Table 7.2 Moduli of elasticity of brickwork in two orthogonal directions (Grade I and II mortar)

Type of brick	*Modulus of elasticity of brickwork*	
	E_y (kN/mm^2)	E_x (kN/mm^2)
Single frog (low strength, 21.55 N/mm^2)	6.2	8.8
Double frog (medium strength, 59.40 N/mm^2)	8.65	15.3
Three holes perforated (high strength, 88.33 N/mm^2)	18.13	16.53

with yielding of the steel. It is not surprising, therefore, that a comparison between test results and those derived from yield-line analysis shows that the yield-line method consistently overestimates the failure pressure of brickwork panels when the orthogonal ratio is interpreted as the strength ratio. Since brickwork or blockwork panels exhibit different strengths and stiffness properties in two orthogonal directions, a simplified method for the design based on fracture lines taking into account both strength and stiffness orthotropies is discussed below. The method has been applied to predict the failure pressure of rectangular panels, rectangular panels with opening, and octagonal and triangular panels of various boundary conditions, and may be used for the design of brickwork or blockwork panels using the published values of the stiffness orthotropy and flexural strengths.

7.5.3 Fracture-line analysis

The fracture-line analysis which is described here is an ultimate load design method for laterally loaded panels. For more details see Sinha (1978, 1980).

Assumptions

All deformations take place along the fracture lines only, and the individual parts of the slab rotate as rigid bodies. The load distribution is in accordance with the stiffnesses in the respective directions. The fracture lines develop only when the relevant strengths are reached simultaneously in both directions.

Consider the idealized fracture lines for a four-sided panel with two simply supported and two continuous edges (see Fig. 7.9). Every portion of the panel into which it is divided by the fracture lines is in equilibrium under the action of external forces and reactions along the fracture lines and supports.

Since it is symmetrical, only parts 1 and 2 need consideration. In case of asymmetry the entire rigid area needs to be considered.

Consider triangle AFB:

$$\text{load on AFB}\,(1) = \tfrac{1}{2} w\beta\alpha L^2 \tag{7.18}$$

and its moment along AB is

$$\begin{aligned}\text{moment} &= \tfrac{1}{2} w\beta\alpha L^2 x(\beta\alpha L/3) \quad \text{(since CG of load drops 1/3)}\\ &= w\beta\alpha^2 L^3/6\end{aligned} \tag{7.19}$$

For equilibrium

$$w\beta^2\alpha^2 L^3/6 = mL$$

Therefore

$$w\beta\alpha^2 L^2/6 = m/\beta \tag{7.20}$$

Similarly, for AFED(2) (the left-hand side of equation (7.21) has been obtained by dividing the rigid body 2 into two triangles and one rectangle for simplification of the calculation)

$$(w\beta L^2/12) + (wL^2/8) - (w\beta L^2/4) = 2\mu m/K \qquad \text{where} \quad K = E_x/E_y$$

$$(wL^2/12)\ (\beta + 1.5 - 3\beta) = 2\mu m/K$$

$$(w\alpha^2 L^2/6)\ (1.5 - 2\beta) = 4\mu m\alpha^2/K \qquad 7.21)$$

From equations (7.20) and (7.21),

$$(w\alpha^2 L^2/6)\ (1.5 - 2\beta + \beta) = (m/\beta) + (4\mu m\alpha^2/K) \tag{7.22}$$

or

$$(w\alpha^2 L^2/6)\ (1.5 - \beta) = (m/\beta)\ [1 + (4\mu m\alpha^2/K)]$$

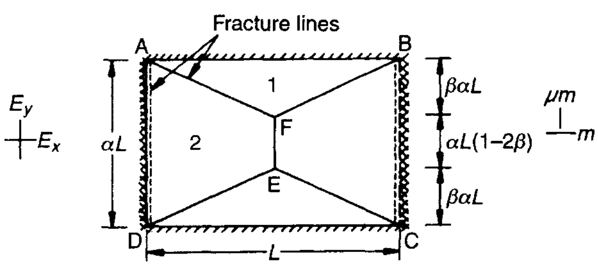

Fig. 7.9 Idealized fracture lines.