SURAT TUGAS

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Title: The conversion enhancement of lauric acid to N-Acyl lysine catalyzed by calcium oxide using Box Behnken Design

Author (s): Zuhrina Masyithah and Bonita Ribkha Hutajulu

Abstract: N-acyl lysine is a surface-active substance that can reduce interface tension between oil and water. N-acyl lysine was synthesized by calcium oxide amidification of lauric acid and lysine. The study aims to increase lauric acid conversion by observing the effect of substrate ratio, catalyst amount, and solvent ratio, through the preparation and observation of mathematical models using Box Behnken Design and Response Surface Methodology. Optimal conditions are observed in the ratio of lauric acid to lysine 1:2; 1:3; 1:4, catalyst amount 3%; 5%; 7%, and a solvent ratio to lauric acid 1:1; 1:2; 1:3. In this optimal condition, the conversion of lauric acid will increase by more than 80%. The variable amount of catalyst showed a more significant effect in increasing lauric acid conversion. The results showed that all three variables affect the percent conversion with an R2 of 90.32%.

Full Text

Title: Study of the possibility of using leaf litter to clean up water environments from petroleum products

Author (s): D. A. Kharlyamov and G. V. Mavrin

Abstract: We studied the sorption properties of tree foliage samples growing in urban anthropogenic landscapes in relation to petroleum products. As sorption material we chose leaf litter of apple-tree (Lat. Malus), birch (Lat. Bitula), oak (Lat. Quircus), and aspen (Lat. Populustremula). The physical and chemical characteristics (moisture, ash content, and bulk density) of the fallen leaves samples were determined. Atomic-emission determination of the content of various elements in acetate-ammonium extracts of selected leaf samples was carried out to evaluate the safety of their use as sorption material. The leaves of an apple tree growing along a busy highway were chosen as an object for evaluation of metal accumulation capacity, and samples of leaves were taken in spring and autumn periods. To assess the background content of elements, samples of apple-tree leaves were also taken away from anthropogenic sources of impact. It was found that the content of heavy metal ions in the leaves of apple-tree under intensive anthropogenic load does not exceed the established standard requirements, respectively; the material in question can be used as a sorbent for purification of water environments from various pollutants. Experiments on purification of model solutions containing oil products were carried out under static and dynamic conditions. It was found that all the leaf samples under consideration possess sorption properties towards oil products to a different degree: the minimum adsorption capacity of aspen leaves - 0.42 mg/g under static and 0.17 mg/g under dynamic conditions, the maximum adsorption capacity of oak leaves - 0.73 and 0.28 mg/g respectively.

Full Text

Title: The development of an integrated platform (CAD/FEA/CAM) for the deep drawing process

Author (s): Hussein Zein

Abstract: The main objective of this research is to develop an integrated platform for a computer aided design, finite element analysis, and computer aided manufacturing modules (CAD /FEA/CAM) of the deep drawing process for cylindrical cups. The integrated platform was done through the use of programs (VB6), UGS-NX9, and ABAQUS on a personal computer. In this paper, these modules are constructed to facilitate several industrial applications in the process of sheet metal die design and manufacturing. Finally, CAD /FEA/CAM results fora case study are applied experimentally to validate the developed integrated platform. Simulation results provide useful information to address the feasibility of the actual production process.

Full Text

Title: Investigation of performance difference between traditional and recommended thermal insulation model

Author (s): Khaled Al Omari, Ghassan Suleiman, Faten Al-Twal and Dania Al-Tarawneh

Abstract: Insulation is the name given to processes and systems that prevent unwanted physical effects or events from passing from one side to the other. Within this scope, preventing heat energy from entering or escaping can be considered as one of these operations. This paper aims to evaluate the traditional types of thermal insulation used for walls in Jordan and recommend an effective new wall type. For this reason, the characteristics of the three types of thermal insulation walls were checked. For example, the thermal transmittance and thermal resistance for each type were determined. The obtained results were compared with the result of the recommended model. The results showed that the thermal transmittance of the recommended model has decreased by 65% with respect to the traditional types. Finally, these results would help for developing the Green Building Guide in Jordan through adopting a specific arrangement of insulation layers, which ensures less energy consumption and thus less harm to the environment.

