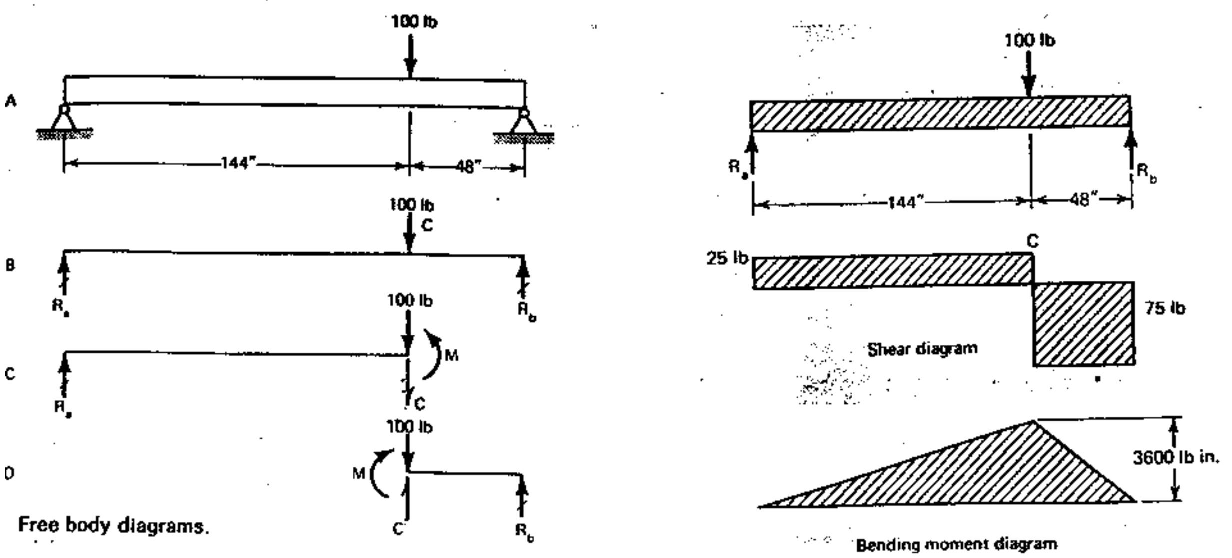

Figure 3: Important diagrams for Beam and Column design

4.1 MAXIMUM BENDING MOMENT

The external forces acting on a beam that tend to bend or break that beam produce a bending moment. Although the magnitude of the moment varies along the length of the beam, it is the maximum Bending Moment (BM) that must be considered in designing a beam to safely resist the bending forces to which it is subjected. The following steps are usually followed in finding the maximum bending moment: -

- Determine the Reactions at the supports.
- Draw a shear force diagram to locate the maximum bending moment
- Calculate the MBM

The shear force diagram consists of a base line which represents both the length of the beam and the axis of zero shear. The shear force at any point is determined by the algebraic sum of all of the forces to the left of that point. Starting at the left end, the reactions and load forces are drawn in proper direction and magnitude.

The point at which the shear line crosses the zero axis will indicate the point on the length of the beam at which the maximum bending moment occurs, the bending moment is then calculated for that location.

* **Example**

When designing the beams for Agricultural buildings, it is often necessary to make an assumption about the type of loading to which a beam will be subjected to. Some common assumptions are given below:

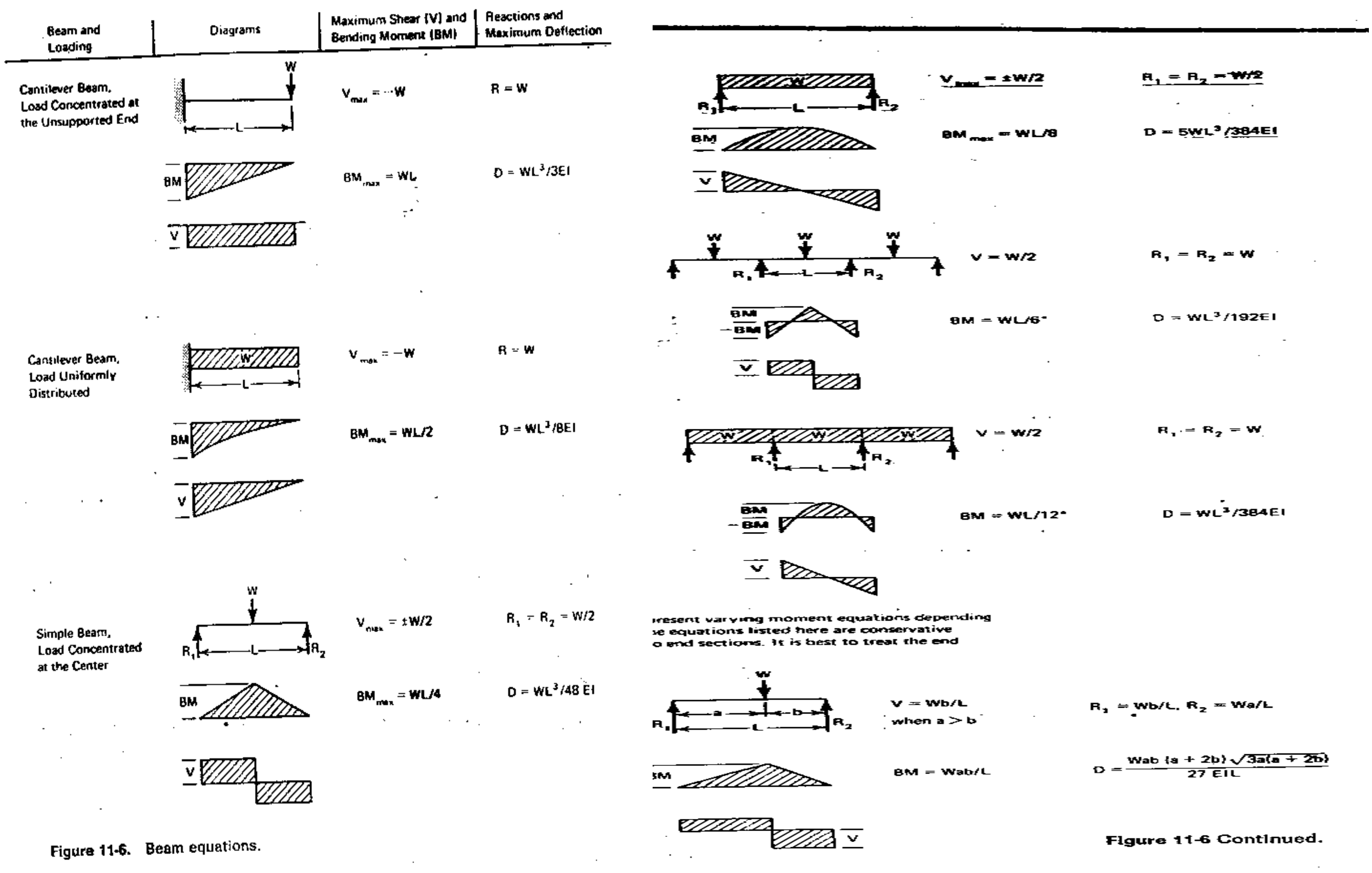

Figure 4: Beam Equations

4.2 FIBRE STRESS

Beams and columns are subject to failure in one or more ways, depending on the material and the type of load they carry. The unit force within a body which tends to resist deformation is called stress. It may be tensile, compressive, shearing or flexural. The safe fibre stress of a material is a measure of the strength characteristics of the material that resist failure.

4.3 SECTION MODULUS

The ability of a beam to resist a bending moment depends not only on it safe fibre stress but also it Section Modulus (S) which is a cubic measurement based on shape, dimensions and position of installation. The Section Modulus and moment of inertia of some shape are given below:

4.4 DEFLECTION IN MEMBERS

Most Agricultural buildings are designed to be safe from failure due to expected loading; however, there are cases, such as farm homes, where maximum deflection (elastic bending) of members becomes an additional factor. Excessive deflection can cause uneven floors, cracks in wall and ceiling panels etc. The two factors that are normally used to determine deflection are Modulus of elasticity and moment of inertial.

