MATERIALS TESTING LABORATORY

FACULTY OF ENGINEERING

CHULALONGKORN UNIVERSITY

Party No. ....   Date of tested ....

Name ....   Graded by ....

TEST No. S8

TENSION TEST OF WIRE AND WIRE ROPE

PURPOSE To determine the tensile stress and efficiency of the wire rope, the structure and ductility of wires of which it is made.

The properties to be determined are

1. Details of construction of wire rope including its diameter, number of strands, number and diameter of wires in a strand, type of center, type of lay and pitch of wires and strands
2. Tensile stress of each wire in one strand
3. Tensile stress and efficiency of wire rope

REFERENCE ASTM

JIS

SPECIMEN Wire rope and one strand from the same coil of rope

APPARATUS Amsler universal testing machine of 1 ton and 20 tons capacity

Autograph testing Machine of 1 tons capacity

Revised by PPS @May 1998

TYPES AND CHARACTERISTICS OF WIRE ROPE

A wire rope is a cord made of strands of wire made of any ductile metal such as iron, steel or bronze, twisted together. Ordinary rope is composed of a number of strands and each strand contains group of wires, usually laid around a hemp center.

The **hemp center** is designed to support and lubricates the wire strands. Obviously, it is impossible to put enough lubricant in a rope during construction to last the life of the rope. Internal friction will be reduced and resistance to corrosion shall be increased if the rope is periodically treated with a lubricant that will adhere to the metal and penetrate to the hemp core. Such treatment is especially necessary if the rope is subjected to acid fumes or acid or salty water.

Most wire rope is made **right lay**, in which the strands are laid around the center, like right-hand screw threads.

The terms **regular lay and lang lay** refer to the type of rope construction in which for the **regular lay** (either left or right lay), **the wires in the strand and the strands in the rope are laid in the opposite directions**, thus making the wires on the outside of the rope lie paralleled with the axis of the rope. This regular lay is standard construction.

In the **lang lay** construction, **both wires and stands are laid in the same direction**, with the result that the wires, which now lie at an angle with the axis of the rope, have a greater exposed length and hence the wearing qualities of the rope are increased. The lang lay rope, although it has a high resistance to abrasion if not damaged, is not generally used because it is more liable to curl and kink and is difficult to handle, often being called a cranky line. Therefore, regular lay is more widely used.

The **efficiency** of a wire rope is computed by dividing its actual tensile stress by the average tensile stress of the individual wires in the rope and multiplying this ratio by 100 to convert to a percentage. **It is always less then 100 and is usually about 80 to 85.**

PROCEDURE

TESTS OF WIRES

1. Unravel the extra strand of rope. Note its construction.

2. Grip one of the wires in one head of the testing machine. Pull the other end of the wire taut and tighten the grip. Taking care that the clear length of the wire between the grip is at least 30 cm.

3. Apply a load that will stress the wire to not more than one-fourth of its ultimate strength, say 15 kg and then measure and record the average diameter of the wire.

4. Apply the load continuously at a speed of the movable head of not more than one inch per minute. Record the breaking load of the wire.

5. Repeat the same operation as above for all wires in one strand, or about 20 wires.

6. Compute the average tensile stress of the tasted wires.

ROPE TEST

1. Sketch the wire rope showing both cross section and side view. Measure the pitch of the wires and the strands and observe the lay. Take complete notes so that a brief description of the construction can be included in the report. Measure the diameter of the rope, which is defined as the diameter of the circle will just enclose it.

2. Secure the wire rope in the heads of the testing machine and apply load at a moderate speed. Record the load when the first wire breaks, the maximum load, the character and location of fracture.

3. Pull the specimen apart, then measure the nominal size of the center and note the kind of the material from which it is made.

4. Compute the efficiency of the rope including the required properties.

DATA

TEST OF WIRES

Number of wires in a strand ....

Lay of wire in the strand ....

Pitch of wire per foot of strand ....

Wire No	Diameter (cm)	Area of Wire (sq. cm)	Breaking Load (kg)	Tensile Stress (ksc)	Remarks
Average					

ROPE TEST

	Specimen No. 1	Specimen No. 2
Length of rope (cm)	....	....
Length between grips (cm)	....	....
Diameter of rope (cm)	....	....
Lay of strand	....	....
Pitch of strand per foot of rope	....	....
Number of strands in rope	....	....
Type of core	....	....
Load when the first wire breaks (kg)	....	....
Maximum load (kg)	....	....
Character and location of failure	....	....

Sketch of Wire Rope Structure

SAMPLE OF CALCULATION

TEST OF WIRES

Specimen No. ....