Full Text

Title: Analysis of flood-prone areas using Geographic Information System

Author (s):   Abdul Wahid, Ida Arianingsih, Misrah Misrah, Naharuddin Naharuddin and Zahra Zahra

Abstract: Tolitoli Regency is an area that often experiences regular floods every year, one of the areas that are often affected by flooding is the Lampasio District, flood disasters that often occur in the District of Lampasio have many impacts on the community and the environment. Based on this background, flood-prone research was carried out in Lampasio District to mitigate disasters. This study uses primary data and secondary data in the form of topographic data, slope, geology, and soil types, as well as rainfall data and land use data. The purpose of this research is to be able to get the level of flood vulnerability with a Geographical Information System. The results of the analysis show that Lampasio District has an area with the highest level of flood vulnerability covering an area of 1,274.31 Ha or 2.04%, then in the area that is included in the moderate flood vulnerability level is 18,765.93 Ha or 30.03% of the total area. , and areas that are included in the low level of vulnerability are 2,444.60 Ha or 67.93% of the total area in Lampasio District.

Full Text

Title: A comparative study of the measurement of the fuel injection rate of a diesel piezo injector with a scale and a positive displacement flow meter

Author (s):   Byung Chul Lim and Choong Hoon Lee

Abstract: The fuel injection rate of a diesel piezo injector was measured using a scale and a positive displacement flow meter (PDFM). The measurement results of the injected fuel quantity were compared in each case. The piezo injector was driven by a microcontroller. The piezo injector driver is designed to charge and discharge current to the piezo injector. The control signal was generated by a microcontroller. The fuel injection durations used in this study were 0.5, 1.0 and 2.0 ms. the common rail pressure was controlled under the three conditions of 30, 100, and 150 MPa. The injected fuel mass per injection was calculated from the total injected fuel mass when the fuel injection was repeated 500 times. The lower the rail pressure, the greater the variation in the injected fuel mass. Variations in the injected fuel quantity per injection with the injection duration were reduced with longer fuel injection durations. In all injection conditions, the accuracy of the scale was higher than that of the PDFM.

Full Text

Title: An empirical study on the effectiveness of energy harvesting from Dynamic Vibration Absorber

Author (s):   Luqmaan Hakiem Sulaiman, M. Azhan Anuar and Zamri A. R.

Abstract: Dynamic Vibration Absorber (DVA) consisting of a simple mass-stiffness mechanism has typically been designed to attenuate excessive vibrations in machines and structures operating at or near their resonant frequencies. This undamped DVA, namely the auxiliary system, helps to reduce the amplitude of the main system by creating the "anti-node" and theoretically lags 180: of the excitation force in order to suppress the vibration amplitude of the main system. DVA demonstrates unused and wasted energy that can potentially be harvested for other purposes. Energy harvesting from the vibration object, which in this case is the DVA, is a technique used to convert unwanted vibrations into electrical energy. This paper will address the effect of the DVA parameters chosen on the basis of the Randy Fox Method (RFM) and its effectiveness will be experimentally tested. The piezoelectric transducer is mounted on the DVA and the energy produced in the form of the generated voltage is measured at different widths of 30 mm, 40 mm and 50 mm for three different tuned mass positions. The experimental results reveal that a single piezoelectric transducer can generate up to 40 millivolts at an operating frequency that excites the original natural frequencies of the main system. It is observed that with the proper selection of parameters, the vibration amplitude of the main system is attenuated effectively along with the sufficient energy that can be harvested.

Full Text

Title: PVD-Coated Cermet applied for hard turning of AISI 4340

Author (s):   A. Ginting and Z. Masyithah

Abstract: Study on performance of PVD-coated Ceramic Metal (TiCN-based substrate/TiCN/TiN) cutting tool applied for turning of AISI 4340 steel with hardness of 50 HRC is the objective of research reported in this paper. The performance was studied through some machinability aspects, i.e. tool wear, cutting time, surface roughness and power. The design of experiment was done by Taguchi with cutting speed, feed and depth of cut as the independent variables and the machinability aspects as the responses. The results of study show that flank wear was observed as the tool wear mode and it was attributed to abrasive wear mechanism. Cutting time gained by the cutting tool was reliable, surface roughness was at the quality of smooth turned, and as the surface roughness, power was recorded reasonable for finish turning. As this study recommends the PVD-coated Cermet for finish turning operation and thus, surface roughness becomes the primary response. Optimization was carried out for surface roughness. Since surface roughness was one among 4 responses, the multi objective genetic algorithm technique was utilized. The result of optimization and the confirmation test showed a good agreement where the optimum surface roughness was about (0.5308-0.5450) microns. It was resulted at cutting speed of 130 m/min, feed of 0.1 mm/rev, and depth of cut of 0.1 mm.

