

# **IDENTIFICATION OF DAMAGES TO BUILDING STRUCTURES DUE TO ROOTS OF TREES**

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## **Abstract**

When trees are planted too close to a building, the roots of them are causing damages to that building in both direct and indirect ways. In many cases, these subterranean problems go unnoticed, until cracks appear on surfaces. The remedial works for such cases can be always difficult and expensive. This research was carried out to identify the causes and effects of not using the safe planting distances and then it is extended with a detail survey to find safe distances using 5 categories of trees, which are most common in Sri Lanka. It was noted that the direct damages to civil structures are very common here in Sri Lanka. It was observed that the damage from Bodhi tree is much greater than other trees. Therefore, its' safe planting distance is around 11 metres. Safe planting distances for Tamarind and Royal Poinciana are in a range between 6 to 7 metres. For Jack & Mango tree, it is about 4 to 5 metres. So these safe planting distances has presented numerically in this report.

**Key Words:** Subterranean problems, Remedial works, Safe distances, Direct and Indirect damages

# 1. INTRODUCTION

Trees are vital and attractive part of our wider urban and rural environment. More than trees in green spaces are an indicator of a city's livability and sustainability. Roadside trees furnish linear greenery that can permeate neighborhoods and serve landscape and amenity functions [1]. Urban trees can favorably affect factors underlying global warming by storing carbon and by reducing energy needs for cooling and heating buildings [2]. Trees and buildings are often able to exist and adapt together in reasonable harmony, but problems do occur in some cases [3]. Blockages in sewer pipes caused by roots are very common and several tree and shrub species are reported to be particularly likely to cause root intrusion [4]. Roots were mostly located in the upper soil more than these roots are very thin [5]. These tree roots anchor the tree in the soil, keeping it straight and stable and absorb water from the soil. They take nutrients and chemicals out of the soil and use to produce what they need for their growth, development and repair. Tree root normally grow outward to about three times the branch spread. Most tree roots are located in the top 6 to 24 inches of the soil and occupy an area two or four times the diameter of the tree crown. They usually don't grow deeper than 3 to 7 feet [6]. As a tree increase in size, its' root system also has to become more extensive, either downwards or sideways in search of the required nutrients while providing adequate support.

Very little root action leading to subsidence damage to buildings indirectly and mostly it is caused by direct physical pressure exerted by them. Damages to hypogeal archaeological monuments, caused by the growth of tree roots, are frequently reported in the city of Rome and problems of compatibility between trees and underground structures may become complex in the case of historical gardens [7]. A tree has to be very close to the structure indeed for such damage to occur. Planting a tree so close to a structure that trunk buttressing or increase in trunk diameter, could lead to damage in the closed by structures .It is occurred more commonly in structures like pavements, boundary walls and storm water drains. Building with adequate foundations, standing some distance from trees, are very rarely subject to such direct damage.

Hence, people really scared to grow trees and wherever building takes place in towns, the next step will be to remove close by tree. Lowering of ground water, compaction of soil, removal of topsoil, destruction of tree roots, covering of root zone with earth, concrete and asphalt, damage to trunk and tree crown all these destroy the conditions for vigorous growth of trees, or even the trees themselves [8]. This often happens through ignorance of the living conditions essential for trees, and of possible ways of curing

injuries to trees. Therefore, trees need consideration in face of the damage, which they may suffer on building sites: the right nutrition, ventilated soil, water, correct care and, if necessary, the attentions of a tree surgeon. If damage has already occurred, tree surgery offers many kinds of remedies.

In this research it is mainly focused on 5 categories of trees, which are planted more commonly near households in Sri Lanka. A detail survey was carried out on trees, which are aged more than 12 years and buildings having life span more than 10 years. Details were collected over 128 trees. Then they were analysed & presented graphically. Those graphs indicate the type of damage, which can occur to a building when planting different type of trees so closed to a building. This study clearly shows that the direct damages caused by the physical pressure exerted by roots are very common here in Sri Lanka.

## **2. OBJECTIVE**

- The main objectives of this research is to identify the nature of damages in building structures due to the tree roots and identify the suitable distance between building structures and trees.
- It is intended to come up with solution, having details from the research, which will help to avoid damages to the buildings from tree roots.

