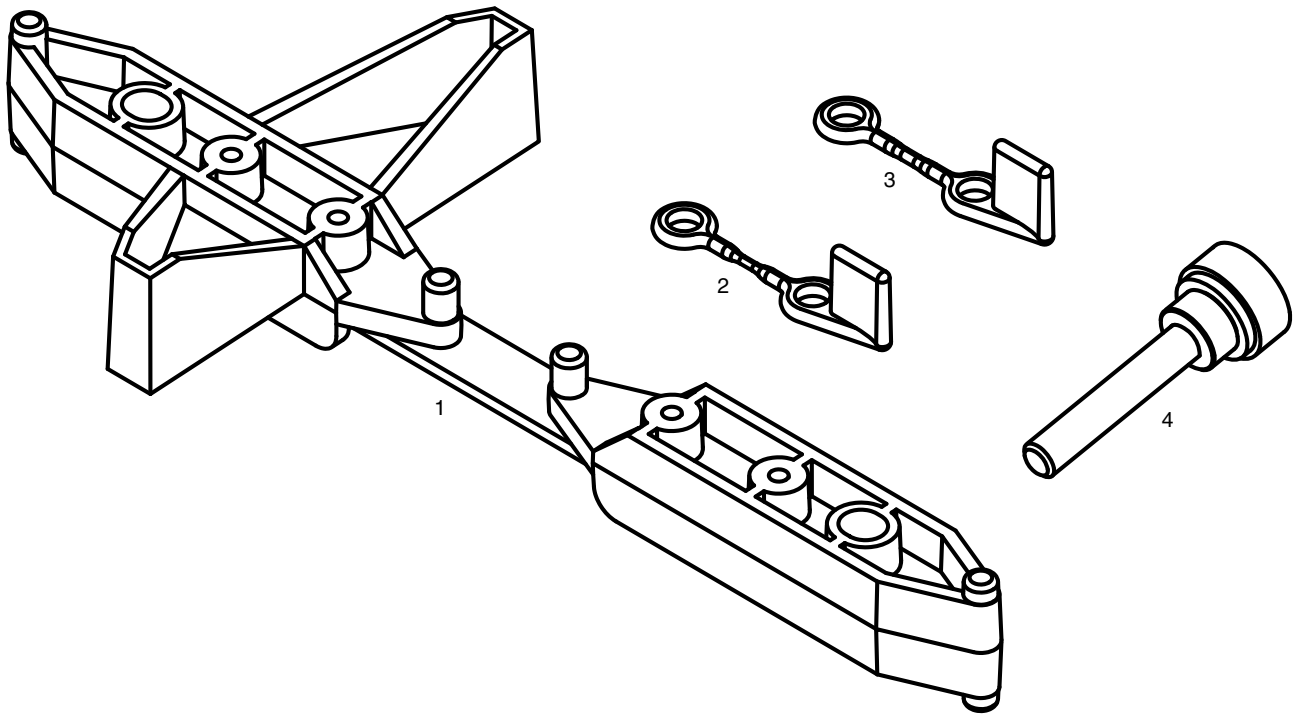
PASCO Structures System

Destructible Bridge Members

ME-7004



Included Equipment	**Quantity**
1. Destructible Member	2
2. Breakable Link A	100
3. Breakable Link B	100
4. Adapter Screw Assembly	2

Recommended Equipment	**Part Number**
• Advanced Structures Set	ME-6992A
• Large Slotted Mass Set	ME-7589
• Displacement Sensor	PS-2204
• 100 N Load Cell	PS-2200
• Dual Load Cell Amplifier	PS-2205
• PASPORT Interface*	(see catalog)
• DataStudio Software*	(see catalog)

Related Equipment

• Cast Beam Spares Set	ME-6983
• Truss Set	ME-6990
• Bridge Set	ME-6991
• Cast Beam Structures Set	ME-7009

**See the PASCO catalog or Web site at www.pasco.com for information.*

Introduction

The Destructible Bridge Members set consists of Destructible Members and Breakable Links of two different strengths. Also included is an adapter screw for fastening a dial indicator of a PS-2204 Displacement Sensor to a beam or a Load Cell. The purpose of the Destructible Bridge Members set is to allow the study of structural failure under heavy loads. The Destructible Member has a metal plate that is a fail-safe device to prevent catastrophic collapse of a structure being tested. The Destructible Member can be used as a #3 beam in any PASCO Structure Set.

