SOME COMMON PROBLEMS IN BUILDING CONSTRUCTION AND MAINTENANCE

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Introduction:

In view of the heavy housing programme and acute shortage of traditional building materials there is an increasing trend towards the construction of light-weight structures and adoption of thinner walls, roofs and other components. On the other hand shortage of accommodation has compelled the continuous occupation and use of old houses which have passed their expected life and have started showing defects. These facts may sometimes lead to defects in buildings affecting the comfort and health of occupants unless adequate remedial measures to eliminate such defects are adopted. In this article some common defects like dampness, efflorescence and leakage through roof and their suggested remedies have been described.

Dampness in Buildings:

Dampness in buildings is a serious defect not only affecting the durability and appearance of the building but also causing damage to decorations, furnitures, books, clothes, etc. and is highly objectionable on grounds of health and comfort of the occupants. Dampness may appear in various parts of a building but the most serious ones are in the walls, floors and roofs. The various causes of dampness and their remedial measures have been discussed in a recent publication[1] of the Central Building Research Institute.

Dampness in walls[2] may be due to capillary rise from foundation, direct penetration of moisture through the joints in the exposed walls surface, junction with roofs, projecting features, leaky pipe fittings etc. or through condensation under certain weather conditions. The most common causes are (a) defective or absence of damp-proof course, (b) defective solid floors, (c) porous brick work or renderings, (d) incorrect levels of earth or path ways, (e) defective sanitary and water supply fittings (f) inadequate waterproofing of roofs, (g) defective parapets, (h) insufficient ventilation. While in new constructions it is necessary to take proper preventive measures in design and construction, in existing buildings, it is essential to first investigate the main causes of dampness before the correct and effecting remedial measures can be adopted. Table I summarises the measures commonly provided in buildings.

Various methods have been suggested to deal with defective or non existent d.p.c. in existing buildings. One of the suggestions is to render the effected walls internally with water-proof renderings. More effective solution is the insertion of damp proof courses in existing buildings. The old practice of underpining the building for such insertion is both costly and cumbersome. An alternative method consists of cutting the wall through a suitable joint by means of special says in stages and inserting bituminous felt d.p.c. in the slot.

Internal dampness arising through the medium of solid floors is generally due to faulty construction or defective material in the floor. Constructional defects are mainly due to faulty inclination of the filling for the base. Use of fine material in the sub-base allows capillary rise of water and to prevent this it is desirable to use coarse gravelly material or use dampproof membrane below the floor in the form of bitumen or polyethelene layer and provide mastic (bitumen mixed with sand) round the periphery of sub-base concrete in floor.

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Table I

Source of dampness	Preventive measures
Walls	
(a) Junction of wall with foundation.	Damp roof course, suitably detailing the construction features at the plinth level.
(b) Surface of wall.	Proper selection of walling unit and mortar, proper renderings, suitable orientation, generous overhangs at roof and Chajjas.
(c) Junction of wall with roof.	Roof overhangs, drip courses and proper water-proofing of roofs and junctions.
(d) Condensation.	Proper ventilation, vapour barrier incorporated in the wall, absorbent wall lining.
(e) Faulty pipe fitting.	Isolation from walls, facing socket ends to directions of flow and antichoke arrangement. Proper jointing, provision of inspection traps.
Floors	
(f) Junction of foundation with floors.	Provision of mastic (bitumen mixed with sand) round the periphery of sub-base concrete in floor.
(g) Faulty levels or earth banking.	The earth or other material must be removed. Avoid nearby flower boxes or similar beds against the walls.
Roofs	
(h) Junction of parapet and roofs.	Provision of d.p.c. at vulnerable points.
(i) Junction of chimney stack with roof.	Provision of flashing at the junction.
(j) Leakage through roof itself.	Proper water-proofing of roof[3].

There are a number of other minor constructional defects which may lead to dampness in walls. A few examples of faulty constructions commonly met with are :

(a) Outlets for water passing through the wall permit the moisture to gain access to the wall.