## **3. METHODOLOGY**

In order to achieve above objectives, the following methodology was adopted:

A survey was carried out in Kandy, Matale, Habarana and Galle districts in Sri Lanka. Pilot survey was conducted in these areas to identify most common tree types and their damages. More than an interview was carried out on randomly selected sample to understand the awareness on safe planting distance and also the especial precautions prior to planting trees close to building.

Through the pilot study, it was identified 5 types of trees, which are planted commonly near households and public buildings .In this research it was considered, trees aged more than 12 years and buildings more than 10 years old. And then details were collected for each 5 types of trees and they were tabulated and analyzed. Finally, the type of damage was identified after presenting those details in graphical format and conclusions were made. The cracks were also categorized to two groups depending on their width and the length and also the criticality of the damage. If the crack can be repaired just be re-plastering without any deep improvement, it was categorized as a minor damage and if the crack need any other detailing than the plaster repairing, then it was grouped as a major damage. After plotting the observation with the distance between the tree and the building, the safe planting distance was picked graphically.

## 4. DATA COLLECTION AND MAIN FINDINGS



*Figure 1 -damage to pavement due to tree roots.*



*Figure 2 -damage to floor due to tree roots.*



*Figure 3 -damage to road due to tree roots.*



*Figure 4 -damage to wall due to tree roots.*

Figure 1-4 illustrates damage types on nearby structures due to tree roots and they were taken when the detail survey was in progress. Survey was carried out in the above mentioned district and the structural cracks were recorded together with the distance and the criticality of the damage. The pilot survey revealed that lots of people in Sri Lanka don't have much awareness on safe planting distances.

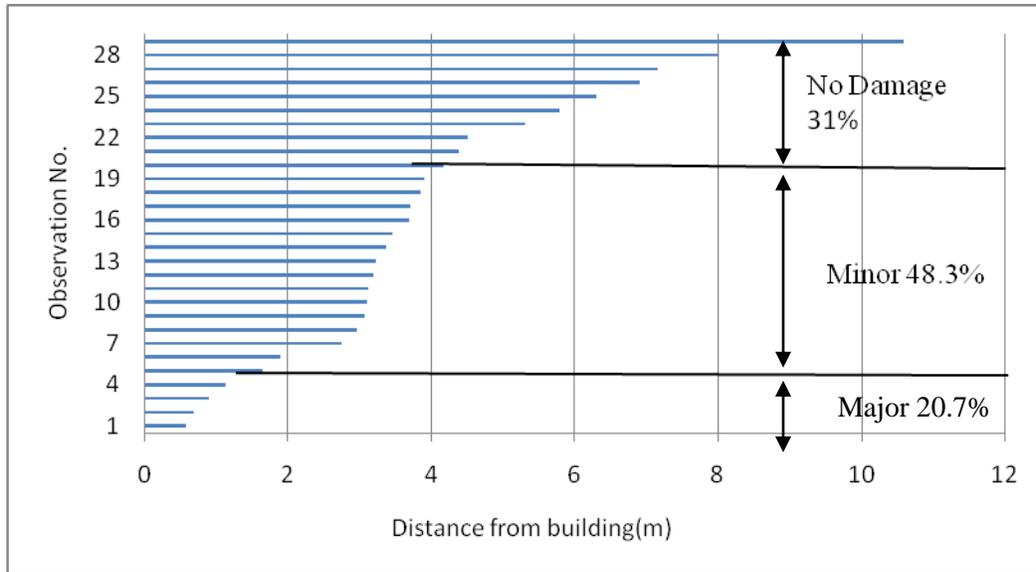
## 5. DISCUSSIONS

Parameters like trunk circumference, distance from building and crack length with its locations were considered during the survey. In here these measurements are discussed together with some comparison and graphically presented in later.