Sensors can be used to measure the force needed to pull apart a Breakable Link when it is mounted on the Destructible Mem-

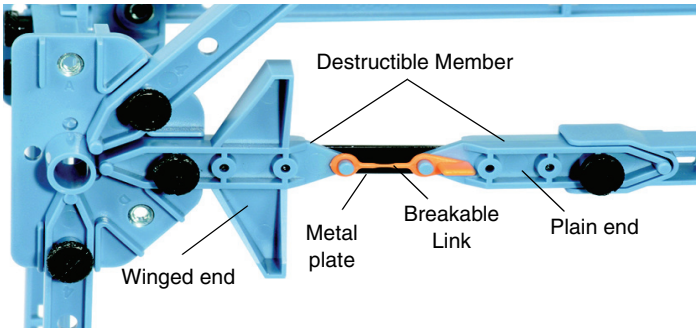
ber. You can calculate the Young's modulus for the material in the Breakable Links which come in two different diameters.

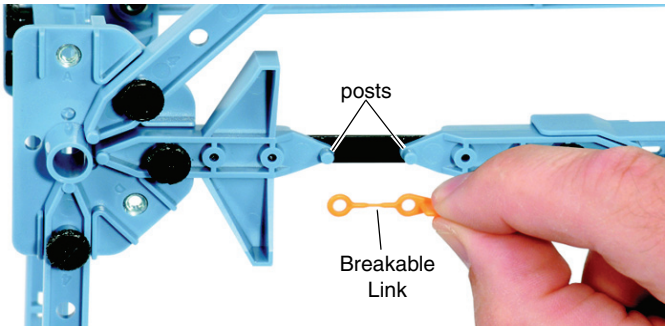
A replacement set of Breakable Links (ME-7005) is available that includes 100 of each type of link. See the note on page 5.

About the Destructible Member

The Destructible Member has two end pieces held together by an aluminum plate that acts as a safety link. The two ends can move slightly relative to the safety link when a load is applied. When the Breakable Link on the Destructible Member breaks, the safety link keeps the two end pieces together.

The Destructible Member is reusable. When a Breakable Link breaks, it can be easily replaced with a new one. Grip the link by its tab and slide the holes of the new Breakable link onto the posts of the Destructible Member.

