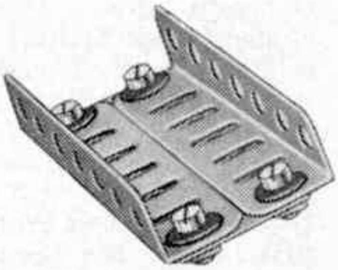
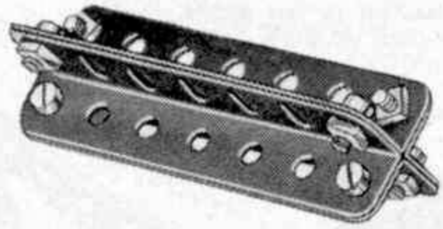
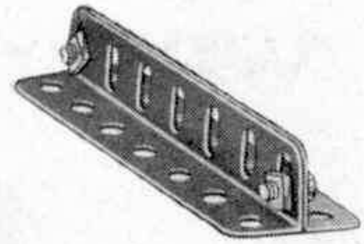






Figs. 1, 2 and 3. A channel-section girder, an X-section girder and a shallow web T-girder, built from Meccano parts.

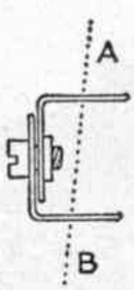
Girders for Bridge Construction

How to Make and Use Them

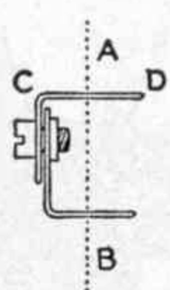
IF model-builders were asked to place in order their favourite subjects for modelling with Meccano I am sure that bridges would appear high in their lists. Simple girder bridges, arch, cantilever, lifting and suspension bridges, all form subjects that can be modelled easily and realistically from even a small Outfit, and I suppose every model-builder has at some stage in his career set to work to build a model of one of the famous bridges, such as the Quebec Cantilever Bridge or the arch bridge across Sydney Harbour, which form vital links in modern rail and road systems. Many excellent examples of Meccano bridges have been illustrated in the *M.M.* and further proof of the popularity of these subjects is found in the large number of bridge models entered in the model-building competitions announced in the *M.M.*

It is easy to see why bridges make such splendid subjects for Meccano models, for the basic structural parts used in their make-up are similar in all essentials to the Meccano Girders, Strips, Flat Trunnions, etc., with which every Meccano boy is familiar.

Although it is fairly easy to produce the general outlines of an original bridge, some knowledge of the principles involved in bridge construction is necessary in order to give large models of this kind the necessary strength and rigidity while using the minimum number of parts. Actually it is possible to bolt together a few Girders and Strips to form a structure that will support a man's weight without difficulty, provided that correct principles of girder design and construction are adopted.



Figs. 5 and 6. Diagrams illustrating (right) the correct and (left) the incorrect methods of bolting Angle Girders together.



The need for proper design and positioning of the girders in bridge work will be easily understood if a girder is regarded simply as a beam. A very simple form of beam is a strip of timber supported at each end. If a load is placed at the centre of such a beam a certain amount of bending will take place, the degree of bending varying with the weight and position of the load. This bending causes the particles forming the material of the upper face of the beam to be squeezed together or put in a state of compression, while the material of the lower surface is made to stretch, or is put in a state of tension, as it is more correctly termed. The load causing this tension and compression exerts its greatest effect along the outer edges of the beam, and there is a line dividing the part where the wood is compressed from that where it is being stretched out. The strength of the beam in these conditions depends on the depth of material above and below this line. If some of the material from near the centre line is removed and placed along the outer edges, the strength of the beam will be greatly increased without increasing its weight, and this is just what engineers do when they make girders for constructional work.