During this research, it was observed that, people are always preferred to plant trees like Mango and jack, which has economic value, near their households. Due to this reason, some direct and indirect damages were visible on the walls of surrounding structures. Even though there is a similarity in spreading of roots in mango and jack trees, Mango tree roots extend beyond than Jack tree roots. Also it is further observed that the damage from Bodhi tree is much greater than other trees. This is because roots in Bodhi trees are spread widely, covering large area in ground in both horizontal and vertical directions, compared to other selected trees. As a result of that, pavements and floors in buildings are lifted above creating some cracks and most of the cases these cracks were propagated to the walls as well.

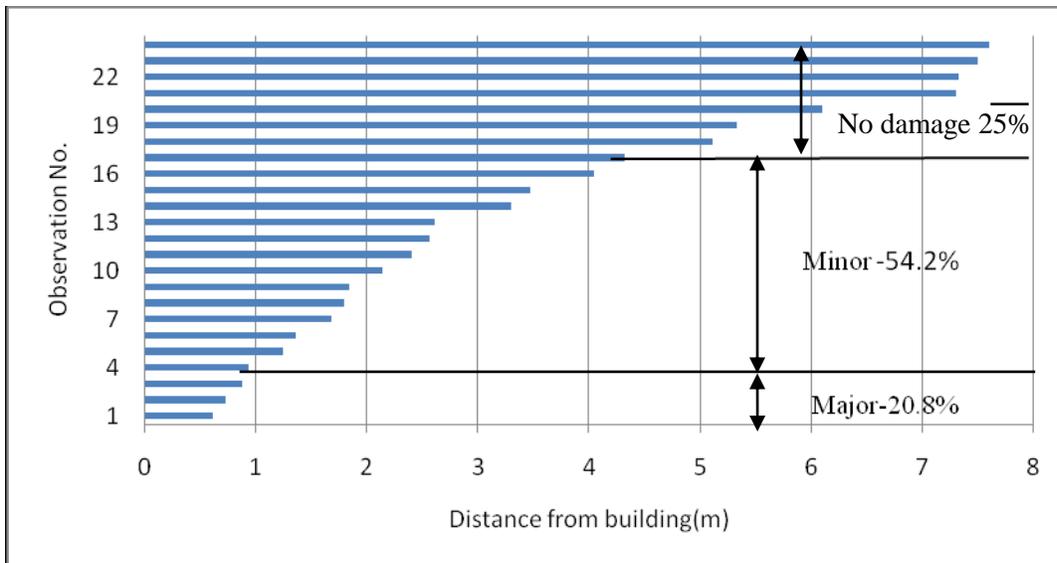
The root spreading distances for Tamarind tree and Royal Poinciana tree are bigger than other trees except Bodhi tree. And also there is a lack of tendency of people in Sri Lanka to plant those types of trees near there dwelling places.

Figure 5-9 shows the damage categorization graphically for each 5 types of trees. By considering the width, length and the criticality, 2 damage types were identified due to tree roots namely Major and Minor. Closer the tree, the damage recorded was major and when the distance increases it changes from minor to No damage. So, each observation was plotted together with the distance from the tree and three zones were marked for each case.



