efforts?

- Implement and test technical solutions diagrammed below using the testbed.
- For each of them, point by showing the diagrams where the bridge carries efforts on the ground and by arrows the direction of forces.

Ex 1

Ex 2

Ex 3

Ex 4

Ex 5

Conclusion.
Activity 3 - Where are exerted efforts?

- Implement and test technical solutions diagrammed below using the testbed.
- For each of them, point by showing the diagrams where the bridge carries efforts on the ground and by arrows the direction of forces.

Commentary

In this diagram, the weight of the truck will do on the beam that is supported at the ends by rock or bridge abutment.

Commentary

In this diagram, the deck is held by the ends of crutches to support obliquely on the rock on each side.

Commentary

In this diagram, the bridge is supported by the basic pillars on prop soil.

Commentary

Here the bridge is supported by the ends the arch support on each side the rock.

Commentary

The deck draws on the cables that are attached to each side on the banks. These cables tend to be torn soil, they are based on the pillars.

Conclusion.

When you drive a car on a bridge, the loads are transmitted through the natural terrain bridge components. Depending on the type of bridge, the floor is not applied in the same way and at the same place.
Activity 3 - Where are exerted efforts? - Listing summary

Influence the passage of a vehicle on a bridge deck.

- The mass of vehicles on the bridge deck has a tendency to distort it. It must be designed to withstand this load. A load test is also provided at the end of the achievement of the work to certify it.
- While passing the vehicle deck is held by all elements involved in the completion of the bridge. The load is transmitted and distributed in all parts of the bridge, finally in contact with the ground.

An analysis of the field by a geologist before the building of a structure is very important that the foundation is stable and resistant to the bridge crossing different loads.

You can see the two examples above that some items like batteries will be tablets under stress and must withstand a compressive force while others such as cables will be stretched and must withstand a tensile force.

According to the forces that will act on the elements, materials are more or less suitable.
- The concrete is very resistant to compressive forces, it is often used for the pillars.
- The steel has good resistance to traction, it is found in the cables but also more more in the beams and box girders aprons.
- Reinforced concrete metal will allow it to withstand not only the efforts of compression but also to tensile forces.
- The stones piled not only resist compressive forces.
- The wood resists compression and less traction.
Activity 4 - integration into a site - Resource Document 1 / 2

You have manipulated the model to produce various types of maintenance for the bridge deck. You research (books, internet, etc.) on different types of bridges.

**Cut and paste into the notebook below the 6 designs.** (2 drawings per page)
- Complete design of each bridge, each time with a different solution for its maintenance.
- Identify each type of bridge.
- Show with arrows where are the supports of the bridge.
- Give the advantages or disadvantages obvious (we’re not talking here of resistance).
- List possible materials for its construction.
Activity 4 - integration into a site - Resource Document 2 / 2

Cutting Drawings
Arch bridge

The arch bridge allows a wider passage under the bridge if it uses the pillars. The forces are transmitted laterally across the bridge abutment, which requires that they can withstand this lateral force. We see stone arches, concrete, metal, wire, wood. The largest metal arches are observed; example Garabit viaduct.

Bridge piles or pillars

The pillars restrict the width of passage under the bridge. We can make very long bridge piers by multiplying the number of batteries. Let the ground beneath the bridge is strong enough to carry the load. You see bridge piers of stone, metal, concrete, wood.
Activity 4 - integration into a site - Fixed 2 / 3

Bridge legs

The arch bridge allows a wider passage below, if you use the pillars. As for arch bridges, the forces are transmitted laterally across the bridge abutment, which requires that they can withstand the lateral force. It can be seen on crutches made of concrete, metal, wire, wood. You see a lot of bridges to stand above the highway.

Girder bridge

The greater part bridges comprise a beam supporting the deck, itself supported by various means (pillars, arch, etc.). We also see girder bridges without intermediate support. The beams are made of wood, metal or wire mesh reinforced concrete. You see a lot of old railway bridges beam wire (iron or steel). The newer bridges are often concrete beams or girders with steel reinforcement. The forces are transmitted vertically under piers and abutments, which requires a firm ground under these elements.
Cable-stayed bridges or suspension bridges allow the maximum free passage under the deck. Compressive forces applied to the pillars and pulling forces applied at anchor cables in the ground. You need soil that can resist tension and (or) of foundations required. The cables are almost always steel (except a few examples with reinforced concrete). Pillars are reinforced concrete. The deck is made of metal or reinforced concrete. It is observed that longer ranges are obtained by suspension bridges.
Integration of bridges in the landscape.

Why some bridges are they "light and elegant" while 'autres have the appearance "massive" one medieval castle?

The architectural success depends on the general lines of the book. The architect must guide the study towards a design aesthetic but that is validated by the engineers who are responsible for them bridge resistance.

Several factors must be taken into account when selecting the type of the structure:
- The distance to cross,
- The matter of the banks which will build the bridge
- The height and width to allow clearance under the deck,
- The variation of the waterway,
- Materials available at the time of construction,
- The traffic that must support the work,
- Access roads to the bridge,
- Economic considerations,
- The aesthetic factor.
- ...

In most cases and especially when the site is remarkable, we built several models which will enable to choose the form and structure type of structure best suited to the landscape.

*Example: Millau bridge*

This is the project "the most clean, most air", who emerges as the landscape that has been retained and realized. We can see that this choice combines both pillars and matte concrete apron beam box girder and steel shrouds.
Activity 4 - integration into a site - Resource Schedule

To avoid having to draw students to the different types of bridge. Drawings to be cut.