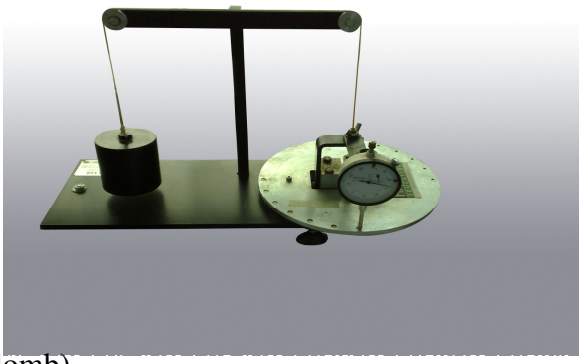
Lab Manual **Mechanics of Materials-II**

EXPERIMENT NO. 5

Objective:
The object of this experiment is to determine what levels of combined bending and torsion cause elastic failure in different material and to compare them with various theories of failure.

Apparatus:
Combined bending and torsion, Weight, Dial gauge, Vernier Caliper, Specimen, Hanger, Spanner



Theory:

Theories of Elastic Failures:

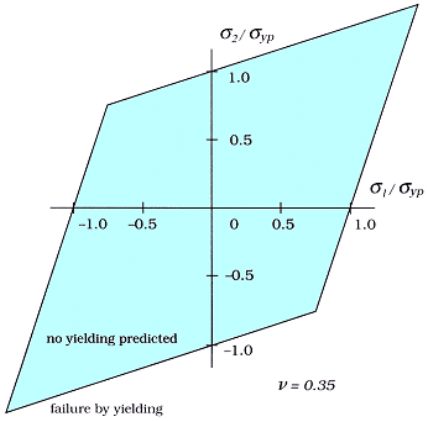
1. Maximum Principal Stress Theory (Rankine, Lamé)
2. Maximum Principal Strain Theory (Saint-Venant)
3. Maximum Shear Stress Theory (Tresca, Guest, Coulomb)
4. Total Strain Energy Theory (Beltrami-Haigh)
5. Maximum Distortion Energy Theory (Huber-Henky-von Mises)
6. Mohr's Fracture Criterion

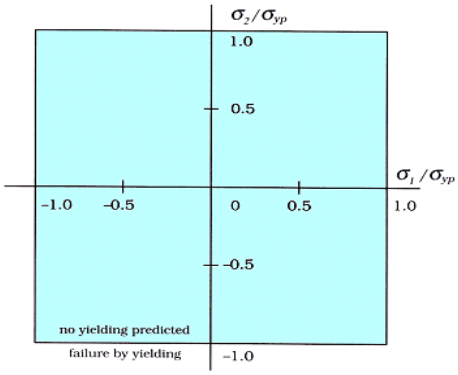
Summary of Theories of Elastic Failure:

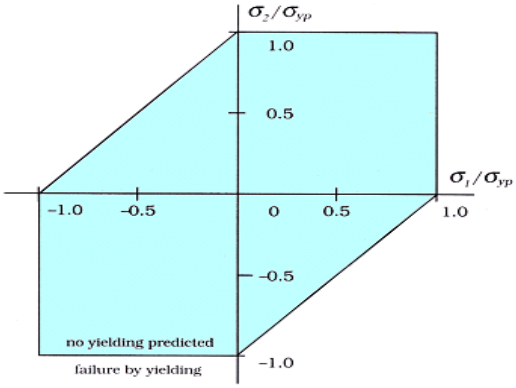
Many experiments have been conducted under complex stress system to study the behavior of different materials & it has been shown that:

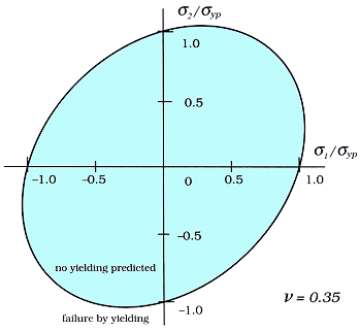
1. Materials does not fail under hydrostatic stress system i.e $\sigma_1 = \sigma_2 = \sigma_3$
2. None of the theories agrees with the test perform for all types of materials and combinations of loads.
3. There is a good agreement between the maximum distortion energy theory and experimental result for ductile materials.
4. The max. principal stress theory appears to be the best for brittle materials

