2.11 CLASSIFICATION OF LOADS

Loads on buildings can be generally classified as dead loads, live loads, snow and wind load, combined loads.

A. Dead loads:

These include the weight of all the materials used in constructing the building, Such as concrete in footings and foundations, timber and other material used in the frame and roof. Dead loads are usually an integral part of the structure, permanent and stationary. It is estimated by making a bill of materials and then determining the force by using standard values of individual components such as concrete, steel, brick walls, aluminum, etc. Standard weights can be found in the book of standards e.g. ASABE, NIAE.

B. Live loads:

These types of loads include the weight of stored products, equipment, livestock and vehicles. These are difficult to estimate because of their intermittent nature and may cause stresses to be applied in an unpredictable manner. Live loads also include the forces of nature such as snow load, wind and earthquake, although they are generally treated separately. Refer to book of standards for values of different types of live loads.

C. Snow loads:

This load is applicable only in temperate regions of the world and like wind load must be estimated on the basis of meteorological records for the area. Probability of occurrence of snow of a given intensity is used as a basis of design. Because of the probable nature of snow and wind, a factor of safety > 2.5 is usually used for building materials and connections.

D. Wind loads:

Wind forces may often prove to be the most critical load imposed on Agricultural buildings, especially in areas where high winds occur frequently. When the wind strikes buildings, it exerts a considerable force on both the wall and roof surfaces which must be withstood by the frame of the building. Adequate bracing and the uses of strong fasteners or anchors at critical joints is a necessary precaution against wind damage. It should be noted that many forces imposed by the wind are negative, or lifting forces and these must be resisted by solid foundations, and use of wind breaks.

E. **Pressures Exerted By Fluids**

A liquid exerts a force against any surface with which it is in contact. This force per unit area is known as pressure, in an open tank for example, pressure increases uniformly from the top of the liquid to the bottom. The pressure exerted at a given level will be equal in all directions and normal to all surfaces. The equation for calculating pressure exerted by a liquid is given as:

$$P = dh \text{ or } P = \ell h$$

i.e. Pressure = density of liquid X depth of liquid (kg/m^2).

3.0 BUILDING FOUNDATION AND FLOORS

A well designed and constructed foundation is essential for the structural stability of a building. The foundation must resist and distribute the forces acting on it so that any movement will be small and uniform. Well built footings and foundation keep buildings plumb, free of cracks and free of leaks. For the purpose of designing footing foundations, the following forces must be considered: -

(1) The dead weight of the building, content of the building, which acts in a vertical direction.

(2) Wind loads that impact lateral or lifting forces.

(3) Horizontal forces from soil, water or stored products.

(4) Uneven soil forces caused by non uniform and variable moisture levels.

3.1 FOUNDATION FOOTINGS

A footing is the enlarged base for a foundation. It increases the area between the foundation and the underlying soil, thus reducing the unit pressure to a safe level. By implication, the size of the footing depends on the weight of the building and the safe bearing capacity of the soil. The soil on which a footing is installed should be undisturbed, level and smooth. The bearing capacity of soils varies with types of soil and moisture content.

Regardless of the material used for a foundation, a continuous cast of concrete is desirable. The width of the footing depends on the soil bearing capacity and the load it will carry. After determining the width of the footing by dividing the load per unit of length by the soil bearing capacity, the thickness of the footing for a wall or pier can be found as shown in the figure below: -

