CHAPTER I

INTRODUCTION

If a metal bar is subjected to a gradually increasing axial load causing only one principal stress on any transverse section, the material will begin to acquire inelastic deformation when the load reaches a certain value. This inelastic action is considered to be the criterion of failure of the material. The strength of the material where inelasticity just occurs is called the yield stress or elastic limit. Hence, when a structural member is subjected to a uniaxial load, the yield stress, as obtained from the simple tensile test, is the limiting value of the load carrying capacity. In fact, there are at least four others properties of the material that have been proposed and used in design as a measure of the limiting resistance value of the material. But in a uniaxial stress they occur simultaneously and give the same dimensions for the designed member.

However, if the member is subjected to a biaxial loading system, these properties will not occur simultaneously. It is a matter of considerable importance in design as to which one of the properties is assumed to limit the loads that can be applied to a member without causing inelastic effects. These five properties suggest five theories of failure. They are : (i) maximum principal stress theory, (ii) maximum shearing stress theory, (iii) maximum principal strain theory, (iv) total strain energy theory, and (v) strain energy of distortion theory.

Review of Past Work

Turner [1]° (1909-1911) who tested relatively thin-walled cylinders under combined internal pressure and axial pull, suggested that yield occured at a critical shear stress which was higher in the combined stress tests than in a simple tension test. His results showed disagreement with the theories because they were affected by the eccentricity of the tubes

and lack of axiality in loading.

Cook, G., and Robertson T. [2] (1917), tested thick hollow cast-iron and mild steel cylinders under internal pressure, this produced principal stresses of unlike sign. They eliminated residual stress by normalizing the specimen before test and measured the eccentricity of loading in the tension tests. They found that for mild steel, the maximum shear stress was valid, while for cast-iron the results show good agreement with the maximum principal stress theory.

Roe, M., and Eichinger A. [3] (1928-1929) tested hollow steel cylinders subjected to axial tension and internal pressure (producing stresses of unlike sign). The results almost followed the strain energy of distortion theory. They also made some tests on cast-iron with stresses unlike sign. The results are approximately in agreement with the maximum principal stress theory.

Lode, W. [4] (1928), tested hollow steel, copper and nickel cylinders subjected to axial tension and internal pressure, producing stresses of like sign. The results followed the strain energy of distortion theory.

Taylor, G.I, and Quinney H. [5] (1931) made tests on thin walled tubes of aluminium, copper, mild steel and carburized steel, subjected to axial tension and torsion. The test results of aluminium and copper showed agreement with the strain energy of distortion theory, while for mild steel and carburized steel, the values lay between the maximum strain and the strain energy of distortion theories.

* Number in the bracket [ ] refers to references at end of the thesis.

Present Study

An apparatus is available for applying combined bending and torsion stresses to a circular section. This is manufactured by the Norwood Instrument Co., and the proportion of bending stress to shear stress can readily be altered. By drilling an axial hole through the specimen, hydraulic pressure can be applied to give a more complex stress system. Thus if tension and torsion tests are carried out for each material, the validity of the various theories can be examined for each case.