Tensile stress of wire = (Breaking load, kg) / (Area of wire, sq. cm)

= ....

= .... ksc

ROPE TEST

Specimen No. ....

Actual tensile stress = (Maximum load of rope, kg) / (Sum of area of all wires in rope, sq. cm)

= ....

= .... ksc

Efficiency of wire rope = (Actual tensile stress of rope / Average tensile stress of wires) x 100

= ....

= .... %

SUMMARY OF RESULTS

	Specimen No. 1	Specimen No. 2	Average
Tensile stress of wires (ksc)	....	....	....
Actual tensile stress of wire rope (ksc)	....	....	....
Efficiency of wire rope (%)	....	....	....

DISCUSSION AND CONCLUSIONS

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TEST No. S10

TENSION TEST OF STEEL

PROPOSE To determine the stress and several elastic and inelastic properties of the ductile steel, to observe the behavior of the material under load and to study its fracture. The specific properties to be determined are

1. Elastic stress in tension
   - a) Proportional limit (P.L.)
   - b) Upper and lower yield points
   - c) Yield tensile stress for an offset of 0.1% strain
2. Ductility
   - a) Final elongation in each 2.5 cm of length
   - b) Percentage of elongation in 5 and 20 cm
   - c) Percentage of area reduction
3. Modulus of elasticity
4. Modulus of resilience
5. Type and character of fracture

REFERENCE ASTM A370 E8

JIS

SPECIMEN Low carbon steel bars.

APPARATUS Extensometer with 20 cm gage length.

Revised by PPS @ May 1998

PROCEDURE

1. Determine the average cross sectional dimensions of the specimen with a micrometer screw gage. Scribe a line along the bar and, with a center punch, slightly marks 20 cm gage length symmetrical within the length of the bar. Also marks 2.5 cm of length within the gage length and make other marks 2.5 cm of length within the gage length and make other marks 2.5 cm outside the gage length at each end.

2. Firmly grip the upper end of the specimen in the fix head of the testing machine. Place the specimen so that punch marks face the front of the machine.

3. Measure the gage length and determine the multiplication ratio the extensometer. Determine the value of the divisions on the dial indicator. Firmly attach the extensometer to the specimen so that its axis coincides with the axis of the specimen and remove the spacer bar (if any). Adjust the testing machine and the extensometer to read zero, setting the latter so that most of its capacity will be available. Grip the lower end of the specimen, taking care not to jam the extensometer.

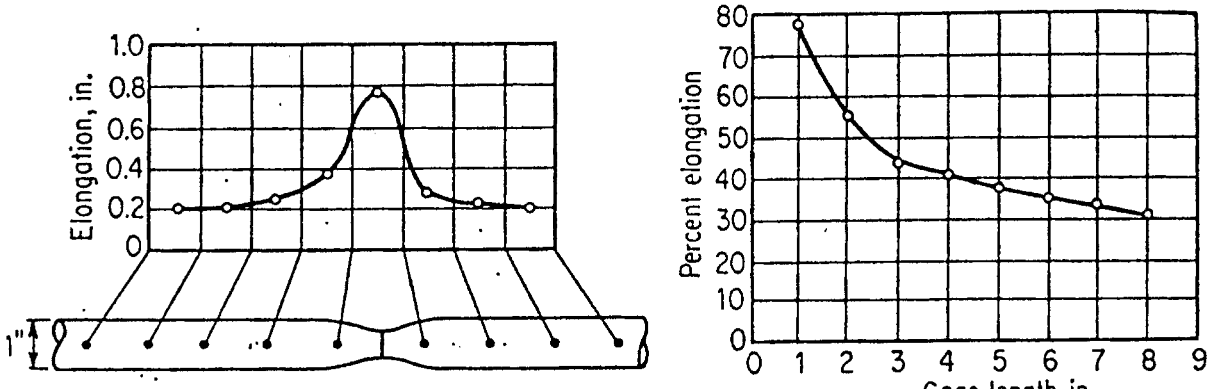
4. Select the suitable increments of load to secure at least 15 readings below the probable proportional limit. Apply load at slow speed, and take simultaneous observations of load and elongation without stopping the machine. Continue loading until the yield point is passed, then stop the machine (but hold the load) to remove the extensometer.

5. Again apply the load continuously. When the gage length was increased 0.25 cm in the 20 cm gage length, as measured with the dividers and scale, read the corresponding load. Thereafter, for each 5 mm increase in the gage length, read the load. Record the maximum and breaking loads.