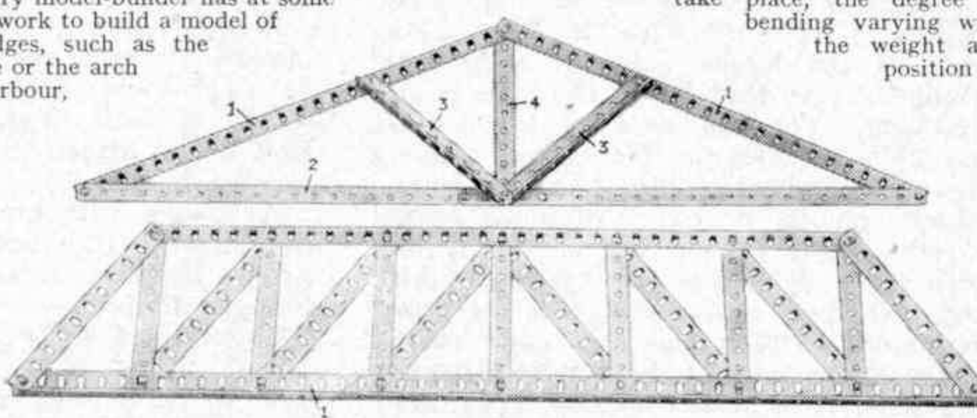


Fig. 4. The upper picture shows a simple but strong roof truss built from girders and strips, and below it is a built-up side member for a girder bridge.

Girders can take several different forms, all of which can be assembled very easily from Meccano parts.

Meccano Angle Girders are similar to two Strips connected together at right-angles, and it is this right-angle formation that gives the Girders their strength and ability to withstand considerable bending stresses. Every Meccano boy will know that each Angle Girder is perforated with round holes in one flange and elongated holes in the other, but he may not know why. The purpose of the elongated holes is to provide the "play" that is often necessary when the

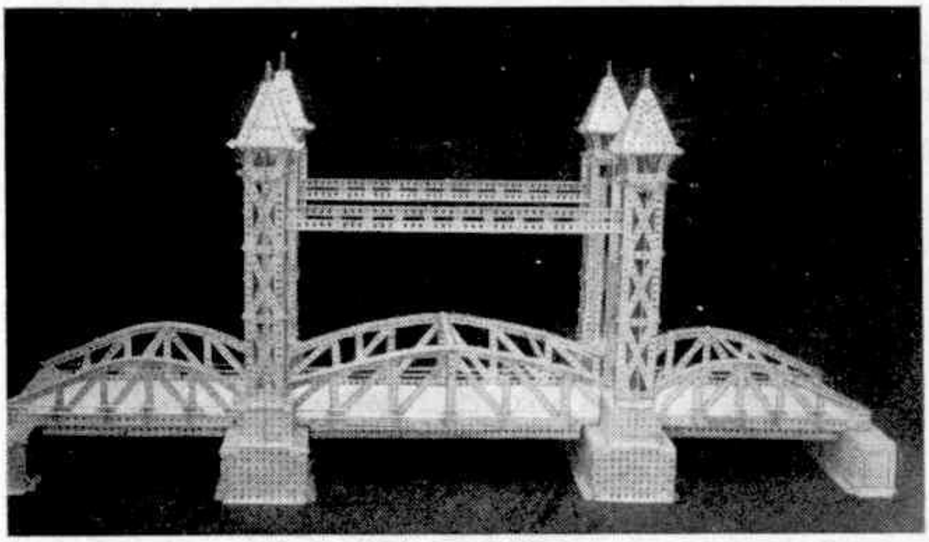


Fig. 7. This bascule bridge built in Meccano makes use of some of the different types of girders described in this article.

Girders are bolted to, or used to support other parts. The value of this adjustment is shown clearly in Figs. 5 and 6, which represent sections of Angle Girders bolted together to form channel or U-section girders. In Fig. 6 the round holes of one Girder are placed over the elongated holes of the other. This is the correct method of assembly, and if a Rod is passed through the flanges of a channel girder made in this way it can be set at right-angles to the girder. The dotted line represents the Rod. In Fig. 5 the elongated holes of the Girders are placed together, and it will be seen that in this case the Rod is thrown out of line when it is passed through the flanges. Short Strips should be bolted over the elongated holes of Angle Girders when Rods are passed through them.

