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Damages to Buildings Due to Trees

by

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Introduction

Planting of trees around or in the vicinity of buildings is an age old custom. Plantation in Newly built townships and building townships in the midst of woods after clearing few trees is the order of the day. There is also organised propaganda for planting trees in cities and towns. Trees are environmental necessity. They give cooling effect, purifies air, filter the dust and above all add to aesthetics of the surroundings.

Trees planted very near to structure cause damage to buildings. Modern urban conglomerations are planned with plot sizes of 12 m × 18 m or even less. Most of the trees spread their roots into building foundations causing damages. Extent of damage depends on the rate of growth of the tree, spread of branches above the ground, spread of roots in the soil, probable maximum height of the tree, ground water conditions and its fluctuations, and climatic conditions. Damages to buildings in clayey soils, expansive or shrinkable soils is well documented (Ward, 1947: Felt, 1953: Skempton, 1954: Bozozuk and Burn, 1960: Szechy, 1961: Radhakrishna, 1965: Hammer and Thompson, 1966: Rao and Murthy, 1968: Rao, 1979, 1984: Driscoll, 1983: Biddle, 1983: Richard*et. al.*, 1983: Saxena *et al*, 1987). In this paper damages to buildings in soils other than clays are described.

Causes for Damage

Damages to buildings and pavements are in general in the form of cracks symptomatically. Trees in the vicinity of buildings and pavements cause damages. Causes are growth and spread of roots in the soil as the tree grows on the surface. Trees need enormous amount of water. It is estimated that certain trees need 50,000 liters or more per annum (Radhakrishnan, 1965) and we cannot water them. Therefore trees grow by drawing necessary quantum of water from ground. Roots spread in search of water and nutrition into the ground and they spread laterally and vertically. It is observed that roots spread laterally as much as branches spread

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on the surface. The pressure exerted by the roots on the structure is considerable. Certain type of soils namely clays shrink and move as the tree absorbs water from the soil resulting into movement of structure and settlement cracks are resulted in it. These soils are identified as shrinkable soils. In sandy silt, silty clay, sandy clay movement of soil is considerable in the early stages of growth of the tree itself. In gravelly type of soils shrinkage and movement of soil is not appreciable but the pressure exerted by the roots of the tree as it grows is considerable and cause damages similar to one caused by swelling pressures in clays on buildings. In filled up soils damages can be due to both movement of soil due to shrinkage and upward pressure due to growth of roots. Silty sands soften during monsoon or any other wetting process and movement of soil occurs in the vicinity of trees causing damages to structures.

Case I

Cracking of a compound wall due to growth of a tree is illustrated in Fig. 1 and Fig. 2 from either side of the wall. Tree is named Ailanthus Excelsa Roxb botanically. In english it is known as Tree of Heaven. Locally it is called Maha nim or Maha rukh. It is a very fast growing tree. What is seen in the figure is third growth in four years *i.e.* it was after first appearance of cracks twice. In fact it was not planted but it grew by natural process *i.e.* its seeds might have been carried by birds and deposited through excretion at the place. In otherwords it was a natural growth.

Soil formations consist of red gravelly soil 1 m thick at the top followed by weathered disintegrated soft rock increasing in hardness with depth. Weathered disintegrated soft rock at 1.2 m depth below ground surface has the following charecteristics.

Grain Size Distribution %

Gravel	>4.75 mm	9
Coarse Sand	4.75–2 mm	20
Medium Sand	2–0.425 mm	45
Fine Sand	0.425–0.075 mm	10
Silt	0.075–0.002 mm	16
Clay	<0.002 mm	
Bulk Density	g/cc	2.24
Natural Moisture Content	%	4