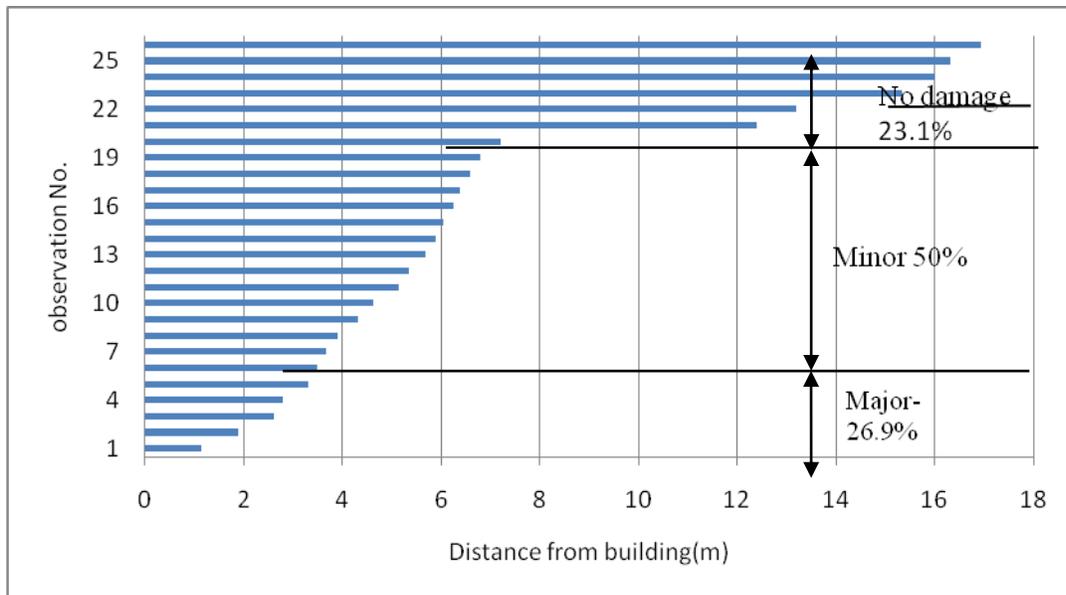
**Figure 5-Jack tree**

Figure 5 gives the observations related to Jack trees. It is convinced that the damage has been more significant up to 1.88 m from the building for Jack tree. From 1.88 m to 4.16 m, the damage is less. Any distance more than 4.16 m, can be taken as the safe planting distance.



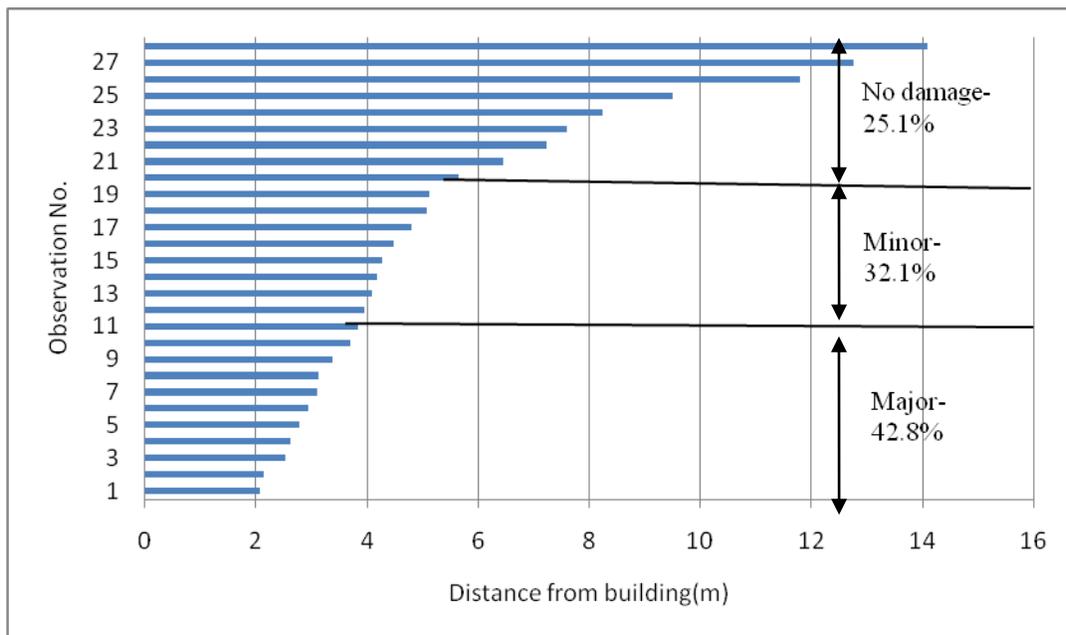
**Figure 6 -Mango tree**

Similar plot can be made for Mango tree and presented in Figure 6. The damage has been occurred significantly up to 1.24 m from the building for Mango tree. Then minor damaging range was from 1.24 m to 5.10 m. Any distance more than 5.10 m is in non-damaging range.



