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Chapter 1 : The Static Analysis of the Truss

Graphical analysis methods for trusses are divided into the method of joints and method of moments. The graphical method of joints was commonly used in trusses for buildings due to its simplicity, ease of application, and self-correcting characteristics.

A structure that is composed of a number of bars pin connected at their ends to form a stable framework is called a truss. It is generally assumed that loads and reactions are applied to the truss only at the joints. A truss would typically be composed of triangular elements with the bars on the upper chord under compression and those along the lower chord under tension. Trusses are extensively used for bridges, long span roofs, electric tower, and space structures. Trusses are statically determinate when the entire bar forces can be determined from the equations of statics alone. Otherwise the truss is statically indeterminate. A truss may be statically externally determinate or indeterminate with respect to the reactions more than 3 or 6 reactions in 2D or 3D problems respectively. Sign convention For truss analysis, it is assumed that: Loads are applied at the joints only. Stress in each member is constant along its length. The objective of truss analysis is to determine the reactions and member forces. The methods used for carrying out the analysis with the equations of equilibrium and by considering only parts of the structure through analyzing its free body diagram to solve the unknowns. Method of Joints for Truss Analysis We start by assuming that all members are in tension reaction. When a member is experiencing a push force at both ends, then the bar is said to be in compression mode and designated as negative -ve sign. In the joints method, a virtual cut is made around a joint and the cut portion is isolated as a Free Body Diagram FBD. An imaginary section may be completely passed around a joint in a truss. The joint has become a free body in equilibrium under the forces applied to it. It is evident that no more than two unknowns can be determined at a joint with these two equations. A simple truss model supported by pinned and roller support at its end. Here are some simple guidelines for this method: The figure showing 3 selected joints, at B, C, and E. The forces in each member can be determined from any joint or point. The best way to start is by selecting the easiest joint like joint C where the reaction Rc is already obtained and with only 2 unknown, forces of FCB and FCD. Method of Sections for Truss Analysis The section method is an effective method when the forces in all members of a truss are to be determined. If only a few member forces of a truss are needed, the quickest way to find these forces is by the method of sections. In this method, an imaginary cutting line called a section is drawn through a stable and determinate truss. Thus, a section subdivides the truss into two separate parts. Since the entire truss is in equilibrium, any part of it must also be in equilibrium. Using the same model of simple truss, the details would be the same as previous figure with 2 different supports profile. The 3 forces cannot be concurrent, or else it cannot be solved. Firstly, the support reactions of Ra and Rd should be determined. Again a good judgment is required to solve this problem where the easiest part would be to consider either the left hand side or the right hand side. The graphical analysis was developed by force polygons drawn to scale for each joint, and then the forces in each member were measured from one of these force polygons. The number of lines which have to be drawn can be greatly reduced, however, if the various force polygons are superimposed. In order to draw the Maxwell diagram directly, here are the simple guidelines: Solve the reactions at the supports by solving the equations of equilibrium for the entire truss, Move clockwise around the outside of the truss; draw the force polygon to scale for the entire truss, Take each joint in turn one-by-one , then draw a force polygon by treating successive joints acted upon by only two unknown forces, Measure the magnitude of the force in each member from the diagram, Lastly, note that work proceeded from one end of the truss to another, as this is use for checking of balance and connection to the other end. Yet again, evaluating the support reaction plays an important role in solving any structural problems. For this case, the value of Hb is zero as it is not influenced by any horizontal forces. The procedure for solving this problem could be quite tricky and requires imagination. It starts by labeling the spaces between the forces and members with an example shown above; reaction Ra and applied force, P labeled as space 1 and continue moving clockwise around the truss. For each member, take example between space 1 and 5 would be the member AC and so forth. Choose a suitable scale for drawing the Maxwell

diagram. In conclusion, the truss internal reactions as well as its member forces could be determined by either of these 3 methods. Nonetheless, the methods of joints becomes the most preferred method when it comes to more complex structures. For more information on the topic:

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Chapter 2 : graphical method for the analysis of bridge trusses | Download eBook pdf, epub, tuebl, mobi

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The structures may consist of several sections. They form the supporting structures of bridges, pillars, roofs etc. It is important to have a basic knowledge of this topic as it concerns with the safety and stability of a several important structures. We will be studying about the various internal forces responsible for keeping the structures together. Following figure gives a basic idea of what we are going to study. The given figure is a normal diagram of a book shelf. The second figure shows the role of internal forces in maintaining the system equilibrium. Free body diagram of various components are shown. It is clear from the diagram that the forces of action and reaction between various parts are equal in magnitude and opposite in direction. Definition of a Truss Am truss is a network of straight slender members connected at the joints. Members are essentially connected at joints. The every member has force only at extremities. Further for equilibrium the forces in a member reduce to two force member. Thus no moments only two force member. In general trusses are designed to support. Trusses are designed to support weight only in its plane. Therefore trusses in general can be assumed to be 2-dimensional structures. Further in case weight of individual member is to be taken into consideration, half of them are to be distributed at each of the pinned ends. Figure below shows a sample truss. Structure is 2-dimensional structure, supported by pin joints at A and E. Analysis of a Truss The second diagram depicts that how instable the truss structure is. No doubt simple trusses are rigid stable. Further it is not always necessary that rigid trusses will necessary be simple. Let m be no. Distribution of forces, reactions forces at pins, tension and compression etc. Above shown are the conditions of compression or tension, deceided as per the direction of force applied by the pin joints to the members. Method of Sections As the name suggests we need to consider an entire section instead of joints. When we need to find the force in all the members, method of joint is preferrable. For finding forces in few of the specific members method of joints is preferrable. Let us consider the same diagram as before. Following is a simple truss. Find the forces in the all the members by method of joints. Find the reaction components at A and C. Also find the forces in each individual member, specify compression or tension.

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The use of Graphical Analysis for the solution of problems in construction has become of late years very wide-spread, and recent discoveries in this line have extended its application in many new directions. The representation to the eye, in one diagram, of the forces which exist in the several.

View next figure Figure 2. The truss roof structure The forces are assumed to be applied to the joints. Accordingly, distributed loading acting to truss weights of members of the truss, effect of wind and so on has to be transformed into joints, too [1 , 2 , 3]. The members of truss represent internal constraints between two mass point â€" joints. These constraints remove the joint one degree of freedom in the axis of a bar. If we remove internal constraints between mass points, we have to replace them by internal reactions in bars. They are assigned by letters Ni, where i is a number of bars in the truss [1 , 2 , 3]. An individual member can be loaded by axial force in tension or compression. Their magnitude and orientation depends on geometry of truss, external loading and support of whole truss [1 , 2 , 3]. Positive axial force tension is oriented outside of cutted bar or joint. Negative axial force compression is oriented inside of cutted bar or joint. In computations we will presupposed to have positive forces in all members. By removing truss members and by their replacement with axial forces as well as by removing external constraints and their replacement by reactions we get a system of mass points in a plane. Such system is in static equilibrium if it is in equilibrium every point of system, i. Some applications of trusses and their assemblies can be seen in [4 , 5 , 6 , 7]. Static Analysis of Trusses 2. Methods of Static Analysis of Trusses The methods of statics allow to solve only statically determinate trusses. These methods allow to solve external reactions and internal forces in members. If we want to compute deformations or statically indeterminate structures, we have to use relations from the theory of elasticity. In the next, we will solve statically determinate trusses by means of statics. We will determine static determinacy, external reactions and internal forces in members [1 , 2 , 3]. The methods of solutions of trusses are divided into three basic groups [1 , 2 , 3]: Every group of method consist of several steps of solution. Application of computers significantly enhanced computational procedures. Computer based methods, e. Cremona method, Wiliott method and so on. In order to explain physical principles of problem solution we explain in the next two most important analytic methods: Method of Joints Principle of method is based on conditions of equilibrium of the systems of mass points. In this case, the mass point is represented by released joint in which act known external and unknown internal forces in members [1 , 2 , 3]. Procedure of computation in case of plane truss [1 , 2 , 3]. We release truss system from external supports and from the equilibrium conditions for whole truss we compute external reactions and from equilibrium conditions for released joints we compute unknown axial forces in members. We start with the joint in which we know external forces or reactions and where are maximum two unknown axial forces. The members in which are zero forces we called zero members. Even if those forces are not loaded, they are necessary for ensuring the stability of truss. Method of Sections Ritter The principle of method comes out from equilibrium conditions of a part of truss which is separated by thought cut by maximal three members whose acting line do not cross one point. The axial forces in sectioned members and external forces that act on separated part of structure have to create an equilibrium system. Moment-static equilibrium conditions of separated part of structure has to be written with respect to points that are cross sections of two sectioned members. In some structures such a possibility does not exist and in such case we have to use static force equilibrium conditions [3]. The basic dimensions of the angle section Figure 4 are given in Table 1.

