swelling, low permeable material. Non-swelling material minimizes the forces exerted on foundations, while low permeable backfill minimizes infiltration of surface water through the backfill into the foundation soil. If only pervious, non-expansive (granular) backfill is available, a subsurface drain at the bottom of the backfill is necessary to carry off in filtrated water and to minimize seepage of water into deeper desiccated foundation expansive soils. In general, the backfills of selected materials should be compacted to 95 percent of standard maximum density and should be wet of optimum water content. As an alternative, backfills of lime-treated natural soil compacted to 95 percent standard maximum density at optimum water content may be satisfactory if the soil is sufficiently reactive to the lime.

2) Moisture barriers

The purpose of moisture barriers is to prevent or minimize the movement of water beneath the foundation through the membrane and thus reducing cyclic edge movement. These barriers consist of horizontal and vertical plastic and asphalt membranes and granular materials. Concrete is an ineffective moisture barrier. The horizontal moisture barriers are used around the perimeter of the structure to reduce lateral variations in moisture content and differential heave in the foundation soil. Plastic or other thin membranes around the perimeter should be protected by a 15 to 30 cm thick layer of earth. The vertical barrier should extend to the depth of the active zone and should be placed a minimum of 1m from the foundation to simplify construction and to avoid disturbance of the foundation soil.

3) Adequate drainage

Drainage is provided by surface grading and subsurface drains. The most commonly used technique is grading for a positive slope away from the structure. The slope should be adequate to promote rapid runoff and to avoid collecting, near the structure, ponded water, which could migrate down the foundation soil. These slopes should be, greater than 1 percent and preferably 5 percent. Covered drains can be provided to discharge away the surface runoff water. Subsurface drains may be used to control a rising water table, groundwater and underground streams, and surface water penetrating through pervious soil. Subsurface drains of perforated pipes, 15 cm diameter can help control the water table before it rises but may not be successful in lowering the water table in expansive soil.

5. Conclusion

From the results of this study, the following conclusions may be drawn:

- The governing factors which contribute to the problems and damages to light structures include: the type and amount of clay minerals, initial moisture content, ingress of surface water into ground, foundation design and the soil investigation, prior to the construction.
- It was found that the damage to light structures was due to generated uplift forces resulting from heave caused by the swelling of soils in response to increase in moisture content. The repairs and maintenance of such damages cost more than the initial construction costs.
- Based on recommendations and experiences of previous researches, practical and economical construction guidelines are recommended to be used in Sudan.

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