

# ASSESSMENT OF IN SITU STRUCTURAL PROPERTIES OF TIMBER

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**Abstract** - Timber is an important natural material used for all type of construction work. One of the best specialty of this material is that it is a renewable material. The timber which is in better condition can be reuse after perming some basic tests on it. Wood having properties like physical, thermal and mechanical and these properties are strongly influenced by its directions because of arrangement of its fibers and orientation. Wood is orthotropic because of having three orthogonal directions of symmetry that are the longitudinal (L) direction or the direction parallel to the grain is aligned with the axis of tree trunk, the radial (R) direction lies along the radius of tree cross-section while the tangential (T) direction is tangential to the growth rings. The radial and tangential directions are referred as direction perpendicular to the grain. Objective of this study is to determine the structural properties of timber by collecting samples from the actual site and perform experiments to determine the performance of strength according to the age of structure. Timber is the building material which give good performance if repair and maintain properly and regularly under expert supervision.

**Key Words:** NDT Techniques, Salvaged timber, Ultrasonic Pulse velocity methods, Parallel to grain direction, Perpendicular to grain direction, UTM.

## 1. INTRODUCTION

Timber is the most beneficial building material. Salvaged timber can be used for the construction after testing. In India not much work has been done on timber, so in this area there is large scope for further study. For the determination of strength property of timber NDT Technique is used. This technique is currently in use. Ultrasonic Pulse Velocity test is one of the essential tests to be perform. Moisture content is the phenomena which influence the timber internally as well as externally. Due to the presence of moisture content in the timber various defects are determined in the whole structure.

### 1.1 Strengthening methods

Ultrasonic pulse velocity, Bending strength, tensile strength, Compression test parallel and perpendicular to the grain direction, Infrared testing.

### 1.2 Ultrasonic Pulse Velocity method

This method is used to determine strength and extent of deterioration in the timber structure. Waves are travel between transmitting transducer and receiving transducer by the source of an oscillating piezoelectric core.

### 1.3 Bending Strength

This test is performed for the determination of Modulus of elasticity and Modulus of rupture. Universal Testing Machine (UTM) is use for this experiment.

### 1.4 Tensile Strength

Indian Standards Codes are available to conduct this test. UTM is used to perform the test. Tensile and Flexural strength can be determined by conducted this test.

### 1.5 Compression Strength test

Compression test parallel and perpendicular to the grain direction. Test is conducted in both the direction of grain. During the preparation of samples grain direction concept is an important step to keep in mind. According to IS:1708(Part 8)-1986 and IS:1708(Part 9)-1986 test is to be perform. Again UTM (Universal Testing Machine) is used to conduct this test.

### 1.6 Infrared Testing

Infrared technique has potential for the determination of physical, chemical and mechanical properties of timber. Infrared is a part of electromagnetic spectrum which is visible to human eye. This technique is used to determine and view temperature distribution based on infrared radiation emitted from a heated surface of an object without physically contacting the measuring equipment and investigated surface.

## 2. RESEARCH AND STUDIES ON PROPERTIES OF TIMBER

Relevant research work and studies are reviewed here:

**1 Artur Jorge De Oliveira Feio et al. (2005)** [1] discussed about Inspection and diagnosis of historical timber

structures with non-destructive techniques correlations and structural behavior. Timber elements are often visible which allows easier conservation, identification of the wood species, characterization of details and evaluation of deterioration. This study is based on the wood which is chestnut wood. The first objective of this study is to quantify the structural capacity of wood- wood mortise and tenon joints by physical testing of full-scale specimens. Second objective is to evaluate the reliability of different non-destructive techniques for determining the mechanical data and joint properties. By the density determination test, it was found for the new sample of chestnut wood and old sample of chestnut wood that the density is very near to each other. UPV shows that measuring the ultrasonic pulse velocity near the joint is a reliable way of evaluating in a quantitative manner the effectiveness of the assembly between the two elements.

**2. Jose Saporiti Machado and Paulo B. Lourenco et al. (2011)** [2] In this research the structural properties of timber members in situ is assessed. Research methodology is actually a probabilistic approach. Two alternative probabilistic models are assessing the reference properties can however be used. One approach used information about original quality of timber element and second approach is the information from direct or indirect measurements made during the appraisal of the structural elements.

**3. James Brandon Davis and Jerome J. Connor et al (2012)** [3] Discuss about the suitability of salvaged timber in structural design. It describes the barriers, opportunities and benefits of using salvaged lumber or timber in the construction. Additional sources of salvaged timbers like marine piles and underwater forestation should also be carefully studied. Only than widespread acceptance and use of reclaimed timber will create economic opportunity and lesser will be the environmental impact of deforestation, demolition and waste disposal of salvaged timber lumber from deconstructed building offers largest possibilities for reclaimed lumber use. Full size lumber from deconstructed houses exhibit 25% of lower bending strength and 10% lower stiffness than in grade virgin lumber.

**4. C. Peter Neimz David Mannes et al (2012)** [4] The researcher has discussed the Non- Destructive testing of wood and wood-based materials. The basic objective of this particular study is an overview on various methods available for the non-destructive inspection of wooden cultural heritage objects. For the evaluation of cultural heritage objects only some of available non-destructive testing methods can be considered. These are: measurement of the moisture content, strain measurement, colour measurement, delamination surveys, computed topography, ultrasound, video image correlation, thermography, chemical analysis using spectroscopy

**5. Jose S. Machado et al (2013)** [5] discuss possible way to use and combine information from Visual grading standards and non-destructive and semi destructive techniques to predict the reference properties such as bending strength, bending modulus of elasticity and density of timber members in service. First stage discusses about preliminary survey of timber members which include visual inspection. From first stage two decisions came out that 1. Structure is considered fit for use 2. Structure is not fit and decision has to be taken either to demolish or carry out more detail survey. Second stage discuss about detail survey of timber.

**6. Candido Ana and Henriques Dulce et al. (2014)** [6] In this research paper it has discussed about the Inspection and diagnosis of timber structures by non-destructive methods the main aim of this study is the application of non-destructive testing in timber structure elements. Another objective of this study is further explanation of the difficulties and limitations related with their applications on site. By this study it has been proved that the choice of NDT is useful not only because it allows for a better mechanical characterization but also because of its careful approach resulting in no damage, not much needed in buildings with such architectural values. In preliminary stage of inspection: It consist of general assessment of timber structures, acknowledgement of its main defects, risk as well as a first approach of identification of wood species. It is also important in this stage to ensure whenever possible conditions of accessibility, lighting and cleaning for the next inspection stage. The second stage is the more detailed stage of inspection and diagnosis of timber structures. It consists of visual inspection and application of non-destructive testing inspection techniques.

**7. Katalin kranitz et al. (2014)** [7] In this study the researcher has given the effect of natural aging on wood. The main purpose of this study is to fill up the gap between the different contradictory statements on aged wood and its properties. To achieve this purpose various experiments on chemical, physical and mechanical properties of aged wood were carried out Various observations could be made like: 1. Aging is generated by chemical changes 2. Aging can also be accompanied by colour changes 3. By mechanical tests, including the observation of elastic and strength as well as investigations on the fracture behavior delivered no remarkable differences between aged and recent wood. 4. The physical and mechanical properties of wood do not change considerably by aging at least for upto 200 years in case the materials are stored in dry climate indoors. Conclusion was that, the aging process is dependent on the storage, service conditions and on the wood species as well. Statistical analysis gives the apparent difference between aged and recent specimens by using various factors like density.

**8. Yongtaeg Lee, Jihee et al. (2015)** [8] proposed an equation for correlation between the compressive strength and ultrasonic pulse velocity of structural timber using the ultrasonic pulse velocity method. Ultrasonic pulse velocity is measured by using direct methods towards fiber directions. Compressive strength test was carried out by using 200KN UTM. The correlation graph between ultrasonic pulse velocity and compressive strength was plotted. The result showing increase rate of compressive strength in air dry and absolute dry condition as per moisture content was an average 39.48% compressive strength increase rate. And increased rate of ultrasonic pulse velocity in air dry and absolute dry condition according to moisture content was an average 44.09% increase rate.

**9. Alberto Cavalli and Daniele Cibecchini et al. (2016)** [9] Gives a review on the mechanical properties of wood and salvaged timber. The main interest of the researcher was in the bending properties variation, while for other mechanical properties less information is available. Mechanical properties like bending stiffness (MOE), bending strength (MOR), compressive strength, tensile strength, impact bending strength, shear strengths are to be studied precisely than the results show that mechanical properties of wood and salvaged timber is quite complex.

**10. Swapna Sarita Pradhan and Dr. Sanjay Sharma et al (2018)** [10] In this research work structural strength assessment of timber members from a sustainable heritage structure has been assessed. The researcher has performed various tests like Compression parallel to grain, Compression perpendicular to the grain, Tension parallel to the grain, Screw with-drawls test are carried out to get reliable information for the prediction of mechanical properties of timber elements. The main objective of this study is to find out the percentage decrease in structural strength of timber members with the passage of time. Results of this study were: 24.8% reduction in tensile strength, 16% reduction in compressive strength parallel to grain, 8.6% reduction in compressive strength perpendicular to the grain and screw holding power is reduced to 12.02% and 33.7% respectively. Conclusion was that, in compression tests the specimens fails in crushing and splitting.

### 3. CONCLUSION

This paper reviewed the concept of utilization of in situ timber members. Timber is renewable material so after demolishing of any structure, wooden member can extract out and can be reuse after conducted some tests. Most of the literature cited above shows that non-destructive testing technique is effective for the determination of properties of timber. Apart from that Ultrasonic pulse velocity test also helps to determine strength properties of timber element. All of these tests can be performed on the fresh samples as well as on an in-situ structural timber member also. There are various factors which influence strength of timber structures

but out of all that moisture content plays very important role in the deterioration of timber structures. So it is very important to have regular check and frequent repair work. Above research work showing the correlation between Ultrasonic pulse velocity and compressive strength of timber member.

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