CHAPTER I

INTRODUCTION

In elastic design, it is usually assumed that the maximum load that a member can withstand is reached when it causes a stress or strain in the most-stressed fibres equal to that which occurs at the elastic limit of the material as taken from a tensile test. Practically, in many engineering applications a member functions satisfactorily in resisting loads until a small amount of plastic deformation has occurred in the most-stressed fibres and hence the loads that may be applied to the member before structural failure by yielding occurs are greater than those which first cause a maximum stress equal to the elastic limit. This condition is met especially in a member that is made of material which has a definite yield point (i.e. black mild steel). The structure could carry more or less additional loads depending upon its type before complete collapse occurred. Fig. 1 illustrates some examples of the modes of collapse that occur for each type of structure. The number shown indicates the sequence of formation of the plastic hinge. Some interesting values of the ratio between the collapse load (W_C) and the working load (W_W) are listed in table 1. Knowing these facts, modern engineers are turning their designs into the plastic range for the saving of the weight in aircraft, missiles, space applications and even in more prosaic applications where the competitive market is forcing the application of more efficient design.

Another application which involves very large plastic strains and deformations is metal forming processes, i.e. forging, extrusion, drawing, rolling etc. In these types of problems the elastic strain is usually neglected and the material is considered to be perfectly plastic.

Purpose of Research

The purpose of this research is to study the elastic-plastic slope-deflexion of simply-supported beams subjected to a concentrated load at mid-span. An attempt is also made to study the collapse load of single bay portal frames.

Scope of Research

For simplicity in analysing the elastic-plastic slope-deflexion equation, the stress-strain curve obtained from the tensile test is represented by three straight lines, namely, the elastic line, the plastic line and the work-hardening line. In order to meet this condition, rolled black mild steel and rolled brass are chosen for the investigation. In fact, the elastic-plastic behaviour of rolled brass is the particular case of the idealization referred to already since the plastic line is neglected in this consideration.

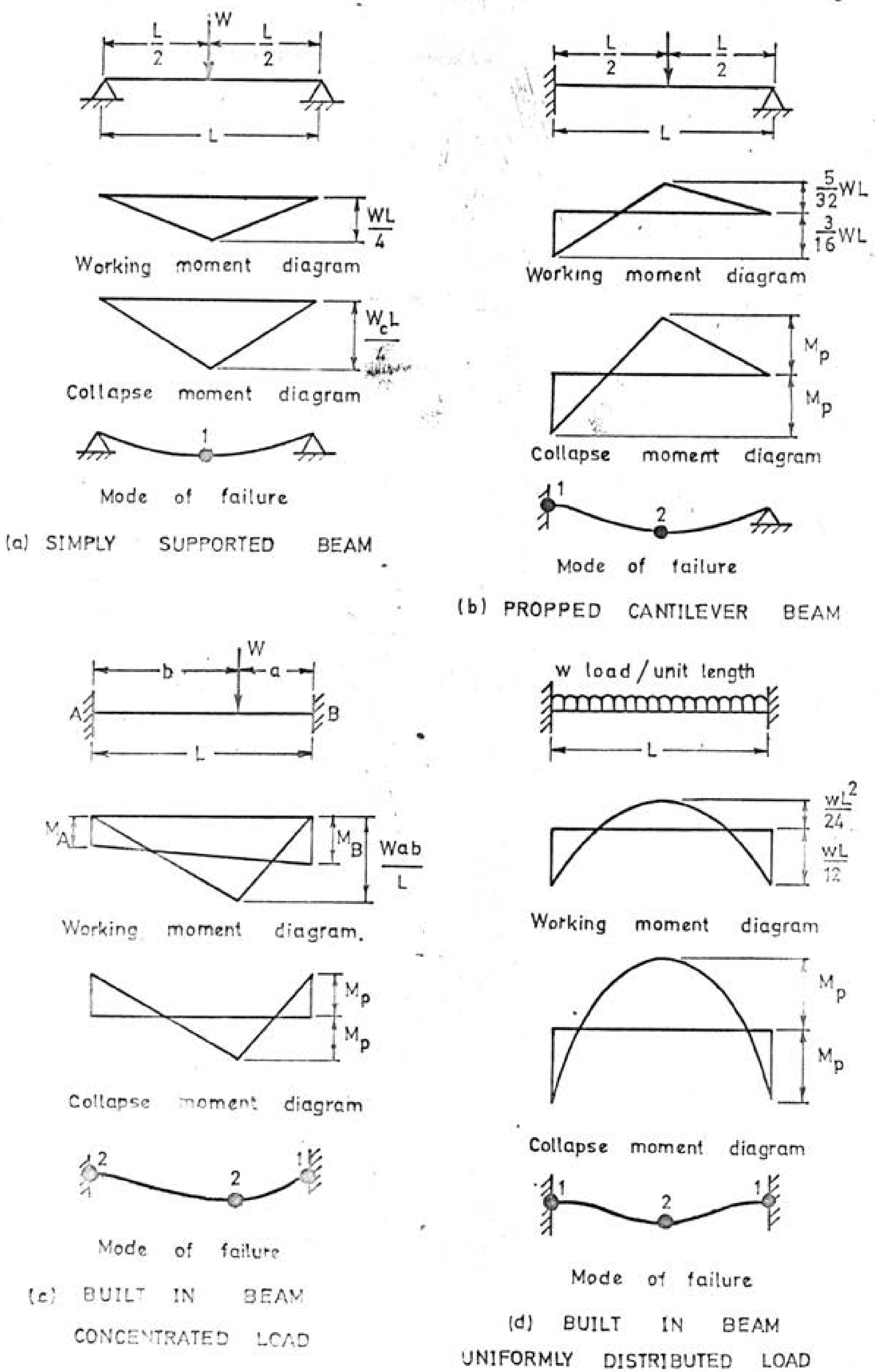

Fig.1 — Examples of simple structural collapse

Table 1

Examples of simple structural collapse

Type of structure	M_W	M_P	$\frac{W_c}{W_w}$	No. of plastic hinges.
(a) Simply supported beam, concentrated load at mid-span.	$\frac{W_w L}{4}$	$\frac{W_c L}{4}$	SN	1
(b) Propped cantilever beam, concentrated load at mid-span.	$\frac{3}{16} W_w L$	$\frac{1}{6} W_c L$	$\frac{9}{8}$ SN	2
(c) Built in beam, concentrated load.	$\frac{W_w ab}{2}$	$\frac{W_c ab}{2L}$	$2 \frac{b}{L}$ SN	3
(d) Built in beam, uniformly distributed load.	$\frac{w_w L^2}{12}$	$\frac{w_c L^2}{16}$	$\frac{4}{3}$ SN	3

S = Shape factor = $\frac{M_p}{M_y}$

N = Safety factor = $\frac{\sigma_y}{\sigma_w}$

In the case of single bay portal frames, two different fittings at the bases of the stanchions were built. One with fixed bases and another with carefully designed pinned bases. The frames were loaded at mid-span until collapse occurred. The mode and load at collapse were compared with that predicted in plastic bending theory.