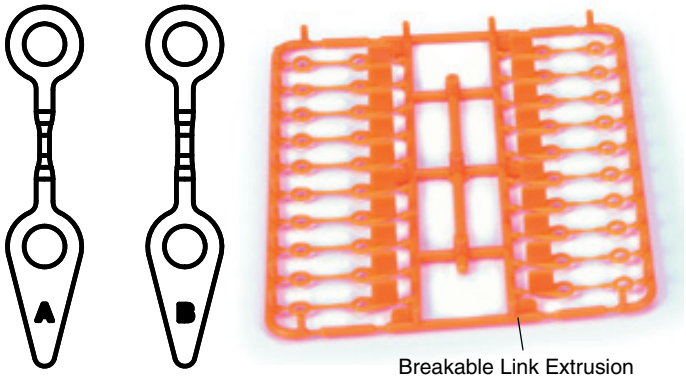




Breakable Links

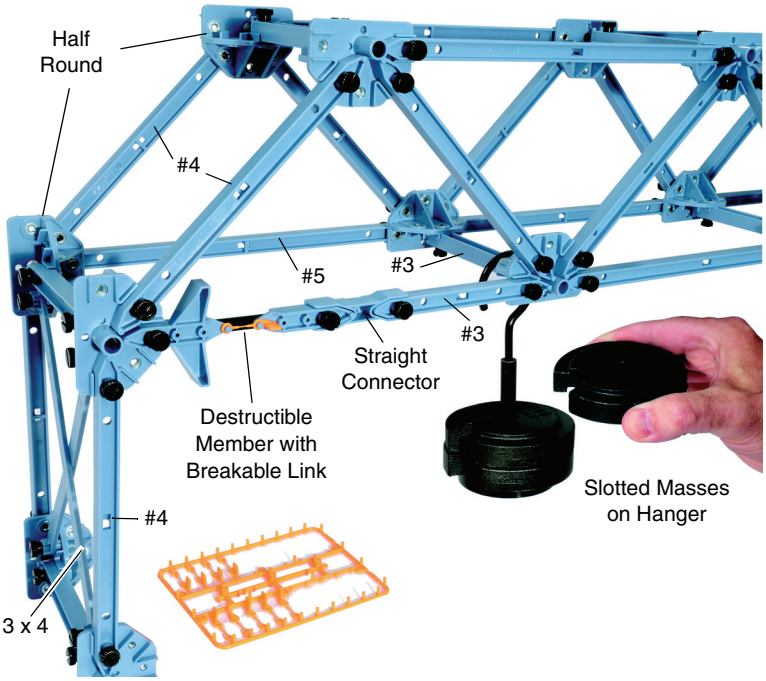
The Breakable Links are made from extruded plastic. The Breakable Link A has a minimum diameter of 0.029 inches ± 0.001 inches (0.736 mm ± 0.025 mm) and the Breakable Link B has a minimum diameter of 0.042 inches ± 0.001 inches (1.06 mm ± 0.025 mm).

The Breakable Links are molded. Twist a link to remove it from the sprue (the passage through which the molten plastic entered the mold). Each extrusion holds ten each of the two kinds of links. Each link has its identifying letter molded on the underside of the pointed end.



Testing the Destructible Member.

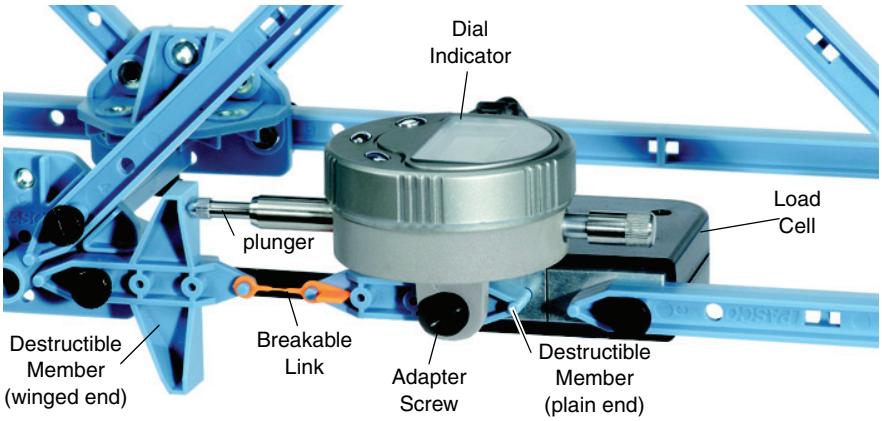
When a Destructible Member is part of the construction of a bridge model, you can hang masses on a cross member of the bridge to apply tension to the Destructible Member. If a Load Cell and the Dial Indicator of a Displacement Sensor are added to the structure, you can measure the tension through the Breakable Link and the displacement (stretch) of the link up to its point of failure



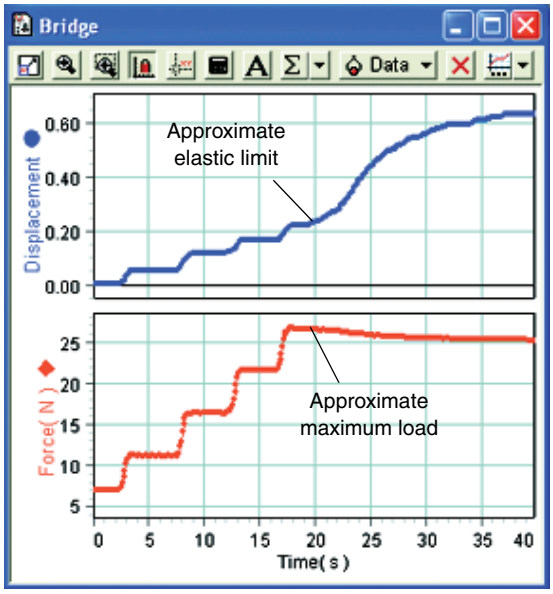
Mounting a Dial Indicator and Load Cell

Replace the Straight Connector shown in the previous illustration with a 100-N Load Cell.

Use the Adapter Screw to attach the Dial Indicator of the Displacement Sensor through the plain end of the Destructible Member and into the Load Cell. Arrange the Dial Indicator so that its plunger touches one side of the winged end of the Destructible Member. Connect the USB cable from the Dial Indicator to the Displacement Sensor (not shown).