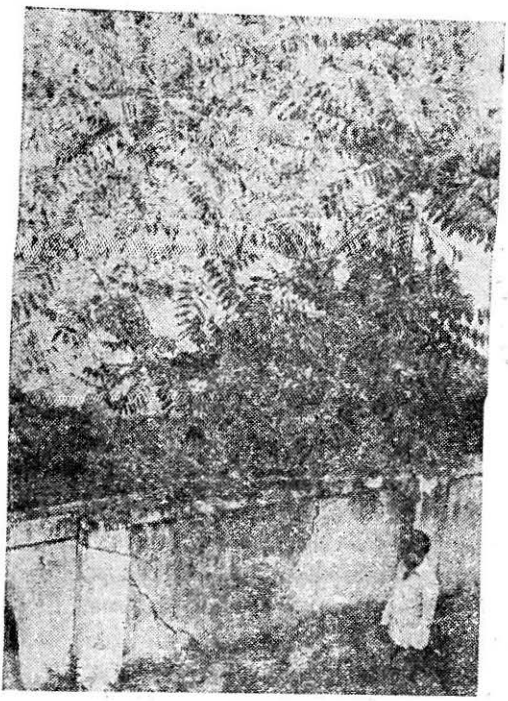


FIGURE 1 Cracking of Compound wall due to uplift pressure of roots in hard soil

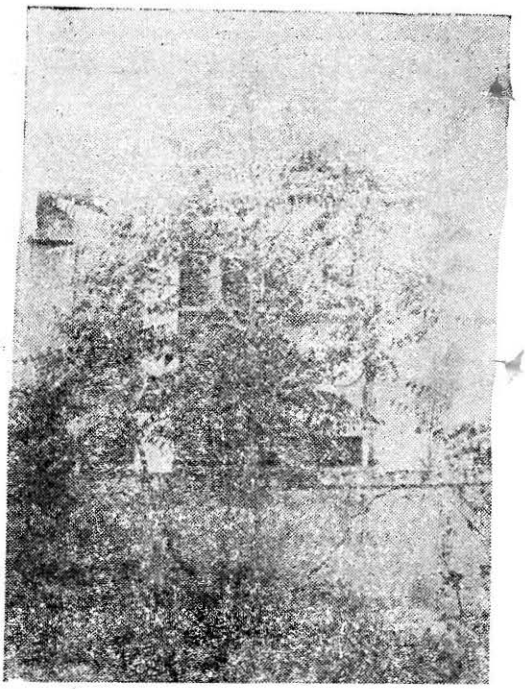
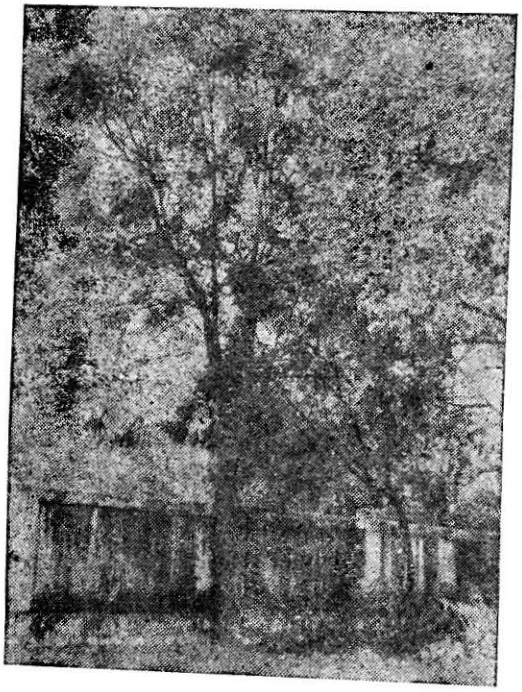


FIGURE 2 Cracked Compound wall of Fig. 1 Veiwing from other side



IGURE 3 15 year old neem tree in the same Compound with no cracks yet developed

FIGURE 4 Cracks in the upstairs

Particles <0.075 mm do not contain any clay minerals *i.e.* they have no plasticity characteristics.

Cracking pattern is V shaped resulting upward movement of cracked portion. It shows that roots of the tree as they grow exerted upward pressure analogus to swelling pressure of clay and damage is resulted. Author has observed that the same species of tree grown very bulky but did not cause any damage to two storey building in similar soil conditions. It is because the upward pressure of the tree roots is countered by the weight of the structure.