Full Text

Title: Design and theoretical analysis of sub-frame structure on dump truck and validation through FEM approach

Author (s):   Rajesh M., Suresh P., Prithuvi Rajan S., Rahulson M., Sathish T. and Srireguram

Abstract: A study is made to enhance the performance of the sub frame in YJ3128 type dump truck by reducing the vibration, weight and provide uniform load in static condition. A three different case studies has been made by modeling the sub frame with three different cross section namely C , I and Rectangular sections. The work is performed by varying the position of the cross members in the sub frame and validate through FEM approach. The dimension and material for this study is taken from the existing model of YJ3128 type dump truck. Based on the comparison of theoretical and analytical results of max principal stress and deflection, the optimized sub frame has been identified. It is mainly utilized in carrying the power train unit of the heavy duty vehicle that are used in mining's, construction sites and highways for transporting sands and gravels.

Full Text

Title: Implementation of conventional software GPS receiver to acquire and track GPS signal

Author (s):   Sreepriya Kurup and I. Hameem Shanavas

Abstract: The GPS signals when transmitted from the satellite have power of 27 W. As they reach the receiver antenna on the earth s surface, the power measured is too low around 10 -16 W. So, the acquisition and tracking of GPS signals become a big challenge. Acquisition and tracking of GPS signal are the initial stages in the software GPS receiver.

Acquisition stage detects the signal coming from the satellite and provides rough estimate of code phase (code delay) and doppler frequency. Tracking phase provides the sheer estimate of the code phase and doppler frequency, which helps us to determine the distance between the receiver and the satellite transmitting the signal. In hardware GPS receivers a specialized chip is being designed for performing acquisition and tracking algorithms. While in software GPS receivers, the signal processing tasks are performed in software. Thereby, increasing the control and flexibility on the tasks performed. It also becomes easy to incorporate any changes in algorithms or approaches in the future. In this paper we have demonstrated the acquisition and tracking of GPS signals data affected by ionospheric scintillation using software GPS receiver. The acquisition of GPS signals is implemented using Parallel code phase algorithm and its tracking using DLL/PLL.

Full Text

Title: Energy-Efficient and fire-resistant light expanded-clay granulates for heat insulation Via heat treatment of bentonite clays with industrial wastes

Author (s): Gulnaz Makulbekova, Yerkebulan Kocherov, Oleksandr Pivovarov, Bibol Zhakipbayev, Shermakhan Shapalov and Gulmira Kenzhaliyeva

Abstract: The influence of brown coal and coal production waste on the bloating of bentonite clay was experimentally investigated for the purpose of optimizing the heat-insulation properties of fire-resistant expanded-clay granulates. The bloating coefficients and bulk densities of the expanded-clay granulate samples with additives showed clear dependence on firing temperature. Coal production waste and brown coal were both found to be suitable as intensifiers of beneficial bloating in bentonite clays of the Kyngrak-Keles deposit, Kazakhstan. In both cases, expanded-clay granulates with high heat-insulation effect and low bulk density was produced. X-ray diffractometry, electron microscopy, and differential thermal analysis helped reveal the bulk chemical and elemental compositions of the additives. This study establishes a quantitative compositional basis for heat-insulation granulate performance, opening up economical pathways to enhancing the energy efficiency of buildings and structures while increasing fire safety, environmental friendliness, and resistance to a range of climatic conditions.

Full Text

Title: Analysis of railway tracks reinforced with geogrids

Author (s): Giovanni Leonardi

Abstract: Use of geosynthetics in civil engineering has advanced rapidly in recent years and it has been popular in railways construction. Geosynthetics provide an important option to improve track support stabilization and to reduce the track maintenance costs. In the present paper, a reinforced railway track has been modelled using the finite element method (FEM). The principal aim of the study is to investigate the influence of geogrids reinforcement in the railway track behaviour. The results show that the reinforcement can provide a significant contribution to improve the performance of railways tracks.

Full Text

Title: Evaluation of fatigue strength of ANSI 304 steel pipe welds

Author (s): Xuan Chung Nguyen and Tuan-Linh Nguyen

Abstract: ANSI 304 austenitic steel is alloy steel with high Ni and Cr content, and this steel has high strength, heat resistance, corrosion resistance, is not magnetized, and is especially easy to weld. However, regarding the welding process of ANSI 304 steel, the heat-affected area is very sensitive and leads to hot cracking of the weld metal. The higher hot crack forming characteristics of the Austenitic group than other alloys, along with a higher coefficient of thermal expansion, lower coefficient of thermal conductivity, welding mode, etc., are the factors that strongly affect the quality of ANSI 304 steel welds. Tensile strength and fatigue strength of welds are two important parameters characterizing the life and safety of the structure. In this paper, an experimental method is used to evaluate the influence of welding materials, welding mode, and weld geometry parameters on the tensile strength of welds when welding ANSI 304 steel pipes. Thereby, find the optimal set of welding mode parameters to fabricate the test samples. Using the Weibull distribution function and Loga normal distribution function, the fatigue graph and fatigue regression equation are built to evaluate the fatigue strength of ANSI 304 steel pipe welds.