As each slotted mass is added, the stretch of the Breakable Link is measured by the Dial Indicator of the Displacement Sensor. The tension (**stress***) is measured by the Load Cell. The displacement (**strain****) suddenly increases when the Breakable Link is stretched beyond its elastic limit. The metal plate keeps the bridge structure from collapsing catastrophically if the Link does fail..



Note in the sample graph that the amount of force needed to continue stretching the Link once it is past its elastic limit is slightly less than the maximum load needed to reach the elastic limit.

Because the plastic used to make the Links is very stretchy, the Link may not break before the metal safety plate reaches its limit. To make the Link break sooner, try scratching a very small groove in the plastic with a fine file.

About the Elastic Limit

When the elastic limit of a material is exceeded, the material's cross section decreases (called "necking down"). This leads to a decrease in total load while the stress level in the material continues to increase to the ultimate stress at fracture.

***Stress** is the tension load divided by the cross sectional area of the sample.

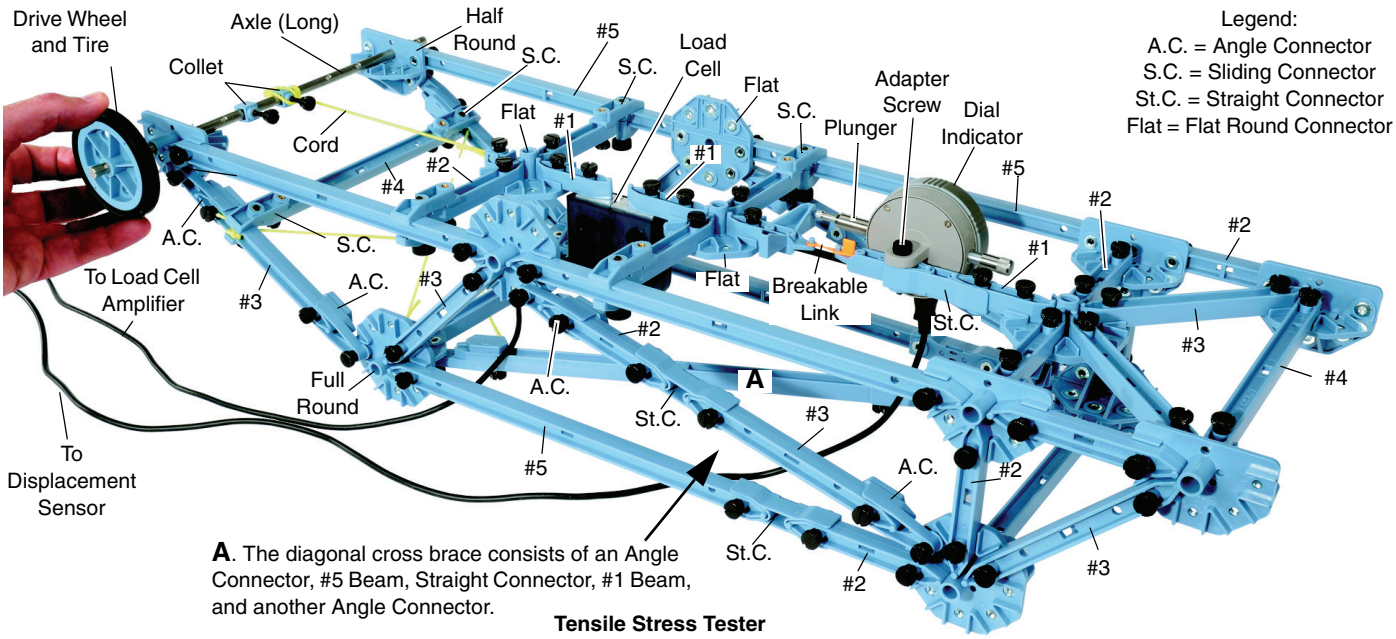
****Strain** is the deflection (or deformation) of the sample due to the loading.

Build a Tensile Stress Tester

A successful Tensile Stress Tester provides the following

- Support for the Destructible Member.
- Mechanism to apply a load to the Breakable Link of the Destructible Member.
- Ways to measure the load on the Breakable Link and also its displacement (stretch).

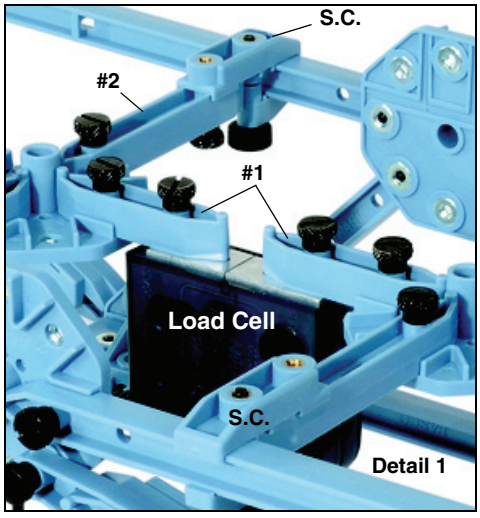
For example, use the Advanced Structures Set to construct the model shown below:

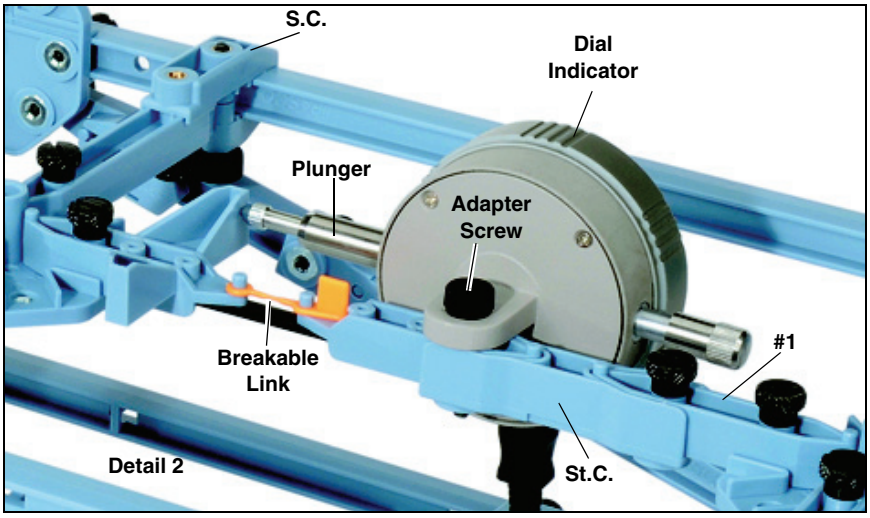


A. The diagonal cross brace consists of an Angle Connector, #5 Beam, Straight Connector, #1 Beam, and another Angle Connector.

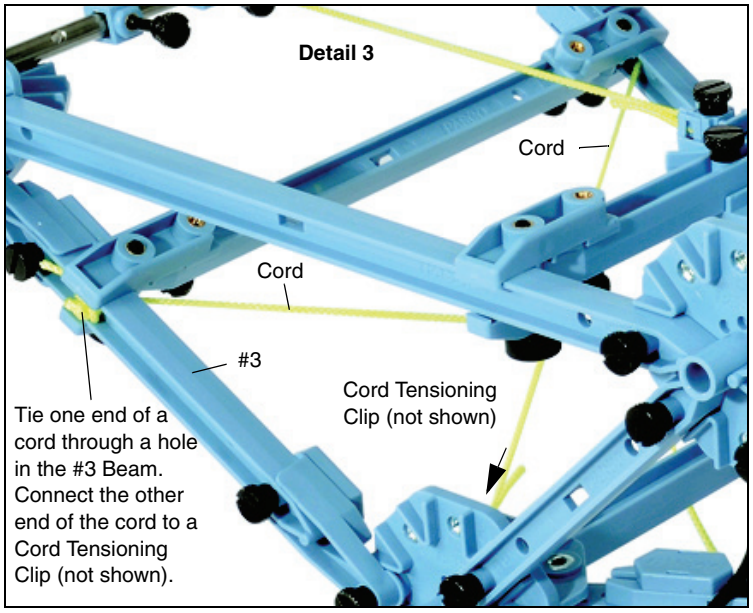
Tensile Stress Tester

- Add a 100-N Load Cell to measure the tension and the Dial Indicator of the Displacement Sensor to measure the displacement (stretch) of the Breakable Link.Arrange the Dial Indicator so that its plunger touches the winged end of the Destructible Member. (See Detail 1 and Detail 2.)
- Attach a cord to a Cord Tensioning Clip on the Flat Round Connector and then to a Collet on the Long Axle. [NOTE: Tie the cord to the Cord Tensioning Clip so that the cord cannot slip.]
- Use the Drive Wheel on the Long Axle to wind up the cord and apply a load. The load limit is 100 N..
- Make sure that the Sliding Connectors on the #5 Beams are slightly loose so that they can slide freely along the beams..





