Transcript for 5.1 Structures

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Hello. For today's video lecture, we're going to be talking about structures. In engineering, a structure is any collection of connected bodies. For example, a pair of scissors consists of three different bodies: the back blade and handle, the front blade and handle, and the rivet holding them together. These connected bodies form a structure.

A bridge is another example-more traditionally thought of as a structure. A bridge has many components and bodies connected into a cohesive whole. In this case, the bridge is rigid, unlike the scissors, but it is still a structure.

A stool is also a structure, clearly in 3D. We could treat it as a single body and analyze it as a whole, or we could treat it as a structure made of many connected parts and analyze individual components.

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Types of Structures
Different types of structures influence how we analyze them and determine the forces acting on their pieces.

A truss is a rigid assembly made entirely of two-force members. We will discuss two-force members in more detail later.

A frame is a rigid assembly containing at least one member that is not a two-force member.

A machine is a non-rigid assembly containing at least one member that is not a two-force member.

The major distinction is between trusses and non-trusses (frames and machines). Trusses use specific analysis methods, while frames and machines use others.

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The basic analysis process is similar for all structures. In statics, the structure is assumed to be in equilibrium. This means the sum of the forces equals zero, and the sum of the moments equals zero. Because the structure is in equilibrium, each member or part of the structure is also in equilibrium.

For each piece-such as member AB or member BC-the sum of the forces must equal zero, and the sum of the moments must equal zero. We analyze structures by breaking them into parts and performing static analysis on each piece.

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When moving from analyzing a single body to analyzing a structure, two important factors arise: applying Newton's Third Law and identifying two-force members.

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Newton's Third Law states that for every action or force, there is an equal and opposite force. In a structure, whenever two bodies are connected, the force that body A exerts on body B is equal and opposite to the force that body B exerts on body A.

For example, in a clamp on a table, there are two Newton's Third Law pairs: one at the top contact point and one at the bottom. Each pair consists of equal and opposite forces between the clamp and the board.

In a structure, these third-law pairs appear at connection points. At point B, member AB is connected to member BC. The force at B on member AB is equal and opposite to the force at B on member BC. If we solve for one, we automatically know the other, reducing the number of unknowns.

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Two-Force Members
A two-force member is a body with forces (and no moments) applied at only two points. For example, member AB has forces at points A and B, making it a two-force member. Member BC, however, has forces at three points, so it is not a two-force member.

A two-force member has two equal, opposite, and collinear forces acting on it. It will be either in tension or compression. This property reduces the number of unknowns because the direction of the force is known-it acts along the line of the member.

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Methods for Analyzing Structures
First, identify the type of structure.

For trusses, we use the method of joints, the method of sections, or a hybrid of the two.

For frames and machines, we use a separate analysis method that relies heavily on Newton's Third Law and the identification of two-force members.

These two principles-Newton's Third Law and recognizing two-force members-are essential for analyzing all structures.

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That's all for today's video lecture. Thank you for watching, and I hope to see you again.