Full Text

Title: An innovative real-time water quality monitoring system for aquaculture application

Author (s): Maricel G. Dayaday and Consorcio S. Namoco Jr.

Abstract: Aquaculture is one of the most promising industries in agricultural sector. Fish as one of aquaculture s contributions, is considered as a substantial source of protein for people around the world. However, one issue confronting the small-scale aqua farmers is the current practice of conventional water quality monitoring which is tedious and time consuming. These current evaluation methods of water quality are laboratory-based tests that required fresh supplies of chemicals, qualified staff and water samples. In this study, an innovative real-time water quality monitoring system for aquaculture application is proposed. The system utilized electronics sensors, microcontroller and SMS technology for notification purposes. There are four parameters were monitored namely: pH, temperature, dissolved oxygen and ammonia. Results of evaluation performance show that there were only minimal errors in the values of the parameters considered in the proposed device as compared with that of a standard device. The device functioned according to its purpose with high degree of accuracy. The said device is a potential innovative solution to small-scale aqua farmers in mitigating fish kill, thus, increasing yield production.

Full Text

Title: Diffraction of a grounded cable on a conducting spheroid in seawater

Author (s): Yuri Kuzmin and Stanislav Proshkin

Abstract: Based on a rigorous solution of the problem, analytical expressions are obtained for calculating the diffraction of the electromagnetic field of a grounded cable on a conducting spheroid in seawater. The calculations are based on the original method of the authors of the analytical continuation of the exact solution of the problem on direct current in the frequency domain, by decomposing the electric field of the spheroid in multipoles. Moreover, the analysis of the solution allows us to represent the secondary electric field of the spheroid as the field of an equivalent dipole. Graphs of the flow characteristics of a conducting spheroid are given.

Full Text

Title: Comparative study between experimental and computational simulation on heart valve leaflet and blood flow

characteristics analysis: A review

Author (s): Nur Afikah Khairi Rosli, Loh Quo Liang, Mok Chik Ming, Idris Mat Sahat, Nurul Natasha Mohd. Sukri and Mohd. Azrul Hisham Mohd. Adib

Abstract: The heart is the blood pumping unit for all mammals which involves transporting the blood throughout the whole body at acertain pressure, velocity, and frequency. This paper focuses on the review of the experimental and computational simulation study on the heart valve and fluid flow characteristics concerning the method, similarities, and limitations on the parameters involved such as heart structure design, fluid properties, and effect of heart valves. There are a few methods to study the working principle of the heart and valves. Many researchers are more familiar with the numerical method than the experimental method. However, experimental modeling of heart structure will give a better understanding and visualize of the heart muscle, valve movement, and fluid flow pattern in the heart chamber.

Full Text

Title: Laminar swirl spray emanating from simplex atomizers with various discharge orifice diameters

Author (s): Ahmad Hussein Abdul Hamid, Muhammad Azfar Bin Zaihan, Zulkifli Abdul Ghaffar, Salmiah Kasolang, Azlin Mohd. Azmi and Mohd. Azan Mohammed Sapardi

Abstract: Studies of swirl spray have received considerable attention due to its importance in numerous applications such as combustion, agriculture, drug delivery, and perfumes. The present study investigates the characteristics of sprays emanating from a simplex atomizers with different diameters of discharge orifice and flow rates. Spray cone angle, breakup length and air core diameter are recorded repeatedly and thier respective averaged values along with the standard deviation are presented. It is found that the size of the discharge orifice does play a significant role in determining the characteristics of the emanating sprays, while the role of flow rates (i.e. the injection pressure) is only prominent for determining spray cone angle and breakup length.

