THE TRUSS

Definition of a Truss-Forces Acting Upon It-Strain and Stress

Different Kinds of Stress-Forms of Members to Resist Stress-The Truss Element-Distinguishing Feature of a Truss

A certain young engineer being asked to give his opinion as to what constitutes a truss, expressed himself about as follows: “A truss is any beam or similar structure which resists bending moment.” This is a remarkable definition, because it expresses not only what a truss is, but also what it is *not.* A truss is a structure which resists bending moment, but a truss is *not* a beam, nor does it act in the same manner as a beam in resisting bending moment. In fact, a truss may quite consistently be defined as a structure which resists bending moment without any of its members being required to act as beams.

A truss is a simple framed structure, composed of straight members which are so connected to each other that the truss, as a whole, will act as a rigid body to resist the forces acting upon it, while each member is subjected to direct longitudinal stress only.

A truss, in resisting the bending moment due to super-imposed loads, serves the same purpose as a solid beam; but *each individual member* of the truss is subjected only to direct longitudinal stress, that is, stress in the direction of its length.

In considering the action of the truss, we have to deal with two classes of forces, known as *external forces* and *internal forces.* The external forces are: the loads sustained by the structure. The weight of the structure, and the supporting forces (called *reactions*) which balance the loads, and thus hold the structure in position. The transfers the loads to the reactions, or, in other words, the reactions counterbalance or support the loads through the medium of the truss. The loads and reactions, or external forces which act upon the truss, always distort it more or less from its original form, and the distortion thus produced is called *strain*. To this strain, or distortion, the members of the truss offer resistance, and this resistance to distortion is called *stress*. The stresses in the various members of a truss are the *internal forces* which offer resistance to the external forces, or, more properly, they are the forces, through the medium of which the external forces balance and resist each other. They are called internal forces, because they are forces internal to the members of the truss. The external forces are so called, because they are forces wholly external to the truss.

It will now be well to notice the two kinds of longitudinal stress common to the members of every truss; namely, *tensile stress* and *compressive stress*, or simply, *tension* and *compression.* A tensile stress is a *pull*, that is, it is the result of two forces applied to a body in such manner as to tend to elongate it or pull it apart. A compressive stress is a *push*, that is, it is the result of two forces applied to a body in such manner as to tend to crush it. Each member of a bridge truss is designed to resist either tension or compression; in some trusses, certain members are designed to resist either tension or compression, according to the manner in which the truss may be loaded.

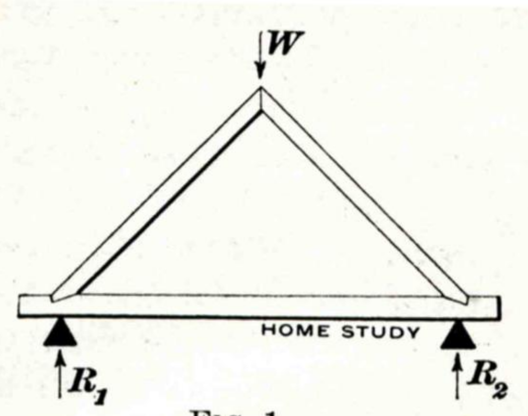

FIG. 1.

If the only office of a member is to resist tensile stress, it is merely necessary that the member shall contain sufficient material to resist the stress, without much regard to the form of the member. But with a member intended to resist compressive stress, it is quite otherwise.

Such a member must not only have sufficient material to resist the direct longitudinal stress, but it must also contain sufficient material, and the material must be given such a form, that the member will not bend sidewise or buckle under the applied stress. In a tension member, therefore, the material may be, and should preferably be, of compact form, as that of a solid rod or bar; but in a compression member, the material should be arranged and distributed in such a manner that it will not bend easily. Hence, the compression members of bridge trusses must generally be much larger, as regards their exterior dimensions, than the tension members. Consequently, compression members, when composed of metal, are, generally hollow or trough-shaped, instead of being solid.

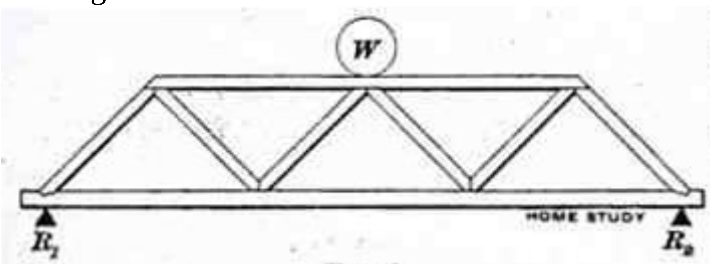

FIG. 2.

A metal compression member, of nearly any form, can readily be made to resist a certain amount of tension also. But members designed to resist tension only, are not generally capable of resisting compression. When it is desirable that a tension member shall resist a certain amount of compression also, it is generally necessary to modify the form of the member.

The triangle forms the primary truss elements, because it is the only simple geometrical figure whose form cannot be changed without changing the length of one or more of its sides. The simplest possible form of a truss is a triangle, and any perfect truss must be either a triangle or an assemblage of triangles. Thus, in Fig. 1, is represented a truss consisting of a single triangle and supporting the single load *W*. The truss, including its load, is in turn supported by the reactions R_1 and R_2. The load *W* and the reactions R_1 and R_2 are the external forces which act upon the truss or, more properly, which act upon each other through the medium of the truss.

It is evident that the truss shown in Fig. 2 is the same in principle as that shown in Fig. 1. It simply has more triangles added. Or it may be said that the truss shown in Fig. 1 is developed or repeated in Fig. 2. There is no difference in the general manner in which the trusses act in supporting their loads.

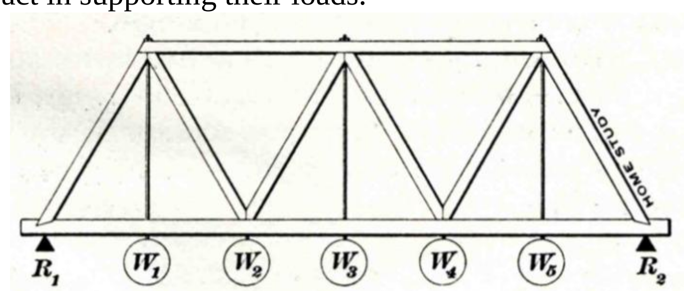

FIG. 3.

The truss shown in Fig. 3 is the same as that shown Fig. 2, except that a load is supported from each of the three upper and two lower joints of the truss. It will be noticed that the three loads W_1, W_3 and W_5 are each suspended from an upper joint of the truss proper, by means of a suspension rod. The five loads act upon the truss in much the same manner as the single load acts upon the truss of Fig. 2.

These simple examples will serve to illustrate, to some extent, the manner in which the primary truss element, the triangle, may be developed into a truss of almost any form and size.

In Bridge Engineering, a framed structure, so designed that its reactions, due to its static load, are vertical, is considered to be a true truss. This distinguishes the truss bridge from the *arch bridge* and the *suspension bridge*, in which the reactions are not vertical. In supporting its loads, the truss simply rests upon its supports, while both the arch and the suspension bridge exert a horizontal thrust against their supports and, consequently, must be firmly attached to them.

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Page 286