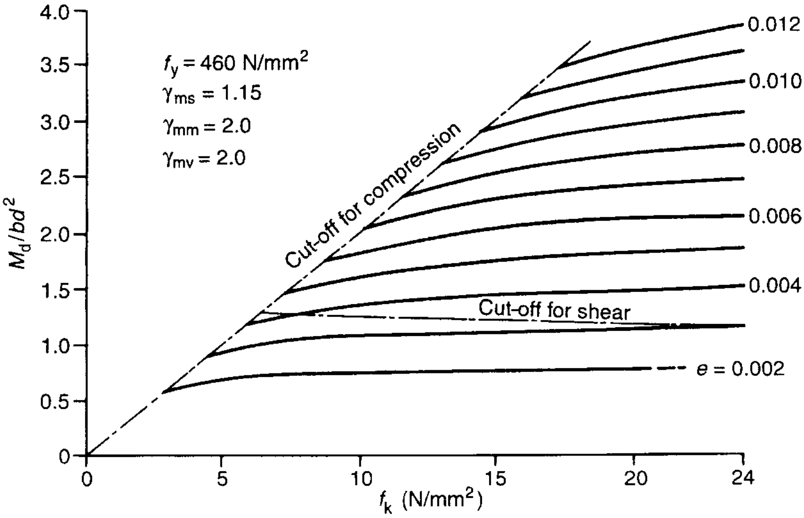

Fig. 10.7 Design aid for bending (f_y=460N/mm²).

Since values of M_d/bd^2 are approximately constant for a particular value of ρ this shows that the characteristic strength of the masonry has limited influence on the design.

10.2.5 Example

Design a simply supported brickwork beam of span 4 m and of section 215mm×365mm to carry a moment of 24kNm assuming that the characteristic strength of the material is 19.2N/mm². Assume also that γ_{mm}=2.0 and f_y=250N/mm².

The effective depth of the reinforcement allowing for 20 mm diameter bars and a cover of 20mm would be 365-20-10=335mm. So

$$M_d/bd^2 = (24 \times 10)/(215 \times 335) = 0.99$$

Using Fig. 10.6 with f_k=19.2N/mm² gives

$$A_s/bd = 0.005$$

$$A_s = 0.005 \times 215 \times 335 = 360\,\text{mm}^2$$

Use two 16mm diameter bars providing 402mm².

Check for stability. The lesser of 60b and $250b_c^2/d$ is 60×215=12.9 m. This is greater than 4m and therefore acceptable.

Note that since the intersection of the lines for M_d/bd^2=0.99 and f_k=19.2N/mm^2 in Fig. 10.6 is below the cut-off line for shear, the design will be safe in shear.

10.3 SHEAR STRENGTH OF REINFORCED MASONRY

10.3.1 Shear strength of reinforced masonry beams

As in reinforced concrete beams, shear transmission across a crack in a reinforced masonry beam can take place by one or more of the following mechanisms:

- Compression zone transmission resulting from the shear resistance of the masonry.
- 'Aggregate interlock' by frictional forces across the crack.
- 'Dowel effect' from the shear force developed by the reinforcing bars crossing the crack.

The relative importance of these effects depends on the construction of the beam. Thus in a masonry cross-section, a shear crack develops stepwise through the mortar joints and therefore aggregate interlock will be limited. Also in a beam of this type, where the reinforcement is placed in the lowermost bed joint of a brick masonry beam, dowel effect will be restricted by the low tensile strength of the brick-mortar joint. In a grouted cavity beam on the other hand, both aggregate interlock and dowel action will be developed in the concrete core and thus the overall shear strength of the beam will be greater than in a brick masonry section of the same overall size. In concrete blockwork it is usual to employ a U-shaped lintel block in the lowermost course which will result in greater shear resistance from dowel effect.

Shear resistance of a reinforced masonry beam is also influenced by the shear span ratio of the beam. In the simplest case of a simply supported beam loaded by two equal symmetrically placed loads, this ratio is defined by the parameter a/d, where a is the distance of the load from the support and d is the effective depth. As the shear span ratio is reduced below about 6 the shear strength increases quite rapidly, as shown in Fig. 10.8. The explanation for this is that when the shear span ratio is low, the beam behaves after the manner of a tied arch, as suggested in Fig. 10.9.

In reinforced concrete beams, shear strength increases with increase in the steel ratio. As might be expected, this is also the case in grouted cavity reinforced masonry beams. However, brick masonry beams do not show such an increase, no doubt because dowel effect is not developed.

Shear reinforcement in the form of vertical steel or bent-up bars can be introduced in grouted cavity beams but the scope for such reinforcement of masonry sections is limited.