



Building Construction: Structural Strength and Stiffness

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Learning Objective: The student shall be able to explain the difference between structural “strength” and “stiffness.”

In building construction, structural strength and stiffness do not describe the same construction characteristic.

Strength is the ability to resist stress in the form of pressure. Strength is a property of the materials involved and the direction of the stress. Material strength usually describes the capability of materials to carry the loads without having failure in shear, elongation, or yield.



These posttensioning rods used in concrete construction add strength, but do not affect the concrete's stiffness.

Stiffness is a derived property involving not only strength but the material's shape. For example, two beams of different shapes made of reinforced concrete will have different stiffness even though they are the same material. Stiffness is a capability of materials to resist against bending, buckling, or deflection.

Here's an analogy that may help explain the difference: stretch a rubber band to its failure point. The rubber band fails at some measurable stress point, but it may stretch more than double its length before failure. The rubber band was not very stiff. In fact, it was elastic.

Next, stretch a kite string and find that it also fails at the same stress point. It may stretch only a small percent of its length before failure. It is very stiff. Both the rubber band and the kite string have the same ultimate strength. However, one is very stiff and the other is very flexible. This should demonstrate that strength and stiffness are not the same thing, and they are dependent upon the chosen material.

Furthermore, the shape of the material also determines its stiffness without affecting its ultimate strength. For example, take a plastic ruler that is 1/8-inch (3.2 mm) thick and 1-inch (25.4 mm) wide and bend it in the flat direction. It is obvious that it is flexible. However, if you try to bend across the 1-inch (25.4 mm) thickness you find that it is very stiff. This demonstrates that the shape of the material causes the stiffness to change.

Structural engineers use these material characteristics to achieve strength and stiffness by selecting the variety of construction materials and configurations most suited to the architect's proposed design.