(b) Joint between the wall and the door and window frames permits access to moisture. Shutters on rainward side are made to open inside the room.

(c) Chajjas have inadequate projection or do not shed off the water readily.

(d) Ventilators placed near the roof do not have any chajja.

(e) Water falling off the balconies or roof outlets is allowed to fall freely instead of being led away in down pipes.

(f) Parapets have flat copings or are plastered on both sides, thereby preventing evaporation of moisture that may find its way in the parapet.

(g) Rainwater or service pipes are embedded in walls with inadequate or no provision for inspection and repair.

These defects can be avoided by taking proper care during construction.

Efflorescence in brick-work

White deposits of salts are sometimes found on the surface of brickwork. These deposits, which may be thin on new constructions but heavy and extensive on old ones, are known as efflorescence ([4]). Efflorescence is caused by the crystallisation of water-soluble salts on the surface of brick work. These deposits besides being unsightly may also damage the brickwork by disintegrating its surface or destroying individual bricks. The persistent appearance of efflorescence in brick work is normally due to faulty construction or the use of unsound materials or both.

Water, if it finds access to brickwork, moves along the brick pores by capillary action and carries with it dissolved salts. As the solution evaporates from the exposed surface of the brick work the salts are left as deposits on the surface or on layers just below it. Disintegration or flaking of the brick surface is caused by the mechanical force exerted by these salts as they crystallise just below the surface. Among the harmful salts Magnesium sulphate causes more disintegration.

Usually sulphates of magnesium, potassium, sodium and calcium (the latter is found in small quantities) cause efflorescence. These salts may be traced to the bricks, the mortar, the foundation soil or heap of earth left through carelessness in contact with the brickwork. These salts may also be formed due to the effect of the atmosphere on lime stones used in combination with bricks or by the inter action between brick and mortar. Contamination with sea water, either direct or through wind is another possible source.

The source of water may be the ground-water, rain striking directly on the surface of brickwork or finding its way into it from the roof, insufficient drainage near the brick work, leaky water mains passing close to brickwork, water used during construction, or air borne moisture condensing on the surface of the brickwork.

The most practical way to avoid the incidence of efflorescence is to concentrate on finding the source from which water gets access to the brickwork and on eliminating it.

Proper construction methods can prevent, to a great extent, water entering brickwork. Dampproof courses, flashing and roof drainage should be provided in a building in order to check water finding its way into the brickwork. Bricks should be protected from contamination by salt bearing materials and should not be subjected to undue soaking in water. Water used in construction should be free from salts and its use should be restricted to a minimum. Soft porous bricks should not be used with lime stones.

The use of bricks prepared from soil having a high salt content is to be avoided. The maximum allowable salt content depends on the nature of the salt and local conditions. During drying of green bricks, salts deposit over the surface of bricks, if the soil contains more than a specified limit of sodium and magnesium sulphates. The limit depends on the characteristic nature of the soil and salt present in it. In the case of calcium sulphate no deposit occurs up to a concentration of 5 per cent and therefore bricks made from such soils are not likely to give efflorescence provided they are fired to a temperature higher than 1000°C. Calcium sulphate present upto 3 percent in soil does not give efflorescence in bricks even when fired at 800°C. In case of sodium and magnesium sulphate, however the limit is much lower. Generally well fired bricks have a lower salt content. Portland cement also contains small quantities of alkali salts which may contribute to efflorescence. The use of wellfired bricks and strong mortars reduces chances of efflorescence.

A simple way to test, if an assembly of bricks and mortar is susceptible to efflorescence, is to place the assembly in a tray containing water (maintained at a constant level) for a period of two to three weeks. If on taking out the assembly and drying it no efflorescence is observed, particularly on the edges of the bricks, the assembly may be taken as safe so far as the materials are concerned.

There is no perfect remedy for efflorescence except complete isolation of the construction from water. This however, may not be practical. Some methods to reduce efflorescence are described below :

(*a*) *Physical*—Dry brushing and washing with large quantities of water can reduce efflorescence on a brickwork where the salts are traceable to the materials and salts from external sources have no access to the brickwork.

