ANNEX G

(*Clause* 38.1)

MOMENTS OF RESISTANCE FOR RECTANGULAR AND T-SECTIONS

G-0 The moments of resistance of rectangular and T-sections based on the assumptions of **38.1** are given in this annex.

G-1 RECTANGULAR SECTIONS

G-1.1 Sections Without Compression Reinforcement

The moment of resistance of rectangular sections without compression reinforcement should be obtained as follows :

a) Determine the depth of netutral axis from the following equation :

$$\frac{x_u}{d} = \frac{0.87\,f_y\,A_{st}}{0.36\,f_{ck}\,b.d}$$

b) If the value of x_u/d is less than the limiting value (*see* Note below **38.1**), calculate the moment of resistance by the following expression :

$$M_u = 0.87\,f_y\,A_{st}\,d\left(1 - \frac{A_{st}\,f_y}{bd\,f_{ck}}\right)$$

c) If the value of x_u/d is equal to the limiting value, the moment of resistance of the section is given by the following expression :

$$M_{u,lim} = 0.36\,\frac{x_{u,\,max}}{d}\left(1 - 0.42\,\frac{x_{u,\,max}}{d}\right)bd^2\,f_{ck}$$

d) If x_u/d is greater than the limiting value, the section should be redesigned.

In the above equations,

x_u = depth of neutral axis,

d = effective depth,

f_y = characteristic strength of reinforcement,

A_{st} = area of tension reinforcement,

f_{ck} = characteristic compressive strength of concrete,

b = width of the compression face,

$M_{u,lim}$ = limiting moment of resistance of a section without compression reinforcement, and

$x_{u,max}$ = limiting value of x_u from **39.1.**

G-1.2 Section with Compression Reinforcement

Where the ultimate moment of resistance of section exceeds the limiting value, $M_{u,lim}$ compression reinforcement may be obtained from the following equation :

$$M_u - M_{u,lim} = f_{sc}\,A_{sc}\,(d - d')$$

where

M_u, $M_{u,lim}$, d are same as in **G-1.1**,

f_{sc} = design stress in compression reinforcement corresponding to a strain of

$$0.003\,5\,\frac{(x_{u,\,max} - d')}{x_{u,\,max}}$$

where

$x_{u,max}$ = the limiting value of x_u from **38.1**,

A_{sc} = area of compression reinforcement, and

d' = depth of compression reinforcement from compression face.

The total area of tension reinforcement shall be obtained from the following equation :

$$A_{st} = A_{st\,1} + A_{st\,2}$$

where

A_{st} = area of the total tensile reinforcement,

A_{st1} = area of the tensile reinforcement for a singly reinforced section for $M_{u,lim}$, and

$A_{st2} = A_{sc}f_{sc}/0.87\,f_y$.

G-2 FLANGED SECTION

G-2.1 For $x_u < D_f$, the moment of resistance may be calculated from the equation given in **G-1.1.**

G-2.2 The limiting value of the moment of resistance of the section may be obtained by the following equation when the ratio D_f / d does not exceed 0.2 :

$$M_u = 0.36\frac{x_{u,max}}{d}\left(1 - 0.42\frac{x_{u,max}}{d}\right)f_{ck}\,b_w d^2 + 0.45\,f_{ck}\,(b_f - b_w)\,D_f\left(d - \frac{D_f}{2}\right)$$

where

M_u, $x_{u,max}$, d and f_{ck} are same as in **G-1.1**,

b_f = breadth of the compression face/flange,

b_w = breadth of the web, and

D_f = thickness of the flange.

G-2.2.1 When the ratio D_f/d exceeds 0.2, the moment of resistance of the section may be calculated by the following equation :

$$M_u = 0.36 \frac{x_{u,max}}{d}\left(1 - 0.42 \frac{x_{u,max}}{d}\right) f_{ck}\, b_w d^2 + 0.45\, f_{ck}\,(b_f - b_w)\, y_f \left(d - \frac{y_f}{2}\right)$$

where $y_f = (0.15\ x_u + 0.65\ D_f)$, but not greater than D_f, and the other symbols are same as in **G-1.1** and **G-2.2.**

G-2.3 For $x_{u,max} > x_u > D_f$, the moment of resistance may be calculated by the equations given in **G-2.2** when D_f/x_u does not exceed 0.43 and **G-2.2.1** when D_f/x_u exceeds 0.43; in both cases substituting $x_{u,max}$ by x_u.