Full Text

Title: Genetic method for optimizing the process of desulfurization of flue gases from sulfur dioxide

Author (s): I. Fedorchenko, A. Oliinyk, J. A. J. Alsayaydeh, A. Stepanenko, V. Netrebko and A. Kharchenko

Abstract: Sulfur dioxide is one of the most commonly found gases, which contaminates the air, damages human health and the environment. To reduce the damage, it is important to control the emissions on power stations, as the major part of sulfur dioxide in the atmosphere is produced during electric energy generation on power plants. The present work describes flue gas desulfurization process optimizing strategy using data mining. Determining the relationship between process parameters and the actual efficiency of the absorption process is an important task for improving the performance of flue gas desulfurization plants and optimizing future plants. To predict the efficiency of cleaning from SO2 emissions, a model of wet flue gas desulfurization was developed, which combines a mathematical model and an artificial neural network. The optimization modified genetic method of flue gas desulfurization process based on artificial neural network was developed. It affords to represent the time series characteristics and factual efficiency influence on desulfurization and increase its precision of prediction. The vital difference between this developed genetic method and other similar methods is in using adaptive mutation that uses the level of population development in working process. It means that less important genes will mutate in chromosome more probable than high suitability genes. It increases accuracy and their role in searching. The comparison exercise of the developed method and other methods was done with the result that the new method gives the smallest predictive error (in the amount of released SO2) and helps to decrease the time in prediction of efficiency of flue gas desulfurization. The results allow to use this method to increase efficiency in flue gas desulfurization process and to reduce SO2 emissions into the atmosphere.

Full Text

Title: Development of tenodesis grip enhance orthosis (T-GEO) using 3D printing technology

Author (s): Shafiq Shukor, Natiara Mohamad Hashim, Nor Ayuni Che Zakaria and Abdul Halim Abdullah

Abstract: The spinal cord is a disease that can cause disabilities and affects the patients to carry out daily tasks. In this case study, the patient could not pinch the fingers but could flexion and extension of the wrist. The objectives of this study are to design and develop a customized adaptive device to help the respective patient. The model was developed based on the engineering design process to select the best design. The model was named Tenodesis Grip Enchance Orthosis (T-GEO) and further analyses using computational analysis to predict the product's performance. Then, the model was fabricated using 3D printing technology. Three different concepts were introduced, and the best design was selected using the Pugh method. The findings suggested the product functioned well and capable of helping the patient regain the ability to pitch.

Full Text

Title: Selig airfoils: Topology of flow patterns at low Reynolds number

Author (s): Che Intan Hartini Che Ibrahim and Aslam Abdullah

Abstract: Over the years, extensive discussions on the flow topology havesparked a motivation for deeper studies on the process of vortex formation and the periodic behaviour of the reattachment profile. Despite a clear methodology, such flow topology studies have not yet covered the majority of airfoil types. This study considers three low Reynolds number Selig airfoils. The computational fluid dynamics simulations carried out involve the airflow passing these models. The attention is given mainly on the separation bubble, vortex shedding and reattachment point. The corresponding effects on airfoils aerodynamic performance are observed. The method is validated against an established mathematical relationship to indicate that both simulations and analysis technique are reliable. The results are applicable in micro aerial vehicles field where the airfoils are those of low Reynolds number.

Full Text

Title: Local and global condition rating determination for concrete damage based on visual assessment

Author (s): Henny Wiyanto, Chaidir Anwar Makarim and Onnyxiforus Gondokusumo

Abstract: This study is done to develop a concrete damage condition rating examination method for existing buildings based on visual assessment, changing it from a qualitative assessment to an assessment that can be measured quantitatively. Structural damage greatly affects building safety and will result in reduced building performance, or even building failure. Existing building structure damage is caused by many factors, one of which is poor construction implementation. To identify the extent of damage done, concrete structure condition rating assessment needs to be performed on the existing building. Assessment must be performed, either on functioning buildings or on post-disaster buildings, in order to provide an image of a building s condition and provide alternative steps that can be taken for a building in a bad condition. Right now, there is no clear reference that can be used to perform concrete damage condition rating assessment on existing building structure, so assessment results tend to be qualitative. This research suggests a concrete damage condition rating assessment method based on visual assessment. This assessment method has a scale

and a condition rating reference, so that the resulted concrete damage condition rating assessment can be measured quantitatively. Aside from that, this assessment method also considers the critical weight and damage area of each concrete structure element on existing buildings. That way, the resulted assessment method can accommodate the need for visual-based concrete damage condition rating assessment for existing buildings.

[Full Text](#)

Title: Single-Phase multi-level inverter: New parallel topology for photovoltaic systems

Author (s): Ouchatti A., Wahbi A., Majdoul R., Moutabir A., Taouni A. and Touati A.