Fig. 3 shows a 15 year old neem tree in the same compound causing no cracks yet though there are symptoms of upheavel at the base of compound wall. It is because the rate of growth of neem tree is very slow and obviously appearance of cracks also delayed. There are many other type of trees adjacent to some compound wall grown over a period of ten years but so far no visible damage occured. Therefore it is opined that rate of growth of tree and insufficient downward pressure is the cause for cracking of compound wall in short period.

Case II

In a newly built campus trees have been grown and after few years many structures developed damages. Figures 4 to 7 illustrate the nature of damages in the area. Soil charecteristics of the area are:

Soil description		SILTY SANDY CLAY
Grain Size Distribution	%	
Gravel	>4.75 mm	0
Coarse Sand	4.75–2 mm	2
Medium Sand	2–0.425 mm	21
Fine Sand	0.425–0.075 mm	27
Silt	0.075–0.002 mm	40
Clay	<0.002 mm	10
Liquid limit		40
Plastic Limit		23
Shrinkage limit*		30
Specific gravity of Soil particles		2.56
Natural Moisture Content		20%

Degree of Saturation		100%
Bulk Density	g/cc	2.05
Dry Density	g/cc	1.70
Void ratio		0.5
Cc		0.45
Cv		1.25×10^{-2} cm²/sec.
Swelling pressure		Nil

*Shrinkage limit is more than plastic limit because of sand content.

Figure 4 shows cracks in the wall. Nearness of the tree from the building can beseen from the leaves of the tree. Figure 5 illustrates seperation of apron from the plinth. Shadow of the tree leaves can be seen on the apron. Figure 6 illustrates the movement of water tank away from the wall at ground level. Tree is just by the side of the tank. Figure 7 illustrates severe damage to a garrage and temporary supports to roof. There are trees near the garrage.

Damages shown in Figures 4 to 7 are typical examples of many existing in the area. As can be seen soil is not expansive type. Damages are due to movement of soil while extracting water during its growth (Penchalaiah, 1986).

Case III

Damages to two neighbouring houses Fig. 8 in a newly built colony (16 years) are illustrated in the Figures 9 to 18. Location of trees and cracks are shown in Fig. 8. The owners with great love planted coconut trees and after twelve years following a drought year cracks became alarming. Clearance of coconut trees and few other trees surrounding the house 2 arrested the progress of cracks.

Figure 9 shows cracking and uplift of a compound wall near coconut trees at location A. Figure 10 shows cracks from inside at junction of compound walls and difference of levels in compound wall due to uplift at location B. Figure 11 shows cracks in the compound wall at location C. There are also cracks in the pan of the well.

Figure 12 and 13 show cracks at location D in the ground floor and first floor of house 2. Figure 14 shows cracks in the first floor at location E. This portion of the house 2 is between two coconut trees. In this zone there was a drain which was levelled at the time of construction. Soil in this zone is black silty alluvial to a depth of 2 m. Figure 15 shows cracks