Patches of salts on isolated bricks in buildings provided with adequate dampproof courses can be removed by this method. Repeated washings at intervals may be necessary. Intensity of efflorescence diminishes after each washing.

Some water repellants are effective in rendering the surface of brickwork waterproof provided the surface is free from cracks. Of the various water repellants in use, silicones are the most effective. A 0.1 to 0.2 percent solution of silicone in water when applied on the surface of brickwork does not allow the water to move into the masonry and so no salt can move towards the exterior during the drying period. Soaking bricks in a silicone solution prior to their use improves the resistance to moisture penetration but is a very expensive treatment. Silicones may also be useful on surfaces subject to direct rain and on masonry work near the sea coast. The effect of silicones however decreases slightly with time. A soap solution (2%) sprayed on an old wall surface is claimed to render the surface almost waterproof. Alternate coats of dilute alum solution and soap-solution are also effective waterproofing agents. Soaking bricks in a dilute soap solution (2%) for about 15 minutes is reported to increase their resistance to moisture penetration.

(*b*) *Chemical*—Portions of brickwork affected by efflorescence may be treated with dilute hydro-chloric acid (concentration should not exceed 10%) and the surface rinsed with large quantities of water to remove the acid. The acid should not be allowed to come into contact with the mortar. The processes is to be repeated whenever efflorescence appears.

Another method is treating with sodium hexametaphosphate solution. The affected surface should first be scrapped and a 15-20 percent solution of sodium hexametaphosphate in water should be liberally applied with a brush. A coat of latext paint may be applied on drying. This treatment is effective in reducing the efflorescence caused by certain salts in brickwork but is not effective on plasters or mortar joints.

Leakage Through Flat R.C.C. Roofs :

During recent years considerable trouble has been experienced from leakage and seepage of rain water through flat concrete roofs. Detailed remedial measures against such leakage has been suggested by the Central Building Research Institute in one of its publications[3].

In most parts of the country a flat R.C.C. roof has to be provided with an adequate thermal treatment to provide adequate thermal comfort. It is therefore, necessary to provide two treatments, one for thermal protection and another for water-proofing or where possible, combine these into one single treatment such as provision of mud-phuska treatment in areas of low rainfall. In severe conditions such a combined treatment is not usually satisfactory and separate treatments for water-proofing and thermal protection have to be provided, which introduce the need of suitable integration of the two treatments. Ideally, the waterproofing treatment should be placed on the exterior to prevent ingress of moisture into the thermal treatment but it is not always possible since the nature of the materials used for waterproofing, such as bitumens or polyethylene, often necessitates protection against direct sun-rays or weat and tear caused by usage. Alternatively the waterproofing treatment is covered with a protective layer thus making up a three-tier arrangement. Both these solutions can lead to collection of rain water in between the two-layers which ultimately finds its way into the slab through any local weakness in the waterproofing treatment. This hazard can be partially got over by laying the water-proofing treatment to slope and permitting the collected water to escape at selected points. The designer of the waterproofing treatment has, therefore, to fully consider the interaction of the waterproofing and thermal treatments and to devise suitable details so that the roof as a whole functions satisfactorily.

Stagnation of water on the roof surface, due to various causes should be avoided to ward off the failure of an otherwise satisfactory treatment. This can be effected by providing adequate slope, limiting the area served by each outlet and designing of outlets to carry full-discharge under normal conditions with a suitable margin for freak conditions. Flat roofs are usually defined as having slopes not greater than 1 in 10, but the slopes are often restricted to 1 in 40 to 1 in 80. While the increase in slope within the above limit of 1 in 10 does not result in a substantial increase in the rate of flow of run off, it certainly elimates the likelihood of stagnation of water due to undulations or depressions developing due to usage. It is therefore advisable to increase the slopes to the steepest practicable, say 1 in 30 to 1 in 40 consistent with the type of materials used and cost. Greater care in achieving proper slopes is necessary when the material used is of a compressible type, such as lime concrete or mud-phuska which may develop an uneven surface while laying or afterwards.