Chapter 4 : Graphical Analysis of Roof Trusses

Excerpt from Graphical Analysis of Roof Trusses: For the Use of Engineers, Architects and Builders The use of Graphical Analysis for the solution of problems in construction has become of late years very wide-spread, and recent discoveries in this line have extended its application in many new directions.

Ritter analytical method method of sections Design of members[edit] A truss can be thought of as a beam where the web consists of a series of separate members instead of a continuous plate. In the truss, the lower horizontal member the bottom chord and the upper horizontal member the top chord carry tension and compression , fulfilling the same function as the flanges of an I-beam. Which chord carries tension and which carries compression depends on the overall direction of bending. In the truss pictured above right, the bottom chord is in tension, and the top chord in compression. The diagonal and vertical members form the truss web, and carry the shear stress. Individually, they are also in tension and compression, the exact arrangement of forces is depending on the type of truss and again on the direction of bending. In the truss shown above right, the vertical members are in tension, and the diagonals are in compression. Truss sections stabilize this building under construction in Shanghai and will house mechanical floors In addition to carrying the static forces, the members serve additional functions of stabilizing each other, preventing buckling. In the adjacent picture, the top chord is prevented from buckling by the presence of bracing and by the stiffness of the web members. The inclusion of the elements shown is largely an engineering decision based upon economics, being a balance between the costs of raw materials, off-site fabrication, component transportation, on-site erection, the availability of machinery and the cost of labor. In other cases the appearance of the structure may take on greater importance and so influence the design decisions beyond mere matters of economics. Modern materials such as prestressed concrete and fabrication methods, such as automated welding , have significantly influenced the design of modern bridges. Once the force on each member is known, the next step is to determine the cross section of the individual truss members. The members under compression also have to be designed to be safe against buckling. The weight of a truss member depends directly on its cross sectionâ€”that weight partially determines how strong the other members of the truss need to be. Giving one member a larger cross section than on a previous iteration requires giving other members a larger cross section as well, to hold the greater weight of the first memberâ€”one needs to go through another iteration to find exactly how much greater the other members need to be. Sometimes the designer goes through several iterations of the design process to converge on the "right" cross section for each member. The effect of the weight of the individual truss members in a large truss, such as a bridge, is usually insignificant compared to the force of the external loads. Design of joints[edit] After determining the minimum cross section of the members, the last step in the design of a truss would be detailing of the bolted joints , e. Based on the needs of the project, truss internal connections joints can be designed as rigid, semi rigid, or hinged. Rigid connections can allow transfer of bending moments leading to development of secondary bending moments in the members. A type of truss used in roofing Post frame structures[edit] Component connections are critical to the structural integrity of a framing system. In buildings with large, clearspan wood trusses, the most critical connections are those between the truss and its supports. In addition to gravity-induced forces a. Depending upon overall building design, the connections may also be required to transfer bending moment. Wood posts enable the fabrication of strong, direct, yet inexpensive connections between large trusses and walls. Exact details for post-to-truss connections vary from designer to designer, and may be influenced by post type. Solid-sawn timber and glulam posts are generally notched to form a truss bearing surface. The truss is rested on the notches and bolted into place. With mechanically-laminated posts, the truss may rest on a shortened outer-ply or on a shortened inner-ply. The later scenario places the bolts in double shear and is a very effective connection.

Chapter 5 : Truss - Wikipedia

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Method of Joints | Analysis of Simple Trusses Method of Joints The free-body diagram of any joint is a concurrent force system in which the summation of moment will be of no help.

Chapter 6 : Full text of "Graphical Analysis of Roof Trusses: For the Use of Engineers, Architects and "

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