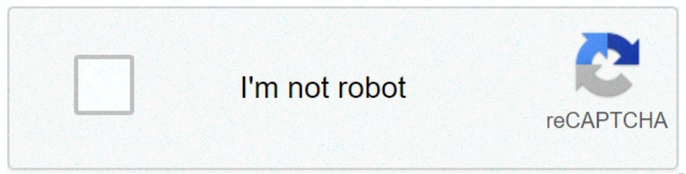

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The structure shown above is supported by a pin and roller

Types of support and connection Structural systems transfer their loading through a series of elements to the ground. This is done by designing the junction of the elements at their intersections. Each connection is designed so that you can transfer or support a specific type of load or load condition. To be able to analyze a structure, one must first be clear about the forces that can be resisted and transferred, at each level of support throughout the structure. The actual behavior of a stand or connection can be quite complicated. So much so that if all the various conditions were considered, the design of each support would be a terribly time-consuming process. However, the conditions on each of the supports greatly influence the behavior of the elements that make up each structural system. Structural steel systems have welded or screwed connections. Precast reinforced concrete systems can be mechanically connected in many ways, while on-site systems typically have monolithic connections. Wood systems are connected by nails, screws, glue or designed connectors. No matter the material, the connection must be designed to have a specific stiffness. Rigid, rigid or fixed connections are at an extreme limit of this spectrum and articulated or fixed connections connected to each other. The connection lasts maintin the relative angle between the connected limbs, while the articulated connection allows a relative rotation. There are also connections in structural steel and reinforced concrete systems in which a partial stiffness is a desired design feature. SUPPORT TYPES The three common types of connections that join a structure built to its foundation are; roll, stuck and fixed. A fourth type, not often found in building structures, is known as a simple bracket. This is often idealized as a frictionless surface). All of these supports can be located anywhere along a structural element. They are found at the ends, at midpoints, or at any other midpoint. The type of support connection determines the type of load that the support can resist. The support type also has a great effect on the bearing load capacity of each element and therefore the system. The diagram illustrates the various ways in which each type of support is represented. A single unified graphical method to represent each of these support types does not exist. Chances are that one of these representations is similar to the common local practice. However, no matter what the representation, the forces that the type can resist are in fact standardized. REACTIONS It is usually necessary to idealize the behavior of a support to facilitate an analysis. An approach is taken that is similar to massless and frictionless pulley in a of physical homework. Even if these pulleys do not exist, they are useful for allowing learning about Issues. Thus, friction and mass are often ignored in consideration of the behavior of a connection or support. It is important to realize that all graphical representations of media are idealizations of a real physical connection. Efforts should be made to research and compare reality with the grpahical and/or numerical model. It is often very easy to forget that the presumed idealization can be remarkably different from reality! The diagram on the right indicates the forces and/or moments that are available or active in each type of support. It is expected that these forces and representative moments, if properly calculated, will bring balance in each structural element. ROLLER BRACKETS Roller brackets are free to rotate and translate along the surface on which the roller rests. The surface can be horizontal, vertical, or tilted at any angle. The resulting reaction force is always a single force that is perpendicular to, and away from the surface. Roller brackets are commonly located at one end of long bridges. This allows the bridge structure to expand and contract with temperature changes. Expansion forces could break the supports on the shores if the bridge structure was blocked at the site. Roller brackets can also take the form of rubber bearings, rockers or a set of gears that are designed to allow a limited amount of lateral movement. A roller holder cannot provide resistance to lateral forces. Imagine a structure (maybe a person) on skates. It would remain in place while the structure should only support itself and perhaps a perfectly vertical load. As soon as a side load of any kind push the structure it will roll in reponse to the force. The side load can be a push, a gust of wind or an earthquake. Since most structures are subjected to side loads, it follows that a building must have other types of support, in addition to roller supports. FIXED SUPPORTS A fixed bracket can withstand both vertical and horizontal forces, but not at a time. They will allow

the structural member to rotate, but do not translate in any direction. It is believed that many connections are fixed connections, although they can withstand a small amount of momentum in reality. It is also true that a fixed connection could allow rotation in only one direction; providing resistance to rotation in any other direction. The knee can be idealized as a connection that allows rotation in only one direction and provides resistance to lateral movement. The design of a fixed connection is a good example of the idealization of reality. A single fixed connection is usually not enough to make a structure stable. Other support should be provided at some point to avoid rotation of the structure. The of a fixed support includes horizontal and vertical forces. FIXED FIXED CONNECTIONS contrast with roller brackets, a designer can often use fixed connections in a structural system. These are the typical connections found in almost all trusses. They can be articulated or hidden from view; they can be very expressive or subtle. There is an illustration of one of the elements at the Munich Olympic Stadium below. It is a molten steel connector that acts as a node to solve a number of tensile forces. After further examination it can be noted that the connection is made of a series of parts. Each cable is connected to the node by a final bracket that is connected to a large pin. This is literally a fixed connection. Due to the nature of the support and pin geometry, a certain amount of rotational motion would be allowed around the axis of each pin. One of the pyramid connections of I.M. Pei's Loiuvre addition follows below. Notice how he also used fixed connections. Fixed connections are confronted daily. Every time a hinged door is pushed open a fixed connection allowed rotation around a distinct shaft; and prevented translation in two. The door hinge prevents vertical and horizontal translation. In fact, if a sufficient moment is not generated to create rotation, the port will not move. Have you calculated how much time it takes to open a specific door? Why is one door easier to open than the other? FIXED SUPPORTS Fixed brackets can withstand vertical and horizontal forces as well as at a time. Since they restrict both rotation and translation, they are also known as rigid media. This means that a structure only needs a fixed bracket to be stable. All three equilibrium equations can be satisfied. A mast placed on a concrete base is a good example of this type of support. The representation of fixed supports always includes two forces (horizontal and vertical) and one moment. FIXED CONNECTIONS Fixed connections are very common. Metal structures of many sizes are composed of elements that are welded together. A cast concrete structure is automatically monolithic and becomes a series of rigid connections with proper placement of reinforcing steel. Fixed connections require greater attention during construction and are often the source of construction failures. Let this small chair illustrate how two types of fixed connections can be generated. One is welded and the other consists of two screws. Both are considered fixed connections due to the fact that both can withstand vertical and lateral loads, as well as develop a resistance to the moment. Thus, it was found that not all fixed connections should be welded or monolithic by nature. That the hinges on sites A and B be examined in detail. SIMPLE SUPPORTS Simple brackets are designed by some to be supports of frictionless. This is correct in how as the resulting reaction is always a single force that is perpendicular to, and away from the surface. However, they are also similar to roller brackets in this. They are different in that a simple support cannot withstand side loads of any magnitude. The constructed reality often depends on gravity and friction to develop a minimal amount of frictional resistance to moderate lateral loading. For example, if a board is placed in a breach to provide a bridge, it is assumed that the board will remain in its place. He'll do it until a foot kicks it or moves it. At this point, the board will move because the simple connection cannot develop any resistance to the lateral loal. A simple bracket can be found as a type of support for long bridges or roof extension. Simple supports are often found in zones of frequent seismic activity. IMPLICATIONS The following films illustrate the implications of the type of support condition on deflection behavior and the location of maximum bending stresses of a beam resting on its ends. Simple beams that are hinged on the left and roll supported on the right. Simple beams that are hinged on the left and fixed to the right. Simple beams that are fixed at both ends. Questions for Thought hmmm..... Homework Problems Additional Reading TBA