- Use cord to cross brace the end of the structure with the Axle and Drive Wheel. (See Detail 3.)



Young's Modulus

In mechanics, Young's modulus (also known as the modulus of elasticity) is a measure of the stiffness of a uniform elastic material. It is defined as the ratio of the stress over the strain in the range of stress in which the graph of stress versus strain is linear (i.e., Hooke's Law applies).

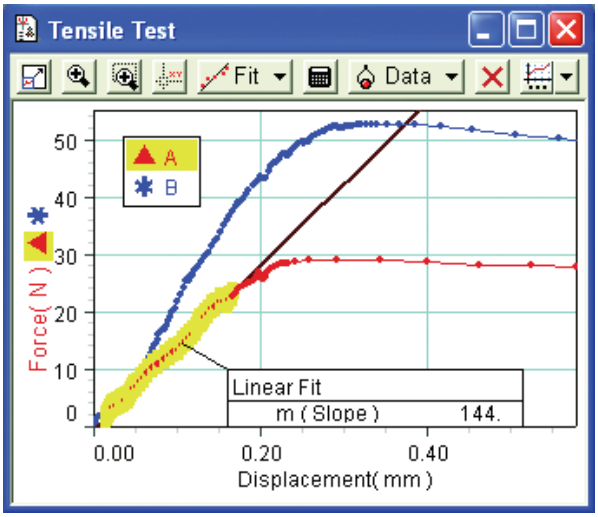
Isotropic materials exhibit the same modulus and yield in both tension and compression. Many metals and plastics are isotropic.

Anisotropic materials exhibit a different modulus and yield in tension than it does in compression. Concrete is an example of an anisotropic material (i.e., strong in compression but weak in tension.). The ME-7009 Cast Beam Structures Set or the ME-6983 Cast Beam Spares Set can be used to explore this phenomenon.

Young's modulus can be experimentally determined from the slope of a stress-strain curve created during tensile tests conducted on a sample of the material. Stress is determined from the load on the sample and strain is derived from the deformation of the sample, such as elongation (stretch).

- A graph* of Force (N) versus Displacement (mm) for Breakable Link A (▲) and Breakable Link B (✱) can be used to determine the Young's modulus of each link.The sample graph shows a linear fit for the data for Breakable Link A.

- *NOTE: The data would normally be shown on a graph of stress (σ) versus strain (δ).



About the Replacement Breakable Links

The ME-7005 Destructible Bridge Members Spares set consists of consumable replacements for the ME-7004 Destructible Bridge Members set.

The set has ten extrusions with ten of each kind of Breakable Link for a total of 100 of the Breakable Link A and 100 of the Breakable Link B.

The Breakable Links are molded. Twist a link to remove it from the sprue (the passage through which the molten plastic entered the mold). Each link has its identifying letter molded on the underside of the pointed end.

ME-7005 Destructible Bridge Members Spares Set

Technical Support

For assistance with any PASCO product, contact PASCO at:

Address: PASCO scientific
10101 Foothills Blvd.
Roseville, CA 95747-7100

Phone: 916-786-3800 (worldwide)
800-772-8700 (U.S.)

Fax: (916) 786-7565

Web: www.pasco.com

Email: support@pasco.com

For the latest revision of this Instruction Sheet, visit:

www.pasco.com/go?ME-7004

Patents Pending The following PASCO products have patents pending:

ME-6987 Flat Structures Members	PS-2198 Load Cell Amplifier
ME-6990 Truss Set	PS-2199 Load Cell and Amplifier Set
ME-6991 Bridge Set	PS-2200 100 N Load Cell
ME-6992A Adv. Structures Set	PS-2201 5 N Load Cell
ME-6995 Road Bed Spares	PS-2205 Dual Load Cell Amplifier