How this slope is to be achieved to equally important. The common practice is to have no slope in the R.C.C. slab and vary the thickness of the treatment. Since the minimum thickness of the treatment cannot be reduced to less than 3 inch the slopes are often restricted to that which can be obtained by a fall of 1½″ to 2½″ often resulting in slopes as flat as 1 : 60 to 1 : 80. It is therefore advisable to provide some slope in the slab itself, so that adequate slope can be provided by varying thickness of the thermal protection layers.

It is a common practice to select the waterproofing treatment on the basis of total rainfall at a particular locality. While this may be an important guiding factor, a more important factor is the duration of rain and dry spells. When a dry roof receives rainfall, it first tends to absorb the rain water till a film of water is formed over the surface encouraging a run-off. The rate of absorption of the rain water depends on the materials used in the treatment, as well as on the pattern of rainfall. A slow rain permits the roof to get saturated while a fast falling rain soon forms a film and the water runs off the surface before saturating the roof.

A slow persistent rain extending over a long period therefore tends to be a greater hazard than a sharp tropical shower. In the former, the water tends to find its way through any joint or crevice which may not be so in the latter.

Waterproofing treatments may be of rigid, elastic and composite types. Rigid treatments involves the use of materials which present a rigid surface to external elements. They usually employ material of local origin such as lime concrete, mud-phuska, etc. which provide adequate thermal protection and are in fact combined treatments referred to earlier. Such treatments are ideally suited for constant traffic or usage ; however they are liable to develop cracks due to temperature variations and the joints with the wall and other vertical features are vulnerable and require provision of flashings. These treatments can safely withstand poor to medium rainfall conditions.

Elastic treatments are commercially manufactured products such as bituminous felt, polyethylene sheets, etc. These treatments are easy to lay or renew. They provide satisfactory protection at junctions with walls and other vertical features. They have a limited life requiring periodical renewal and do not provide any thermal protection which has to be taken care of separately. They can withstand moderate to heavy rainfall but require to be protected against direct sunlight.

Composite treatments are a combination of elastic and rigid treatments such as felt laid on lime concrete, mud-phuska laid on polyethylene etc. This treatment can be designed to withstand any given conditions of rainfall in addition to providing adequate thermal protection.

Lime concrete terracing has been used since time immemorial and its satisfactory performance has been long established for flat roofs of traditional type such as tiles or slabs on battens and joists, jack arch roof. Madras terrace, etc. This fact has encouraged its use on R.C.C. roof with variable results. In West Bengal and Southern India, its use has been successful while in Central and Northern India the treatment has not been equally successful in all cases. While the precise reasons for this behaviour need to be established by systematic investigation, the likely causes may lie in the relative rigidity of the R.C.C. slab as compared to traditional flat roofs and its greater susceptibility to movements, indifferent quality of lime and inadequate compaction of the lime concrete. These can to some extent, be mitigated by providing a separation layer of a flexible type, better control on quality of lime (which should be non-hydraulic) and use of mechanical compaction.

Bitumen felts treatment is advocated where the rainfall is heavy and not interrupted by long drying out periods and where the roof is not normally used as terrace. The Code of Practice for waterproofing roofs with bitumen felts (I.S. 1346-1959) specifies 4 to 8 course treatment for moderate to very severe conditions. These treatments have limited life and their periodical renewal is essential though the surfacing of the felt with pea gravel and bitumen affords a measure of protection and increase the durability of the treatment. Adherence to requirements of ISI standards is essential to obtain requisite performance.

Conclusion.

In this article some common problems in building construction and maintenance, enquiries on which are very often received at the Central Building Research Institute, have been dealt with and some suggested solutions have been outlined. The information has been compiled in abridged form, from the various publications of the Institute issued from time to time. Further details on any specific problem may be had from the Institute.

Acknowledgment.

The compiler thanks the various scientists of CBRI from whose publications the information given in this article has been compiled and in places freely quoted. The article is published with the permission of the Director, CBRI.

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