Chapter 27

COLUMNS

27.1 Introduction

1 Columns resist a combination of axial P and flexural load M, (or $M = Pe$ for eccentrically applied load).

27.1.1 Types of Columns

Types of columns, Fig. 27.1

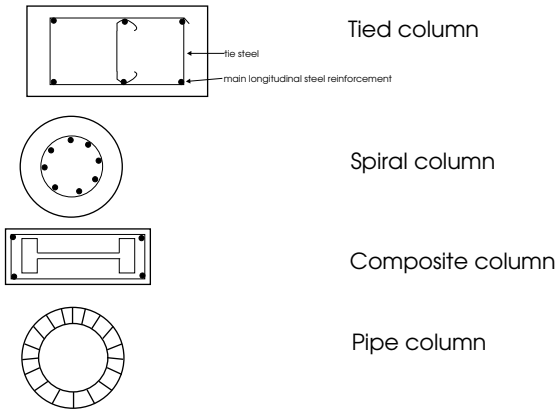

Figure 27.1: Types of columns

2 Lateral reinforcement, Fig. 27.2

1. Restrains longitudinal steel from outward buckling
2. Restrains Poisson's expansion of concrete
3. Acts as shear reinforcement for horizontal (wind & earthquake) load
4. Provide ductility

very important to resist earthquake load.

note:

1. 0.85 is obtained also from test data
2. Matches with beam theory using rect. stress block
3. Provides an adequate factor of safety

27.2.2 Eccentric Columns

Sources of flexure, Fig. 27.4

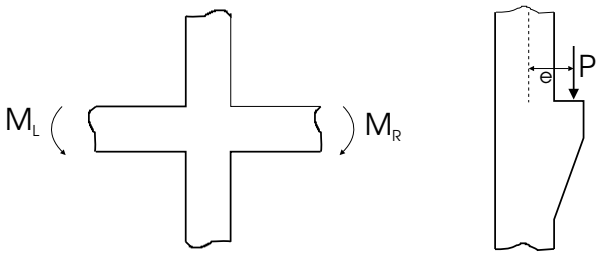

Figure 27.4: Sources of Bending

1. Unsymmetric moments $M^L \neq M^R$
2. uncertainty of loads (must assume a minimum eccentricity)
3. unsymmetrical reinforcement

Types of Failure, Fig. 27.5

1. large eccentricity of load $\Rightarrow$ failure by yielding of steel
2. small eccentricity of load $\Rightarrow$ failure by crushing of concrete
3. balanced condition

Assumptions $A'_s = A_s; \rho = \frac{A_s}{bd} = \frac{A'_s}{bd} = f'_s = f_y$

27.2.2.1 Balanced Condition

There is one specific eccentricity $e_b = \frac{M}{P}$ such that failure will be triggered by simultaneous

1. steel yielding
2. concrete crushing

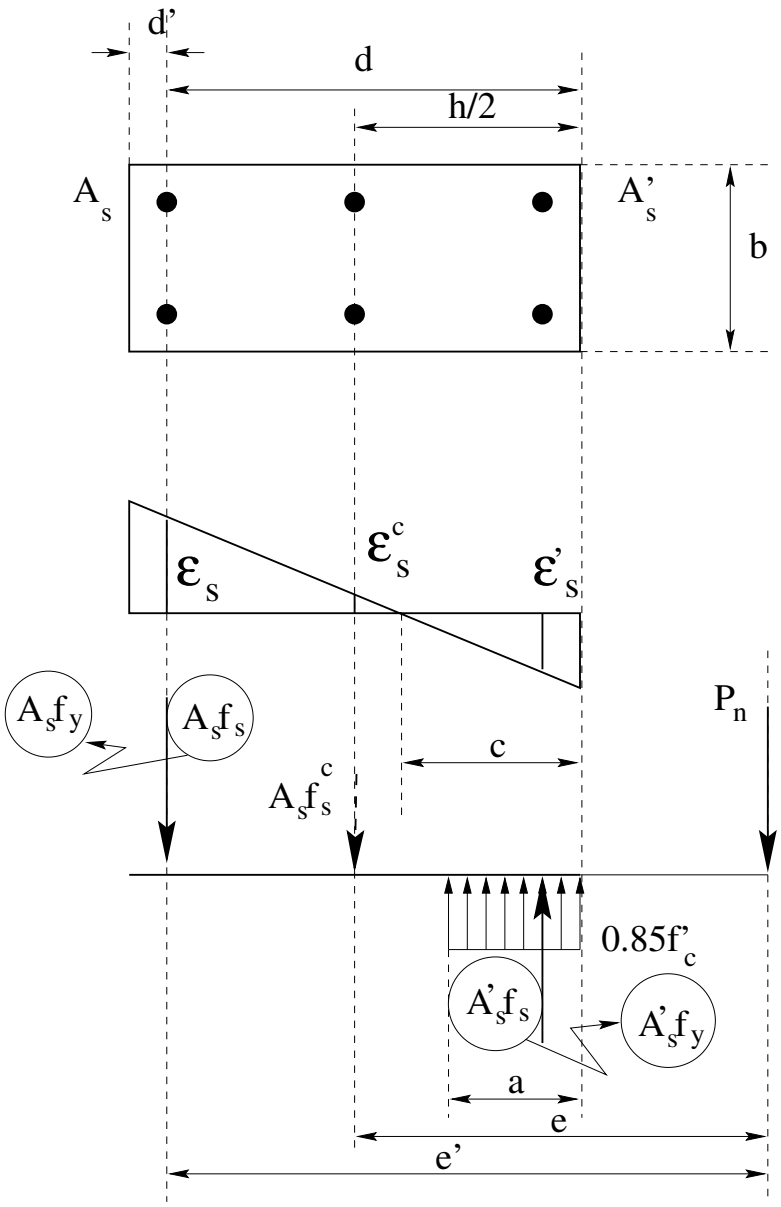

Figure 27.6: Strain and Stress Diagram of a R/C Column

```
error=0.1805
a= 20.7445
iter= 2
c=24.4053
epsi_sc=0.0015
f_sc=44.2224
f_sc=40
M_n=1.6860e+04
P_n=1.4789e+03
epsi_s=-4.1859e-04
f_s=12.1392

Failure by Tension
e=24
error=1
a=10
iter=0
iter=1
c=11.7647
epsi_sc=-6.0000e-
f_sc=-1.7400
P_n_1=504.5712
P_n_2=381.9376
a_new=7.5954
error=-0.3166
a=7.5954
iter=2
c=8.9358
epsi_sc=-0.0010
f_sc=-29.8336
P_n_1=294.2857
P_n_2=312.6867
a_new=7.9562
error=0.0453
a=7.9562
iter=2
P_n_1=294.2857
```

■

■ Example 27-3: R/C Column, Using Design Charts

Design the reinforcement for a column with $h = 20$ in, $b = 12$ in, $d' = 2.5$ in, $f'_c = 4,000$ psi, $f_y = 60,000$ psi, to support $P_{DL} = 56$ k, $P_{LL} = 72$ k, $M_{DL} = 88$ k.ft, $M_{LL} = 75$ k.ft,
Solution:

1. Ultimate loads

$$\begin{array}{rclcrcl} P_u &=& (1.4)(56)+(1.7)(72) = 201 \text{ k} & \Rightarrow & P_n &=& \frac{201}{0.7} = 287 \text{ k} \\ M_u &=& (1.4)(88)+(1.7)(75) = 251 \text{ k.ft} & \Rightarrow & M_n &=& \frac{251}{0.7} = 358 \text{ k.ft} \end{array} \tag{27.26}$$