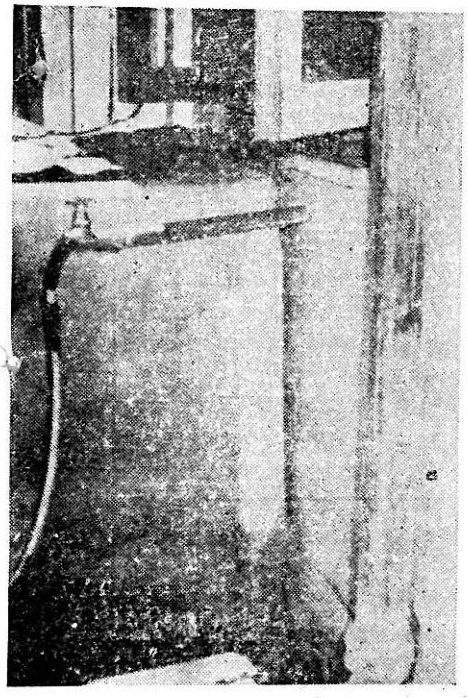


FIGURE 5 Movement of apron away from plinth

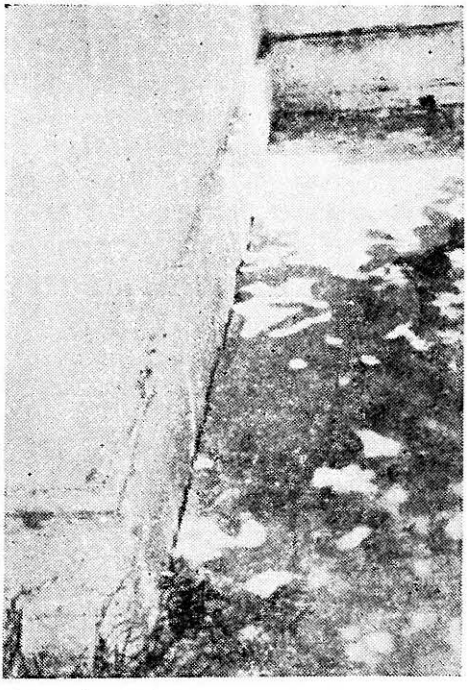


FIGURE 6 Tilting of water tank at ground level

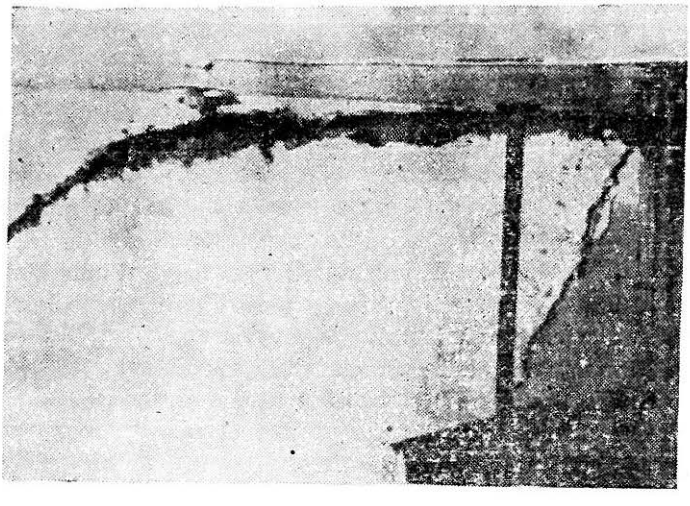


FIGURE 7 Cracks in garrage

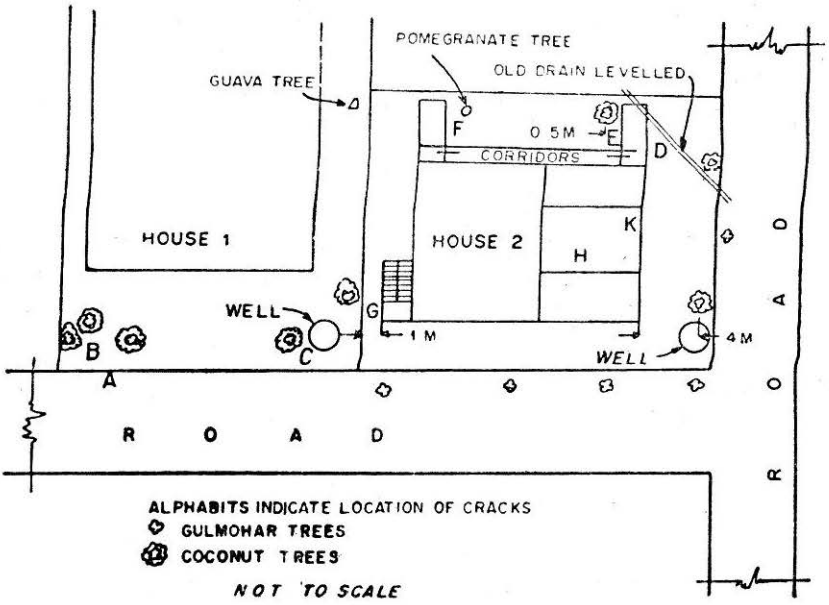


FIGURE 8 Location of trees and cracks

at location F. This portion of the building is located between two trees one pomegranate and another guava. There are several cracks inside and in the floor in this part of the building. Figure 16 shows cracks in the compound wall and seperation of support to landing of stairs. Figures 17 and 18 shows cracks in the walls at location H and K inside the building. There are no cracks in other parts of the house 2.

