

CHAPTER 1

INTRODUCTION

1.1 General

Columns are structural elements used primarily to support compressive loads. Axially loaded columns occur rarely in practice because some bending is almost always present as evidenced by the manner in which loading is applied by beams and slabs and the moments introduced by monolithic construction.

A column loaded by an axial load and bending moment can be looked upon as the column subjected to an eccentric load, it is generally known as a beam column. Eccentrically loaded columns can be divided in two major cases like eccentrically loaded columns with uniaxial bending and eccentrically loaded columns with biaxial bending.

1.2 Eccentrically Loaded Members with Uniaxial Bending

A considerable work is reported for structural members loaded with compressive load and uniaxial bending. The capacity of the section for combined direct load and bending moment is determined, in general, from the following equilibrium conditions.

(i) P_u = Algebraic sum of all the forces in concrete and steel.

(ii) M_u = Moment due to the external load P_u about any reference line is equal to the algebraic sum of all the moments of forces in concrete and steel about the same reference line.

Members subjected to axial load and bending may have two types of failure. (i) Compression failure : This occurs when failure is due to crushing of concrete and is caused by the presence of the direct load at a small eccentricity. (ii) Tension failure : This is caused by a large eccentricity of the applied load and the failure is initiated by yielding of tension steel.

Unlike beams, the compression failure in case of columns cannot be avoided by reducing the depth of the compression block as the mode of failure primarily depends on the eccentricity of the applied loads. The balanced failure is obtained when concrete strain reaches to its ultimate value and the steel strain reaches the condition of the yield.

1.3 Eccentrically Loaded Members with Biaxial Bending.

Columns subjected to biaxial bending and direct load

are of very common occurrence in practice, but the design of such members is not straight forward. Assuming the position of neutral axis, the ultimate load P_u at eccentricities e_x and e_y which cause the limiting condition in the member, can be determined from the conditions of equilibrium. For all practical problems, one needs to start with the known axial load for which the section is to be designed. With neutral axis unknown, a lengthy process of successive approximations has to be resorted to.

Among the very few methods which are reported to ascertain the ultimate strength of biaxially loaded beam columns, some of them can be conveniently used for producing design charts. The approach to utilize design charts for the purpose though not accurate, promises to be an effective tool.

In general, there are two main approaches to the problem of biaxially loaded beam columns. They are : (a) Equilibrium method and (b) the failure surface method. Both these methods are theoretically sound and each agrees well with the limited amount of experimental data available.

The equilibrium approach is based on the

equations of static equilibrium. In general, an iterative solution to the three static equations is used, together with the usual assumptions for ultimate load design of flexural members.

The failure surface method is in actuality an extension of the use of the wellknown interaction diagrams that are extensively used in reinforced concrete design for uniaxial bending. The interaction diagrams are commonly found in designers' handbooks. The basic idea of the failure surface method is to use interaction diagram to generate a three dimensional surface. The actual shape of the two dimensional diagram varies with the cross-section, the yield of steel and the compressive strength of concrete.

It is felt that a combination of the equilibrium method with a simplified failure surface approach should reduce number of trials considerably.

It is apparent that more experimental data is needed to verify the theories so that further understanding of the behaviour of biaxially loaded columns is possible and an approach to develop a rational method is evolved.

1.4 Notation

The letter symbols used in this study are defined where they first appear in the text. Symbols used in the development of theory are listed in Chapter 4.