CHAPTER V

CONCLUSIONS

The value of Young's Modulus, Modulus of Rigidity and Poisson's Ratio as obtained for the Mild Steel are in good agreement with the generally accepted values.

In the combined bending and torsion tests for mild steel at a small angle ϕ, the results follow closest the maximum principal strain theory. At higher values of ϕ they tend towards the maximum shear stress theory (see Fig. 17). According to the tests made by Taylor and Quinney, the results lie between the maximum principal strain theory and the strain energy of distortion. In their diagram, the line of maximum principal strain energy theory was not shown, but examination shows that the results lie more closely to the maximum strain energy line than the strain energy of distortion line.

The results of mild steel in bending, torsion and internal pressure, satisfy best the strain energy of distortion line. The results show good agreement with those tested by Ros and by Lode.

For the results of brass subjected to bending and torsion, they follow best the maximum strain energy theory. As in the mild steel case, the value for $\phi = 90°$ tends more to the maximum shear theory. When internal pressure was added, the results show good agreement with the strain energy of distortion line.

For the cast-iron results, they show close agreement with the maximum principal stress theory, which in turn agrees with the tests made both by Ros and by Cook and Robertson, but their specimens were thick-walled and so a third Principal Stress was present.

When the specimens were subjected to bending and torsion only, the value of bending stresses at $\phi = 0^\circ$ was used as the denominator, instead of the value yield stress. This is because the specimens had solid symmetrical section so that bending stresses lay between the ultimate tensile stress and ultimate compressive stress. When the specimens were subjected to bending, torsion and internal pressure, the ultimate tensile stress was used as the denominator again.

The principal stresses were calculated by using the values of stresses that occurred at the outer surface of the specimen, because the internal pressure was not high enough to produce maximum principal stresses at the inner surface.

Fig. 20 and 21 show the failures of the cast-iron specimens. The plane of fracture is perpendicular to the maximum principal stress direction.

To sum up, it is seen that the results obtained are reasonably in agreement with the theoretical ones, although it is to be expected that the results will be affected by stress concentrations due to scratches on the surface and also by residual stresses in the metal bars, since no normalization was carried out. However, care was taken to avoid using the ends of the metal bars, and portions of the cast-iron bar where chilling was evident.

Any errors due to lack of concentricity of bore and outside surface should be very small due to the method of machining the surface after reaming the bore.

From the tests, it can be concluded that :-

(1) For ductile metals subjected to combined bending and torsion, if $\tau < 0.4\sigma_e$, the maximum principal strain should be used in design; as $\tau > 0.4\sigma_e$, the maximum strain energy theory is recommended.

(2) For ductile metals, subjected to combined bending, torsion and internal pressure, the strain energy of distortion theory satisfies the results very well.

(3) For brittle metals, subjected to combined stresses, the maximum principal stress is well defined.

Owing to the simple nature of the apparatus, inaccuracies should be small. The precautions taken when selecting the materials should ensure reasonable homogeneity and the high quality of the surface finish should reduce any stress concentrations to very small values.