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PLASTIC DESIGN OF A PORTAL FRAME

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PLASTIC DESIGN OF A PORTAL FRAME

by

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Project Report

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Project Report Submitted by:

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In part satisfaction of the award of Diploma of Technician Engineer in Civil Engineering of the Higher Technical Institute, Cyprus.

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SUMMARY

The objectives of the project are to carry out an extensive theoretical study of the plastic design of structural steelwork, to carry out the structural analysis and design of a portal frame to be used for a large - span warehouse using plastic design, to produce construction drawings and connection details for the particular portal frame and to carry out a cost comparison of steel elements designed by plastic and elastic method.

All steel used is in accordance with BS 4360, grade 43 and the design is in accordance with BS 449, BCSA and Constrado publication.

INTRODUCTION

In the conventional engineering practice for building frame, it has been usual to design structural steel elements on the basis of elastic design but the tests of steel structure Research Committee made it clear that a steel frame behaves very differently from the way assumed by the Elastic Design and as a result, the safety factor can be much less, or, in other cases it may be excessive and an uneconomical structure will result.

After the publication of the Final Report of the Steel Structures Research Committee, it was evident that some other method of design would have to be found. As a result, work started on plastic theory, and the plastic method of design was first permitted in 1948.

Plastic Design estimates the value of the factored loads which cause collapse of that structure and the main design criterion for a given structure is that of strength. On the contrary, Elastic Design estimates the loads under which the structural elements are in pure elastic conditions providing by this way a margin of safety against failure and the main design criterion for a structure is serviceability.

A rough guide when a particular structure is suitable for plastic design is:
a) If maximum permitted stresses govern a conventional elastic design, the plastic methods can probably be used.
b) If deflection limitations govern an elastic design then they will probably use plastic theory for that particular structure.

Plastic theory has been developed to deal with the ductile rigid frame. A framed structure carries applied loads mainly by bending of the members, and plastic collapse analysis is undertaken by the examination of bending moment diagrams. The effects of axial loads and shear forces on the frame member are assumed to be small. Trusses whose members are subjected to large axial forces cannot be dealt with simple plastic theory, special methods exist for the design of trusses which are outside the scope of this Project.

Simple Plastic Design can be used if the structure satisfies the following requirements:

a) Loads are carried mainly by bending and the effect of axial load and shear force on a member are small.

b) The designer is satisfied that strength is the main design criterion; checks on deflections may have to be made if these are suspected to be too large.

c) The design is fabricated in a ductile steel to B.S. 4360.

Subject to these limitations, Plastic Theory makes the design process easy and economical.