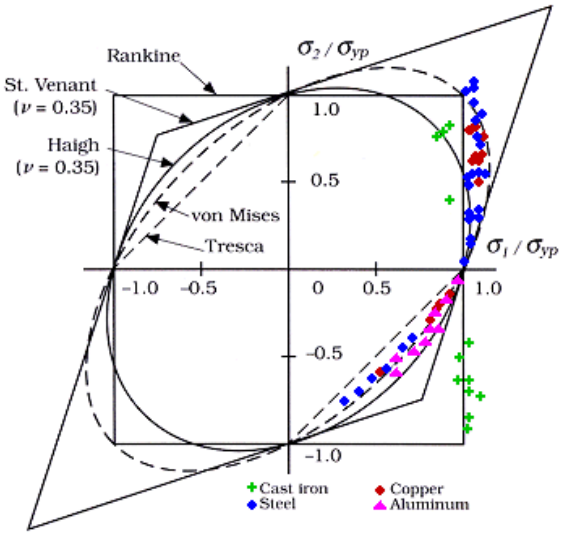
5. Max. Shear stress or max. Strain energy theories give the good approximation for ductile materials but the max. Shear stress criterion is somewhat more conservative.
6. The max. Strain theory should not be used in general as it only gives the reliable results in particular cases.
7. If the brittle material has a stress strain diagram, that is different in tension and compression, then the MOHR'S Failure Criterion may be used to predict the failure.

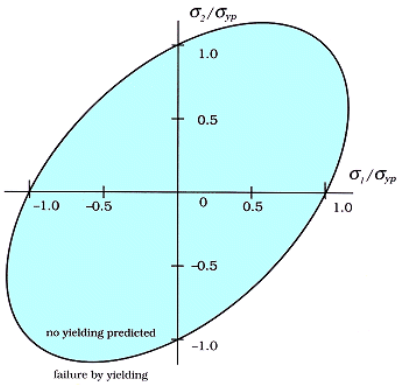












1. Maximum Principal Stress Theory (Rankine, Lamé) (Fig. 1)
2. Maximum Principal Strain Theory (Saint-Venant) (Fig. 2)
3. Maximum Shear Stress Theory (Tresca, Guest, Coulomb) Fig. (3)
4. Total Strain Energy Theory (Beltrami-Haigh) Fig. (4)
5. Maximum Distortion Energy Theory (Huber-Henky-von Mises) (Fig. 5)

Procedure:

Record the material and neck diameter for the test specimen being used into table 1a.

Place the apparatus near the corner of a worktop with the circular loading plate overhanging the edge. The dial gauge side should face the other edge of the corner.

Record the weight the of the load hanger. Put the first specimen in the apparatus and clamp it as described above. Set the dial gauge diametrically opposite the zero degrees load point and use the adjustable bezel to zero the outer ring against the large pointer. Now put the load hanger on the zero degree dimples and enter the dial gauge reading in the column marked DTI rdg in table 1a. This will be the zero load reading. Add 4Nto the load hanger and again enter the dial reading in table 1a. In the column diff in table 1a, fill in the difference, this should be similar to one before for linear elasticity.

Repeat the 4n increments while carefully watching for a trend to increasing differences as the linearity limit is reached. As the end of the linearity approaches reduce the load increments to 2N and then 1N, reckoning the differences between successive load in proportion. Try to stop adding more load before there is a 10% increase in the differences.

As soon as non-linearity is determined unload the hanger and remove it move the dial gauge round by 15°and re-zero. Then repeat the above procedure. Carry on doing this until the loading at 90° has been completed.

Unclamp the specimen and replace it with a new one of the same material. The whole of the foregoing procedure can then be followed, but starting at 90° position and working back by 15° interval to the 0° position. The results should be recorded in table 1b.

Graph: On graph plot the Torque Vs Moment.

Lab Report:

The laboratory report should contain the following:

1. Plot of curve between Load and Deflection as shown above.
2. Hand calculations showing all results under procedure above.
3. Derivation of formulae.
4. A discussion / comments of factors affecting the results of the experiment.
5. Practical Applications

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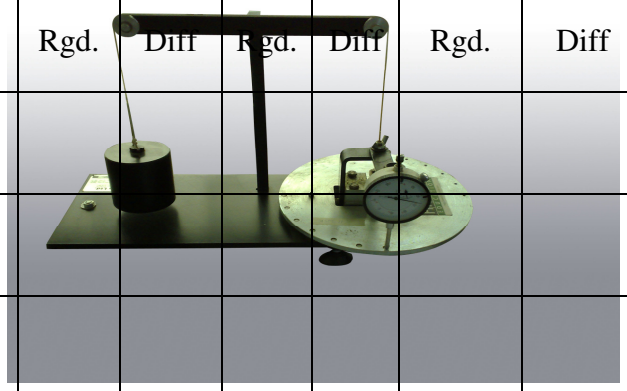
Material	**Steel**	T_{max} = _____	T =0.1 W_1 Cos Ø
Neck diameter, mm	_____	M_{max} = _____	M=0.1 W_1 Sin Ø
Load hanger wt, N	**4.6**		

Added Load	0°		15°		30°		45°		60°		75°		90°	
(N)	Rgd.	Diff.	Rgd.	Diff	Rgd.	Diff	Rgd.	Diff	Rgd.	Diff	Rgd.	Diff	Rgd.	Diff
1														
2														
3														
4														
5														
6														
7														
8														
T														
M														



Name: _____ **Reg. # 2009-ME-_____**

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