4.5 COLUMNS

The formulas used for determining the safe loads on solid wood columns are based on pin-end (hinged) conditions. This may also be applied to square-end condition; one of the factors affecting the design of columns is the slenderness ratio (L\d), where L is the unsupported length of the column.

4.6 REINFORCED CONCRETE

Ordinary concrete has very little tensile strength; it is necessary to use steel reinforcing embedded in that portion of a beam, slab or column that will be subjected to a high tensile force. Reinforcing steel consist of either deformed (rough surface) bars or welded wire mesh. Specification for standard reinforcing steel can be found in structural design text books and hand books. It should be noted that reinforcing steel should be clean and free from both rust and oil.

Good quality concrete with the correct size aggregate is essential for constructing reinforced structures usually not more than about 21 liters of water per sack of cement are used with enough aggregate to produce a medium slump concrete. Maximum aggregate size may be limited by the spacing of the reinforcing bars.

Beams have their main reinforcing in one direction in order to resist the bending moment. One-way slabs are similar to shallow beams, although they will carry cross reinforcing to distribute the effects of temperature changes and non uniform loads. They will ordinarily be supported continuously along the sides that are perpendicular to the main reinforcing.

Two-way slabs, either square or rectangular in shape, have reinforcing designed to withstanding bending moments in both directions. They will ordinarily be supported on all four sides.

4.61 Concrete Floors:

Concrete Floors are commonly used in farm buildings; they are hard, strong and durable and make an effective barrier against rodents and water. The type of construction varies with use; if the building is for grain storage, there is need for protection from ground moisture only, while other floors need to be well insulated to prevent heat loss as in the case of a farrowing house. Other buildings such as machinery sheds need only a smooth, durable surface.

4.62 Concrete Columns

Reinforced concrete columns are not often required in Agricultural construction unless a high degree of fire resistance is needed. Piers of lengths up to four times the least diameter do not require reinforcing. Columns of lengths up to 11 times the least dimension can be reinforced with a bar in each corner embedded at least 38mm from each surface. The corner bars are held in place with No. 3 bars formed into squares and installed 305mm on centre.

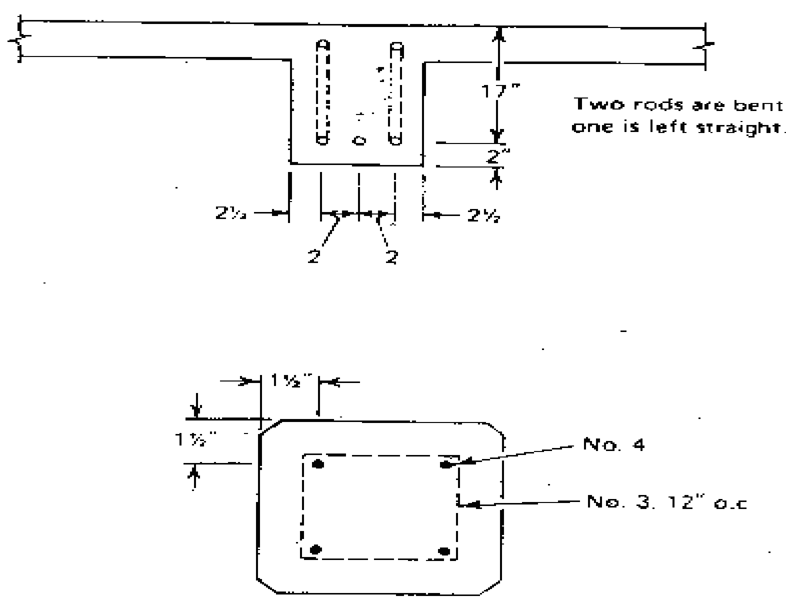

Figure 5: Reinforcement in Beams and Columns