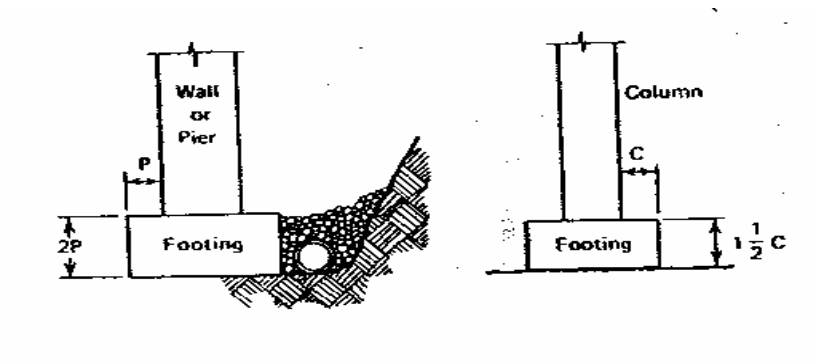

Figure 1: foundation footing proportion

It should be noted that all, foundations, piers and columns should be loaded as nearly as possible along their central axis to prevent any tipping action. If a building is constructed on sloping land, the footing may need to be stepped down with the grade. In this case, the horizontal length of each step should be at least double the height of the step and each section of footing should be tied to the adjacent wall with reinforcing rods. It should also be emphasized that each section of the footing should be bearing on ground that is carefully leveled.

3.2 TYPES OF FOUNDATION

Floating Slab foundation: - This type of foundation is conducive for areas subject to little or no ground frost, it consists of a concrete floor in which the outer 150mm is thickened to at least 300mm below grade, it is simple and economical to construct for small buildings.

Curtain wall foundation: This is commonly used for Agricultural buildings. The soil is filled against both sides of the foundation as shown below; the typical wall is built 8" – 10" thick without reinforcing. A much thinner wall could easily support the vertical load but would need reinforcement near the top and bottom with No 4 bars.

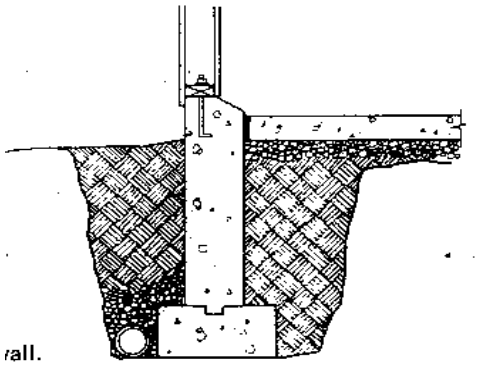

Figure 2: concrete curtain wall

Masonry blocks foundation: - Blocks of 9", 10", and 12" width may be used for a foundation, they are however not as strong nor as watertight as poured concrete foundations. While the labour and material for form work are saved, the cost of blocks and the labour of placing them often equal or even exceed the cost of a concrete wall. This is the most common type of foundation in Nigeria; it should be noted that, whenever a block foundation is chosen, the first course should be set in a full bed of mortar on a concrete footing. This is also known as strip foundation in civil engineering construction.

Treated wood foundation: -

This type of foundation is more common in America and Europe and is used mainly for barns and in some cases, living quarters. The wood to be used is treated with preservatives to prevent decay. During installation, crushed stone may be used as base on which the studs are installed above the footing plate.

Other types of foundation include pad foundation for factory buildings, pile foundation for water logged areas and raft foundation for soils with very poor bearing capacity.

4.0 DESIGN OF BEAMS AND COLUMNS

Beams and Columns are the structural members of a building frame. They must be carefully designed to carry the loads to which they will be subjected. A beam is subjected to loads that are perpendicular to the long axis. Beams such as floor joists are installed horizontally, but they may be inclined as in case of a rafter. A column on the other side is subjected to loads that are parallel to the long axis. They are usually installed vertically, such as a post under a beam. It should be noted that structural members subjected to similar compressive forces are also found at various angles in trusses and other structures.

Structural members are subjected to the loads of snow, wind, stored products or equipment and other component of the building. The forces that resist the loads are called REACTIONS. If the reaction just balance the loads, the structural members is said to be in static equilibrium.

In analyzing the stresses in objects, it is convenient to use free-body diagrams. This diagram shows all the forces acting on a body or member. If a body as a whole is in equilibrium, then it may be assumed that a cut at any desired point in the body will result in two members that are still in equilibrium. Examples of free body diagrams are shown below: