



## Condition Assessment of Structure and Remedial Measures-A Review

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**Abstract** – Condition Assessment is one of the stages in the structural monitoring management which plays an important role in the maintenance and Re-strengthening of the structure. The main ambition of the paper is to give review about assessment of structures and past researches with reference to the assessment strategies adopted and monitored different structural elements and suggest the suitable remedial measure. The assessment strategy classified on the basis of types of structures, their functional uses, life span, the degree of deterioration, and their economical preservation. To adopt the suitable methods on the structure which is having issues regarding the functionality and adverse effects on the metabolism of the structure. The assessment plays an important aspect in the rehabilitation, repairs, and retrofitting techniques which is directly related to durability, strength, serviceability of structure.

**Key Words:** Condition Assessment, structural monitoring, Re-strengthening, metabolism, deterioration

### 1. Introduction:

The structure such as buildings, water tank, bridges has specific function to perform in their life span. As maintenance is very crucial for smooth functioning of the structure. In the past years we have seen various structural integrity to loss their functionality before their utility life because of lack of maintenance and monitoring. To sustain the structure in diverse condition and to work smoothly during useful period, the term condition assessment plays an important role; it is the process of collecting, observing the information, data and systematically using them to evaluate the existing condition of the structure. Now a days, Assessment has been a major aspect to stabilize the integrity of the structure and proper functioning until the utility time period. Going into this paper we have review the past researches about the assessment, monitoring, retrofitting, restrengthening and repairs of the structure and the different techniques they have adopt for monitoring and Re-strengthening. We have mentioned the past researches with typical site condition and the techniques they have adopted for the assessment of structure and certain remedies towards it. The review has given us the boost to build towards advancements in the methods of assessment and measure to adopted for restoration of structure.

### 2. Brief Literature Review:

**1. Sahaduta Linggar, Akhmaad Aminullah and Andreas Triwiyono “ Analysis of buildings and its components assessment case study of dormitory buildings”:** The researchers explained that the condition assessment is one of the vital stages in assets management. The authors explains that the inter building performance can be evaluated by comparison with the other building ,while intra-building evaluation is the performance evaluation of the building by self- assessed without any reference. The author has taken two models as dormitory building and Gadjah Mada University for assessment which they have divide in 6 different categories. Each category has different elements in respective group and evaluated the loading factor for all the

categories and element inside the building. The loading factor is used to determine condition of building.

**2. Shekhar verma , Dr. Vijay Raj “Structural Health Monitoring Case Study Review”:** The paper reviews the various techniques for preventing lateral forces are applied; to check the functionality of techniques the monitoring of structure is required. The authors showcase the case study of various monumental building all over the globe such as Vintage Bridge in Russia, Burj Khalifa Tower in Dubai, Republic Plaza in Singapore, Heritage Temple and Naina Bridge in India. Further explains the various sensors are used in the monuments for monitoring without interrupting their functionality and prevent the danger of sudden damageability.

**3. Er. Nilesh B. Deshmukh, Er. Manesh B. Satpute, Er. Rahul B. Abhale, Er. Akshay B. Varpe, “Structural Audit – A Case Study of Educational Building”:** The author suggested that there are four important steps in construction field; these are structural planning, construction, architectural planning and maintenance. The structure is getting deteriorated before the service life, that’s when the maintenance is required in the structure. To nullify the effect of collapse mechanism the structural audit is important to find the root cause and suggested the suitable method.

**4. SachinRambhaushelke, Prof. Darshana Ainchwar, “Structural Health Assessment, Audit, Repair and Rehabilitation of Building in Construction Industry”:** The author explained that the structure requires regular maintenance and any structural element are deteriorating requires proper remedial measures for repairs. Retrofitting and restrengthening should be done. The author further explained the deteriorated structure can be restrengthened and modern repairs materials can be applied. The paper gives the present scenario of building and suggested the improvement strategies which can be applied to the structure during the service life . They also explain the various methods of rehabilitation, repairs, retrofitting.

**5. Duzgun Agdas , Jennifer A. Rice, Justin R. Martinez, Ivan R.Lasa “Comparison of Visual Inspection andStructural Health Monitoring as Bridge Condition Assessment Methods”:** The author explains that the deficiencies in structure have a fatal damage to the living being. The paper explains structural health monitoring approaches are used to identify hidden defects in the structural elements. They have given various techniques to prevent the deterioration of structure in which visual inspection has proven to be effective for general inspection . For other structure such as bridges wireless sensors are used for additional investigation for betterment of structure.

**6.Chittaranjan B.Nayak, Sunil B. Thakare “Seismic performance of existing water tank after condition ranking using non-destructive testing”:** The author have carried out the assessment of the elevated service reservoir by using different non-destructive tests to find out the condition index. The researchers have performed various technical aspects for assessment such as corrosion investigation, seismic analysis. The results which are obtained are used to determine the issues of seismic response of the retrofitted structure in terms of time history , mode shape, base shear , acceleration and velocity. On the basis on these parameters the retrofitting techniques are applied to the structural elements of water tank.

**7. G. Pascale, A. D. Leo, and V. Bonora, “Non-destructive assessment of the actual compressive strength of high-strength concrete”:** The authors carried out a testing which involves both NDT and DT methods applied to different mixes, with cube strength varying from 30 to 150 MPa, which is used to determine a relation between strength and parameters. Tests performed are pulse velocity, rebound hammer, pull out, and probe penetration, micro-coring and combined methods. Author has given the tests procedure in descriptive manner with significance and application.

**8. R Sanjeev Kumar Verma, Sudhir Singh Bhadauria and Saleem Akhtar “Review of Non-destructive Testing Methods for Condition Monitoring of Concrete Structures”:** The author have discussed that the engineers has good practice of using different NDT equipment according to present site condition. The paper explains various NDT methods with full details about the process, principles, limitation and details about the process and how it is executed with proper drawing. The research also mentions different ISCODE describing the method.

**9. M. K. Lim and H. Cao, “Combining multiple NDT methods to improve testing effectiveness”:** The paper explains that earlier to determine the strength and quality of concrete in construction work, manually several specimen were casted then with reference to the properties their compressive, flexural, tensile strength is checked, which sometimes causes difference in results from the actual structure due to specimen size, shape, and condition. To overcome this problem the NDT methods being a vital tool in present condition to evaluate the condition of the structure, several methods has being discussed such as Ultrasonic pulse velocity test, Rebound hammer test, Pull out test, Hall cell potentiometer.

**10. Adam B. Noel, Ahmed Badway “SHM Using Wireless Sensor Network: A Comprehensive Survey”:** In this paper the author presented a compressive survey of WSN Based SHM system. The foundation information relating to Structural health monitoring such as basic parameters, and damage detection. The main challenge of this system is scalability, time synchronization and sensor placement optimizing the data processing were presented and solution of this problem.

**11. Tracy Kijewski-correa, Martin Haenggi, PanosAntsaklis, “Wireless Sensor Networks for Structural Health Monitoring: A Multi-Scale Approach”:** In this paper it was described that nowadays number of Countries were facing a problem regarding to restoration of infrastructure likewise bridge, railway route, dam. It required time to time maintains, so it needed to monitoring system which gave the proper information to the structure so we needed structural health monitoring system for a multi scale approach.

**12. B. Arun Sundaram, K. Ravishankar, R. Senthil “Wireless Sensors for Structural Health Monitoring and Damage Detection Techniques”:** In this article they discussed about the recent research and development and application of sensing. Monitoring and damage detection for civil infrastructure. Sensors such as wireless sensors, optic fiber, piezoelectric sensors and their application were discussed. Recent development are present ambient vibration based monitoring, damage assessments using soft computing, WSNs using without data collision, local damage detection using wireless sensing system.

**13.Sanket Sanjay Suryawanshi, Vaibhav Vishnu Vishe, Deepak PremchandSah, ReetikaSharan, “Structural audit of RCC building”:** The authors have differentiated the structure in various methods and in suitable parameters with respect to the assessment methods . The author after the assessment of structure has detected faulty mechanism in the structural elements and studies the origin of the problem . After deciding the percent of degree of deterioration , suitable remedial measures to overcome the failure is suggested. Authors also have suggested immediate remedies for sudden collapse of structure.