Wells in the houses are dry for most part of the year. Soil formations consist of 0.3 m top soil followed by a layer of gravelly soil below which weathered disintegrated soft rock exists increasing in hardness with depth except in the zone passing the drain.

In house 2 damages are due to movement of soil due to shrinkage at locations D,E,F,H and K. At location G compound wall crack is due to uplift pressure and stair landing beam support is due to shrinkage. This shows near the trunk uplift pressure is considerable whereas at a distance where roots are thin or small in size shrinkage of soil occurs as soil moisture is absorbed. In house 1 all cracks in compound wall are due to uplift pressure caused by roots as the tree grows. Cracks due to uplift pressure of roots are in general in light structures.

FIGURE 9 Cracking at A

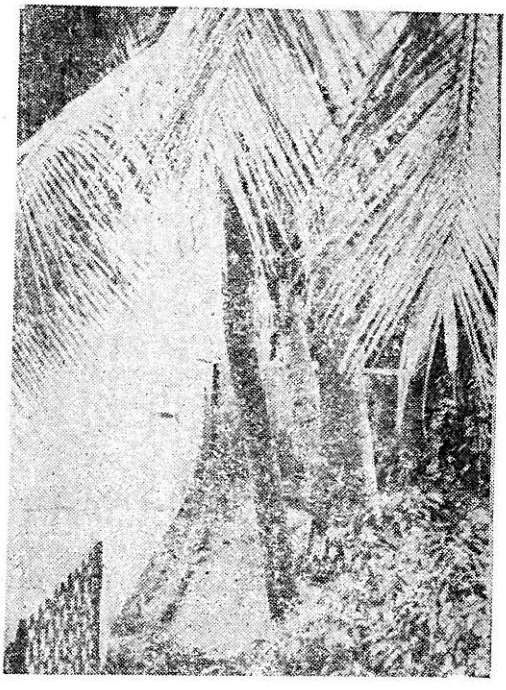


FIGURE 10 Cracks at B

FIGURE 11 Cracks at C

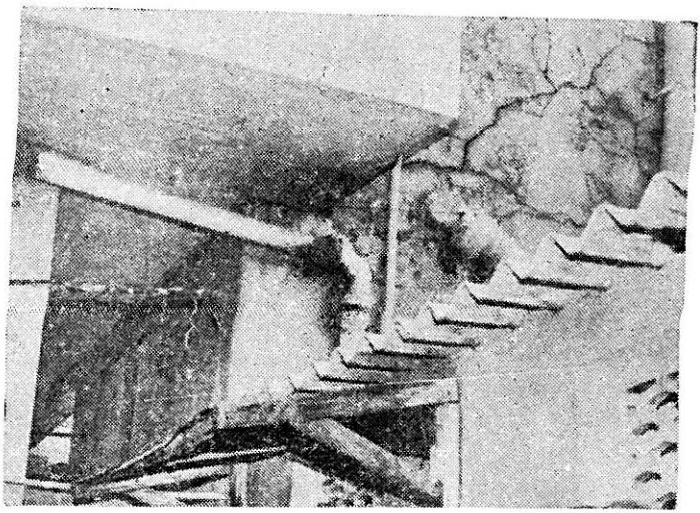


FIGURE 12 Cracks at D ground floor

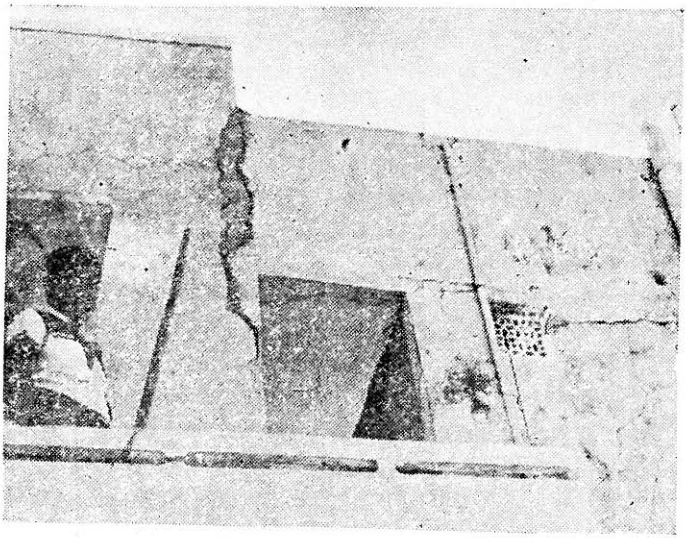


FIGURE 13 Cracks at D first floor

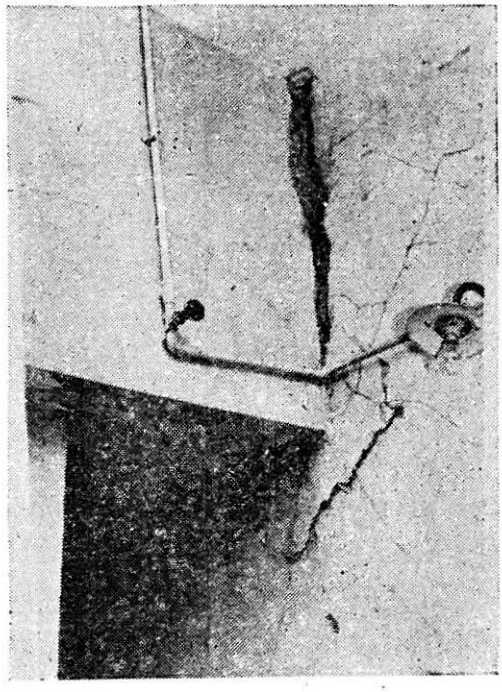


FIGURE 14 Cracks at E first floor

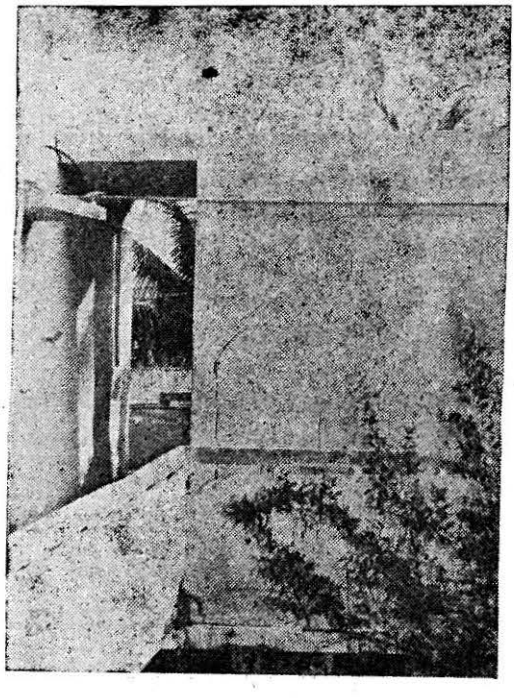


FIGURE 15 Cracks at F first floor

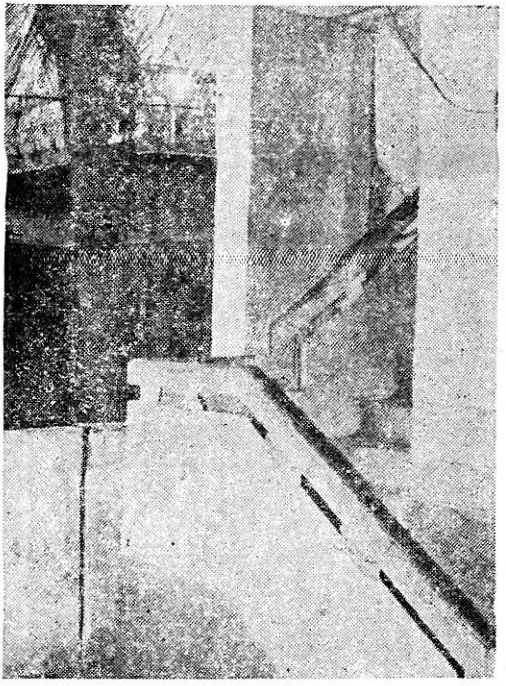


FIGURE 16 Cracks at G

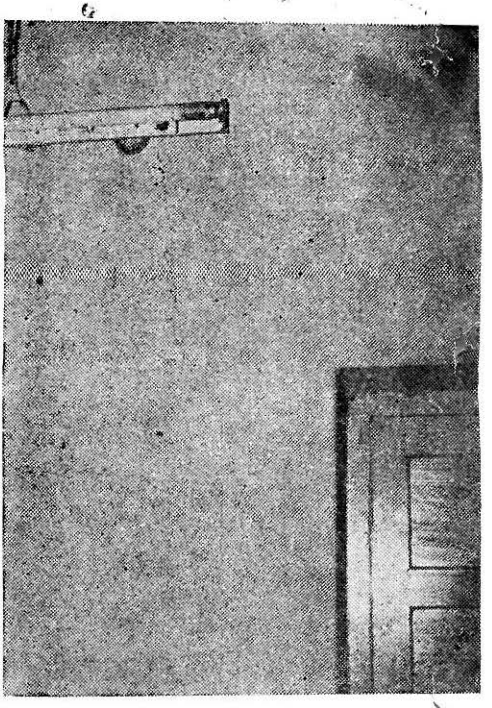


FIGURE 17 Cracks at H

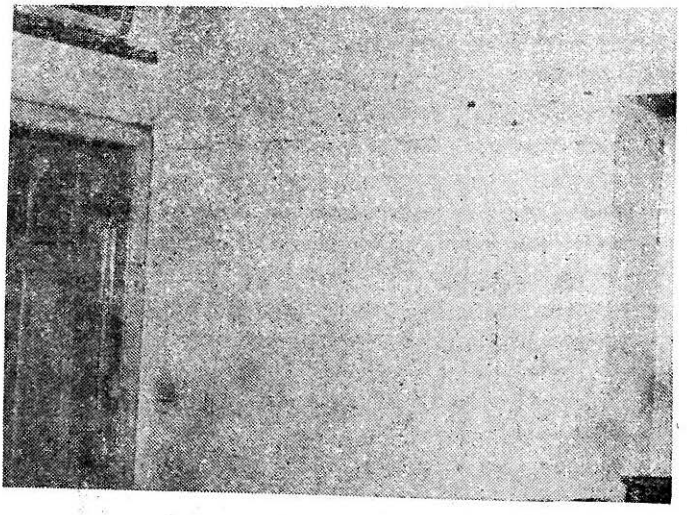


FIGURE 18 Cracks at K

Conclusions

Plantation of trees in the vicinity of buildings need be discriminative. Tall and bulky Trees which cannot be watered as they grow should be planted at a distance at least one and half times to twice the maximum height of the tree when it grows fully to avoid damages. Damages to buildings due to trees occur either by movement of soil due to shrinkage or uplift pressure of roots. Damages due to *shrinkage* of soil is in clays, sandy silt, silty sand, sandy clay. Damages due to uplift pressure of roots are in general in hard soils near the trunk in light structures. Extent of damage depends on type of soil, rate of growth of tree, maximum possible height and spread of branches which is related to spread of roots in the ground, ground water level and its fluctuations, and climatic conditions of the region.

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