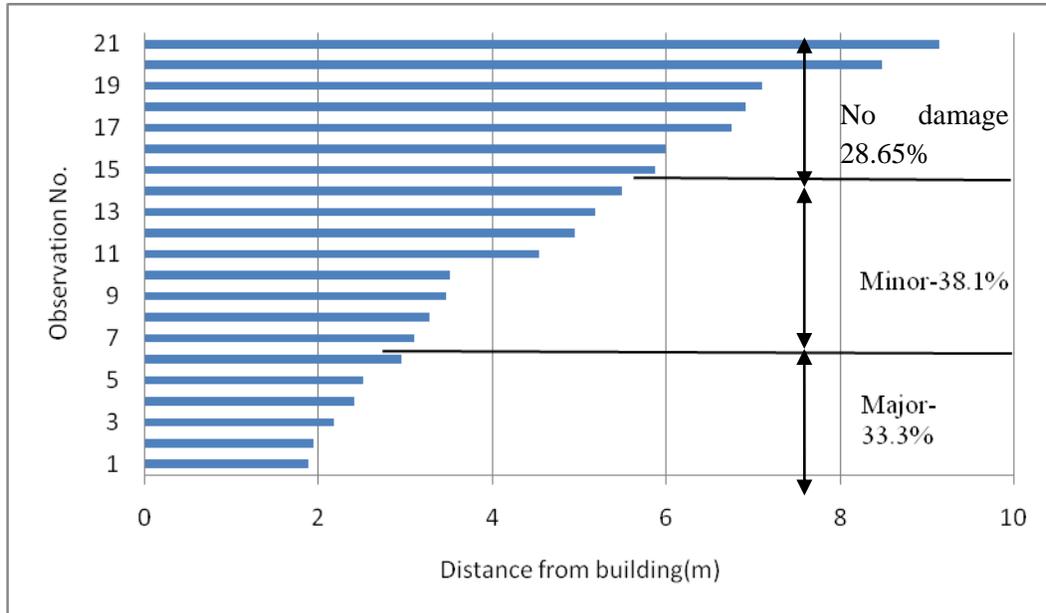
**Figure 7 -Bodhi tree**

Figure 7 shows the damage identification with respect to the distance and observations made for Bodhi tree. It is clear that the damage has been more significant up to 3.89 m from the building for Bodhi trees. From 3.89 m to 7.20 m, the damage is less. Any distance more than 7.20 m, can be taken as the safe planting distance for this type of tree.



**Figure 8 -Royal Poinciana tree**

Figure 8 gives the damage classification based on the distance for Royal Poinciana tree. Here, the damage has been occurred significantly up to 3.94 m from the building to the tree. Then it range from 3.94 m to 6.45 m can be categorized as minor. Any distance more than 6.45 m is in No-damage range.



**Figure 9 -Tamarind tree**

For Tamarind tree, it is convinced that the damage has been more significant up to 3.09 m from the building. From 3.09 m to 5.86 m, the damage is less. Any distance more than 5.86 m, can be taken as the safe planting distance.

## 6. CONCLUSIONS& RECOMMENDATIONS

This research was carried out to find the damages in building structures, which occurs due to tree roots as well as to find the safe distance to plant trees from building without causing any damage. The detail survey revealed that lots of people don't have any awareness on safe margins to plant trees near their households. So, the outcome of this research provides the suitable guidelines to avoid these problems. In additionally, it is obvious that the direct damages to buildings are very common here in Sri Lanka resulting cracks on civil structures such as road pavements, building pavements finished floors and boundary walls etc.

The Information gathered from the research suggests the following:

<b>Common Name</b>	<b>Botanical Name</b>	<b>Maximum root spread damage recorded (Meters)</b>	<b>Suggested min safe distance from property (Meters)</b>
Jack tree	AtrocarpusHeterophyllus	4.16	4.25
Mango tree	Mangifera Indicia	5.10	5.25
Bodhi tree	FicusReligosa	7.20	11.00
Royal Poinciana	DelonixRegia	6.45	7.00
Tamarind tree	TamarindusIndica	5.86	6.00

However, this research is only limited to three districts and the number of observations are not enough to make a general conclusion, which will cover whole country. The damage and also its nature can change with the soil type and also the foundation type used. So, it's highly recommended to do further studies on the same area with different climatic conditions and different soil types. Planting trees has many advantages. So, this can be surely helpful to achieve safe natural environment around manmade structures, which can help to mitigate heat island effect as well.

## Acknowledgements

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