**14. Jedidi Malik, Machete Couthier “Destructive and Non-destructive Testing of Concrete Structure”:** The paper mainly deals with the determination of compressive strength and dynamic modulus of elasticity from Destructive and Non-destructive testing. The author has explained the procedure of Schmidt Rebound Hammer and Pulse Velocity with varying w/c, cement, sand and gravel content. The Rebound hammer gives the compressive strength of concrete and the dynamic modulus of elasticity can be determined using ultrasonic measurements.

**15. Graham Thomas “ Overview of Non-destructive Evaluation Technologies”:** The author explains wide range of Non-destructive techniques are available to characterize material and defects in variety of structural components .The author have explained application of the appropriate methods which helps in assessment of the structure and allow cost effective solution for re-strengthening programs. The paper emphasis on techniques forthe evaluation of mass structure such as bridges, highway, aircraft, airports, civil structures, dams, etc.

**16.Pravin B. Waghmare “Materials and Jacketing Techniques for Retrofitting of Structure”:** The author presented that the building needs to be strengthen for better performance against lateral forces. The paper explains the technique which can be used for increasing the strength, durability of the structure by using different materials. The research explains the uses of different materials such as steel, fibre reinforced polymer according to site conditions. Author mentions that the retrofitting techniques such as Steel jacketing, R.C jacketing, FRP composite jacketing with carbon and glass fiber ,this material should be implemented on



structural element such as beams and column. The paper explains the uses of different materials , techniques, behavior of materials under various circumstances and modification for better results.

**17. Pierre Fouche, Michel Bruneau, F. ASCE, and Vincent P. Chiarito “Modified Steel Jacketed Columns for Combined Blast and Seismic Retrofit of Existing Bridge Columns”:** The author investigated the modifications over the steel jacketing which perform considerable good in resisting blast failure and earthquakes vulnerability and helps in preventing direct shear failure. The research shows that they have performed four tests by varying the blasting box distance from the bridge columns and investigate the structural performance for each set. The MSJC concept was introduced by the authors to increase the blast resistance of bridge column. The paper describes the experimental and analytical study of performances of modified steel jacketing columns and structural behavior during blasting.

**18. Vasant A. Matsagar and R. S. Jangid “Base Isolation for Seismic Retrofitting of Structure”:** The author illustrated the seismic response of structural retrofitting using base isolation. The research explains the retrofitting of various structural integrity such as historical building, liquid storage tank, bridges , etc. and in view that the goal of seismic isolator is to shift the fundamental frequency of structure away from dominant frequencies of earthquake ground motions and fundamental frequency of fixed base superstructure. The various isolation systems has discussed in the paper such as high seismic damper, lead rubber bearing, friction pendulum system etc. The research paper justifies the response of existing structure with retrofitting and structure without retrofitting. Without interrupting the functionality of structure, the resistance of monuments to lateral forces and their durability can be incorporated with the help of base isolation technique.

**19. M. ELGawady, P. Lestuzzi, M. Badoux “A Review of Conventional Seismic Retrofitting Techniques for URM”:** The paper emphasise on the retrofitting of masonry walls and conventional techniques. To counter the effect of seismic vulnerability the researchers has explained various methods such as surface treatments, grouting and epoxy injection, external reinforcement, confining using tie column and post tensioning. The methods are quite cost effective and according to the site condition or degree of deterioration of structure the applicable methods can be executed.

**20. U. Ersoy, A. T. Tankut, and R. Suleiman, “Behaviour of jacketed columns,”:** The author explained the remedial measure of increasing the strength , ductility and earthquake resistant for column by jacketing. The author has studies the process of jacketing under for column with typical dimension and reinforcement under axial loading. After casting the basic column they have done jacketing to the specimen. Author called the intervention either a repairing or strengthening jacket depending on whether the basic specimens had been loaded to a damaged level.

## Conclusion:

1. The paper includes brief discussion of literature of past development of assessment methods and non-destructive methods which helps us to step towards advancement.
2. Various Assessments methods are reviewed on the basis of different principles, with their individual merits and limitation are characterized in the paper.
3. It has been recognized that the Condition Assessment plays an important role in the maintained of existing structure to rectify the defects and suggest the standard remedial measures such as repair, rehabilitation, retrofitting and conservation.
4. NDT provides useful information by revealing hidden or unknown defects and one of the major integral parts of condition assessment.

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