Abstract: In recent years, the multilevel DC/AC static converters are increasingly used for their benefits especially in terms of reduction of total harmonic distortion (THD) of the output current and reduced voltage stress on semiconductors at switching moments. In this article, a parallel structure of inverter is proposed for systems using photovoltaic panels. Although the proposed structure requires a number of voltage sources more than that used in other structures proposed in the literature, this structure has the advantage of being simple, contains only semiconductors for switching (no additional components as switching capacitors are required), and easy logic of control of semiconductors. The used modulation is based on the sinusoidal fundamental frequency pulse width modulation technique with single carrier. The proposed structure with its command scheme is adapted to voltage source inverter (VSI) applications. The inverter performances are evaluated through simulations in Matlab-Simulink environment on a nine-level inverter example.

[Full Text](#)

Title: Novel design for pest detection based on feature extraction with Artificial Neural Networks

Author (s): M. Karpagam, S. Christy, A. Maheshwari and Teena Joseph

Abstract: Identifying the pest and eradicating one of the significant and challenging tasks to the farmers in the agriculture field. It is considered to be one of the devaluating processes while farming and it pushes cultivation productivity to face a downfall. Usually farmers follow conventional approaches to the diminish growth of pests and propagate the productivity. Recently researchers incorporate machine learning methods to classify the categories of pest present in the paddy crop through various images practically. This paper deals with Artificial Neural Networks that is used to identify ten kinds of pest. There are 3549 images available in the data repository. An augmentation methodology is incorporated to support large dataset via machine learning process. A noise removed leaf images are preprocessed and given as input. Sobel operator based edge detection is used to Segment the ROI of processed images Advanced Feature extraction methods are incorporated to clearly sort out the three important criteria of the images like Shape, Intensity and Texture. The proposed model validates the images through ANN and accurate results are produced in pest image classification.

[Full Text](#)

Title: Reconfigurable multi-band microstrip antenna with defected ground structure

Author (s): R. Kanimozhi, M. Saravanan, N. Nachammai and R. Arul

Abstract: With the increase in the number of devices every day, the modern telecommunication world has been advancing to cater to the needs of every individual and has introduced the use of different frequency bands for different applications. This paper presents a multi-band antenna design tuning into different frequency bands which include 1.6 GHz, 2.4 GHz and 3 GHz using RF switches. The design is simulated using Ansys HFSS and the results for the same at the three frequency bands are presented here.

[Full Text](#)

Title: Overview on performance analysis of combined cycle gas turbine (CCGT) Power Plant

Author (s): Biswajit Datta, Pankaj Kr Roy, Manish Pal and Kaberi Majumdar

Abstract: The current paper presents a review of literature on the performance of the Combined Cycle Gas Turbine (CCGT) Power Plant. Focus is placed on the modelling of CCGT and optimization techniques. Available literature emphasizes the importance of CCGT as an effort to increase the efficiency of Gas Turbines (GT) through heat recovery. Using standard models that have wide consensus, the review highlights on various factors that affect the performance of CCGT. Performance, as measured by relative efficiency, is viewed as the ability to effectively use existing resources optimally. The review notes several optimization techniques based on existing and new models including operational, design, and environmental factors.

[Full Text](#)

Title: Management of municipal solid waste of Udaipur town, Tripura, India using Analytical Hierarchy process

Author (s): Sukanta Chakraborty, Manish Pal, Kaberi Majumder and Pankaj Kumar Roy

Abstract: Municipal Solid Waste management is an important part of modern city planning. Under the present scenario, the appropriate selection of treatment and disposal technique for Municipal Solid Waste management under multi-criteria decision making approach is a key factor for newly developed urban areas. In the study, an effort is made to ascertain the most suitable Municipal Solid Waste Management technique for the developing urban town named Udaipur of the state of Tripura, India through Analytical Hierarchy process under Multi-criteria decision making atmosphere. The study shows the Sanitary Landfilling which is the most appropriate technique for the urban body to dispose the municipal solid waste followed by Composting and Vermicomposting. This result interprets the rural bias of the study area.