6. Remove the broken specimen from the machine. Observe the location and character of the fracture and measure the dimensions of the smallest section. Fit the broken parts together and measure the gage length and the intervals between intermediate punch marks.

7. Plot a stress-strain diagram for the test on the first sheet and on the second sheet, plot a graph showing the elongation in each 2.5 cm of gage length as ordinates and the number of 2.5 cm divisions as abscissas and connect the plotted points by straight lines. Indicate the location of the fracture on this graph.

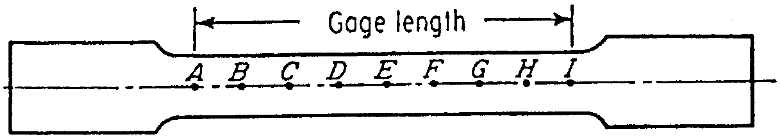
8. Compute all properties required. For the percentage of elongation in 5 cm, use 5 cm length most nearly center of the fracture.



(a) Elongation in each inch

(b) Percent elongation vs. gage length

Effect of gauge length on percentage of elongation

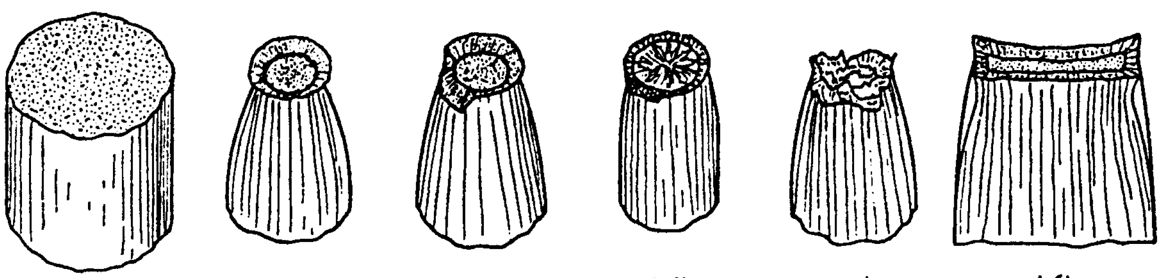


For breaks between C and G; Elongation = Final AI − Original AI

For breaks between A and C but nearer B than A;
Elongation = Final (AC + 2CF) − Original AI

For breaks within one half division of A; Elongation = Final 2AE − Original AI

Determination of approximate elongation for breaks outside middle-third of gauge length



(a) Flat, granular, cleavage

(b) Cup-cone, silky

(c) Partial cup-cone, silky

(d) "Star fracture"

(e) Irregular, fibrous

(f) Cup-cone, silky (flat specimen)

Typical tensile fractures of metals

DATA

	Specimen No. 1	Specimen No. 2
Average diameter of specimen before test, d (cm)	....	....
Average cross sectional area of specimen	....	....
Reduced diameter after test, d' (cm)	....	....
Gage length, L (cm)	....	....
Elongation in each 2.5 cm length (cm)	....	....
	....	....
Elongation in 5 cm gage length (cm)	....	....
Elongation in 20 cm gage length (cm)	....	....

Specimen No. 1					Specimen No. 2				
Load (kg)	Dial (mm)	Elongation	Stress (ksc)	Strain	Load (kg)	Dial (mm)	Elongation	Stress (ksc)	Strain

SAMPLE OF CALCULATION

Specimen No. ....

Tensile stress at Proportional Limit	=	=	ksc
Tensile stress at Upper yield point	=	=	ksc
Tensile stress at Lower yield point	=	=	ksc
Yield stress for an offset of 0.1% strain	=	=	ksc
Ultimate tensile stress	=	=	ksc
Percentage elongation in 5 cm	=	=	%
Percentage elongation in 20 cm	=	=	%
Percentage of area reduction	=	=	%
Modulus of elasticity	=	=	ksc
Modulus of resilience	=	=	kg-cm/cc

SUMMARY OF RESULTS

	Specimen No. 1	Specimen No. 2
Average diameter of specimen before test, d (cm)	....	....
Reduced diameter after test, d' (cm)	....	....
Tensile stress at Proportional Limit (ksc)	....	....
Tensile stress at Upper yield point (ksc)	....	....
Tensile stress at Lower yield point (ksc)	....	....
Yield stress for an offset of 0.1% strain (ksc)	....	....
Ultimate tensile stress (ksc)	....	....
Percentage elongation in 5 cm (%)	....	....
Percentage elongation in 20 cm (%)	....	....
Percentage of area reduction (%)	....	....
Modulus of elasticity (ksc)	....	....
Modulus of resilience (kg-cm/cc)	....	....

DISCUSSION AND CONCLUSIONS