The type of girder most frequently used in bridge construction is one shaped like a letter I. In these girders the horizontal plates are called "flanges," while the vertical sections are known as "webs." An I-section girder can be made very easily with Meccano as shown in Fig. 10. In this example the flanges are each made from two Angle Girders, while the web is a Flat Girder. An even stronger I-section girder can be made by increasing the depth of the web, as in Fig. 9. In this example the web consists of two Flat Girders bolted together. I-section girders are particularly useful for the main longitudinal members of bridges.

Other girders commonly used in bridge construction are T-section and channel or U-section girders, and their Meccano counterparts are shown in Figs. 1 and 3. The type of girder shown in Fig. 2 is in the form of an x. This type is not used so frequently as those already mentioned, but it is valuable in cases where the structure has to withstand bending strains acting in different directions.

Generally girders are used for every part of a bridge or other structure that has to resist a compressive force. Those parts of the structure that are in tension do not need to be so sturdy and can be of lighter material and weight. An example of this arrangement in the form of a simple roof truss is shown in Fig. 4. The sides 1 are made from Angle Girders, as they are in compression, but for the side 2 Strips can be used as this is in tension. The rigidity of the triangle formed by these sides is ensured by adding struts and ties at 3 and 4.

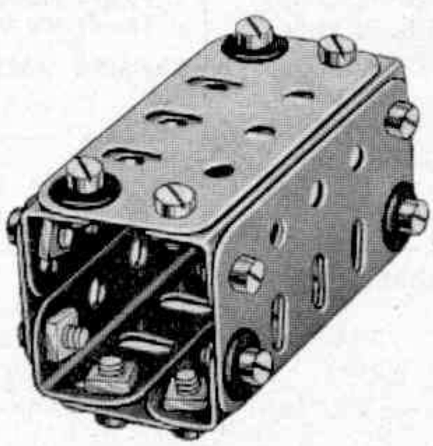
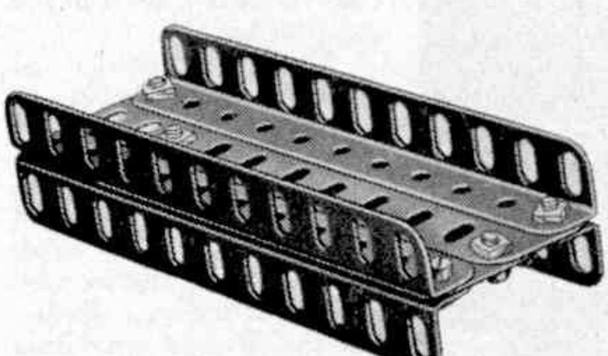


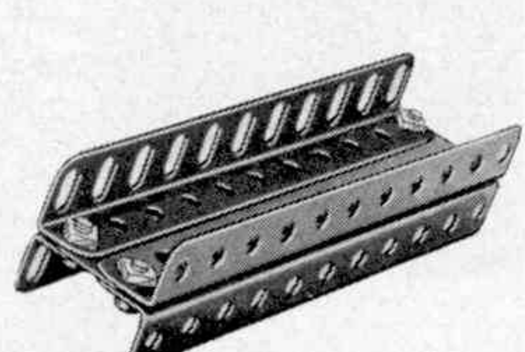
Fig. 8. A box-section girder capable of resisting great bending forces.

A built-up girder suitable for the side member of a bridge is also shown in Fig. 4. This is really an I-shaped girder with a very deep web, the upper and lower flanges being formed by Angle Girders. In this case however, the flanges are connected by a series of Strips instead of a solid web, as this construction saves material and reduces the weight of the complete girder. Diagonal Angle Girders are bolted between the flanges to brace the structure.

Another girder used frequently in engineering structures is in the form of a complete box-section, as shown in Fig. 8. Box girders of this type are capable of withstanding enormous bending stresses. Some of them have been made to such large dimensions that a railway train can run through them! In effect these huge box girders form a bridge by themselves, and an excellent example of this is provided by the famous Britannia Tubular Bridge over the Menai Straits, North Wales.

A good example of the use of various kinds of girders in Meccano bridge construction is shown in Fig. 7.





Figs. 9 and 10. Two examples of I-section girders. The one on the left will withstand a greater bending load owing to its deeper web.