[Full Text](#)

LOCAL AND GLOBAL CONDITION RATING DETERMINATION FOR CONCRETE DAMAGE BASED ON VISUAL ASSESSMENT

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ABSTRACT

This study is done to develop a concrete damage condition rating examination method for existing buildings based on visual assessment, changing it from a qualitative assessment to an assessment that can be measured quantitatively. Structural damage greatly affects building safety and will result in reduced building performance, or even building failure. Existing building structure damage is caused by many factors, one of which is poor construction implementation. To identify the extent of damage done, concrete structure condition rating assessment needs to be performed on the existing building. Assessment must be performed, either on functioning buildings or on post-disaster buildings, in order to provide an image of a building's condition and provide alternative steps that can be taken for a building in a bad condition. Right now, there is no clear reference that can be used to perform concrete damage condition rating assessment on existing building structure, so assessment results tend to be qualitative. This research suggests a concrete damage condition rating assessment method based on visual assessment. This assessment method has a scale and a condition rating reference, so that the resulted concrete damage condition rating assessment can be measured quantitatively. Aside from that, this assessment method also considers the critical weight and damage area of each concrete structure element on existing buildings. That way, the resulted assessment method can accommodate the need for visual-based concrete damage condition rating assessment for existing buildings.

Keywords: condition rating; local and global concrete damage; existing building; visual assessment.

1. INTRODUCTION

Concrete damage is a change to the concrete's condition and relates to the quality of the concrete. Concrete damage will cause a downgrade to the quality of concrete, which affects the reliability of the concrete structure. Concrete damage can occur on either new or existing buildings. On new buildings, concrete damage can be caused by natural factors and resource factors such as weather, poor construction implementation, material, or incompetent manpower. On existing buildings, damage can be caused by natural factors such as disaster or land condition, chemical factors, or human factors, such as overuse, function change, or poor maintenance [1, 2]. Poor construction implementation can result in damage to existing building.

In order to fulfil building safety requirements, existing buildings need maintenance, reparation, or even demolition if it can't be maintained any further. Often a building's owner or manager ignores the condition of an operational building, and doesn't implement proper building examination because of the cost. In reality, building condition assessment can lower the risk of further building damage which can endanger building users. This can result in higher risk and higher costs compared to the cost of building maintenance through building structure condition assessment. One of the measures that have to be taken is building maintenance through building structure condition assessment. Regular building inspection is done to ensure building reliability. Building reliability requirements examination includes fulfilling a building's safety, health, comfort, and ease of use requirements [3]. One of the safety requirements includes building structure requirements [4]. Assessment isn't only performed on post-disaster or deteriorating buildings, but also on functioning buildings.

Structural damage has a large effect on building safety and will result in a decrease in structure function, or even building failure. Building failure is a situation where a building is collapsed or non-functional after construction service final hand over. In every construction service execution, owner and contractor are required to fulfil safety, security, health, and longevity standards [5].

Visual assessment is the first assessment done in order to help detect early concrete damage on existing buildings before implementing reparation. Visual assessment is done by identifying and determining the concrete damage types seen on the building. Visual assessment is limited to building structure surface that can be accessed with the sense of sight (eyes).

Concrete damage to a building structure is detected by assessing the concrete's physical condition, which can be seen from the concrete surface or the downgraded quality of concrete. To understand the condition ratings of concrete damage, it is necessary to perform an assessment to detect the damage, which is undertaken through a preliminary visual assessment [1]. These visual attributes are used for condition assessment in visual inspection. Condition assessed by means of visual inspection is primarily qualitative, i.e., condition is usually expressed in imprecise linguistic terms such as "poor," "good," and "excellent". Condition expressed in linguistic terms varies from person to person; for example, the distress state opined as poor by one person may not be poor for another person. Therefore, the qualitative information obtained from visual inspection, i.e., assessed condition, is subjective in nature and depends on the experience, knowledge, expertise, and judgment of the

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inspector carrying out the assessment [2]. Control inspection needs to be performed in order to identify the building structure condition. A building's functionality depends on the control inspection. A lack of control will accelerate building damage and have an impact on reparation costs. The first step in performing control inspection is visual assessment to the building structure [6]. Visual assessment is often used as the first step to evaluate structure, analyze strength or deformity, or determine maintenance and rehabilitation needs [7]. Building material condition assessment on existing buildings is done with visual assessment, non-destructive testing, and destructive testing methods, including field and laboratory procedures [1].

The problem is how to identify an acceptable existing building structure condition rating. Existing buildings are buildings that have been used, or buildings that have been given the final hand over in terms of building construction implementation with a contractor, or a building that has been built for at least 1 (one) year in case the building's construction implementation isn't using a contractor [4]. Currently, the visual assessment is the descriptive assessment, because there is no standard reference for measurement yet. In order to establish a reference for visual assessment, the concrete damage rating needs to be determined. The concrete damage can be differentiated based on the damage condition rating. The concrete damage is determined based on the condition rating value and concrete damage type. In order to assess reliability, a reference value is needed as condition ratio scale. Because of this, the building structure reliability acceptable value [8] first needs to be determined. This acceptable value can be determined from the planned target reliability level [9].

Field assessments usually come as general recommendations from field examination results which explain the existing building structure condition. These results in the form of recommendations are delivered descriptively without any condition rating measurement. This is because there is not yet a reference and code for measuring existing building condition rating assessment, so assessment results are qualitative. Qualitative assessment will result in opinion differences, since they are made based on the perception of each appraiser. To reduce these differences, an assessment method that can be measured quantitatively is needed. Therefore, concrete structure condition rating assessment method that can be measured quantitatively for existing buildings needs to be developed.

2. MATERIALS AND METHODS

This concrete condition assessment method for buildings is set as an assessment method based on visual assessment.

2.1 Concrete Damage Condition Rating

Condition rating scale and reference for visual assessment is determined based on the scale and reference used in concrete testing. In order to apply this assessment

method in Indonesia, the scale and reference set here refers to codes that apply in Indonesia.

Several older researches perform assessment using concrete condition rating comparison scale for each condition rating. But, that scale and reference hasn't been able to accommodate all possible building conditions that can happen in field work, because the scale with the lowest criteria reference is unable to describe the worst building condition where the building can't be used anymore. The condition rating assessment scale and reference used in assessment based on visual assessment can be seen in [2, 6], [10-20].

Based on the research review about concrete damage condition rating determination on a visual assessment, stating a concrete's damage rating is determined with six condition ratings, ranging from a condition that does not require repair to a condition requiring immediate action. The condition rating is determined based on concrete repair priority that is processed with the fuzzy logic approach [2], [10-12].

2.2 Local and Global Condition Rating Determination

This concrete condition assessment method for buildings is set as an assessment method based on visual assessment. A visual assessment of concrete damage is the first step taken before testing the concrete quality [1]. Visual assessment is conducted by identifying the concrete damage that is visible on the surface of the concrete to the naked eye. This assessment is limited to the condition of the concrete that can be seen visually. Identification of concrete damage that can be assessed visually refers to [1, 7].

Local and global condition rating values for each damage type is determined by processing questionnaire data using the fuzzy logic approach which refers to [2], [10-12], [20], [23-24]. Data in the form of condition rating for each concrete damage type from appraisal consultants is processed using data validation. Data validation is done by removing invalid data and removing responses that are less than 10% of the total amount of respondents.

The condition rating assessment is completed by determining the condition rating value of each type of concrete damage. The condition rating value of each type of concrete damage is determined based on expert analysis using the fuzzy logic approach. The condition rating value is determined using the following formula.

$$CR_{se} = \frac{\sum_{i=1}^{n} \mu_i i}{\sum_{i=1}^{n} \mu_i} \text{ and } \mu_i = \frac{R_i}{R_{i,\max}}$$

where CR_{se} is structure element condition rating, μ is membership function based on questionnaire results, i is condition rating, and R is number of respondents.

Concrete damage condition rating is determined based on the amount of damage done on the building. Therefore, local and global concrete damage condition rating for each damage type needs to be analyzed. Local

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damage is damage on a smaller surface area, while global damage happens on a wider scale. 25% of the reviewed element surface is taken. Local and global condition rating assessment is done by determining condition rating with membership function on each point that exists between each condition rating using linguistic hedges known as Vertex Method using the following formula.

$$i_x = i_{lw} + \frac{\mu_x - \mu_{lw}}{\mu_{tp} - \mu_{lw}}(i_{tp} - i_{lw})$$

where i_x is condition rating on the reviewed point, μ_x is membership function on the reviewed condition rating, lw is the value on the lower condition rating, and tp is the value on the higher condition rating.

Membership function for local damage and global damage on each reviewed location is determined by using the following formula.

If $x_i < x_{\mu_{i,max}}$ then $\mu_{x_{lc}} = \mu_i^{0.5}$ and $\mu_{x_{gl}} = \mu_i^2$

If $x_i > x_{\mu_{i,max}}$ then $\mu_{x_{lc}} = \mu_i^2$ and $\mu_{x_{gl}} = \mu_i^{0.5}$

If $x_i = x_{\mu_{i,max}}$ then $\mu_{x_{lc}} = \mu_{i,max}$ and $\mu_{x_{gl}} = \mu_{i,max}$

where x_i is the reviewed condition rating point, $x_{\mu_{i,max}}$ is the condition rating point with the highest membership function, $\mu_{x_{lc}}$ is the membership function for local damage, $\mu_{x_{gl}}$ is the membership function for global damage, μ_i is the membership function with interval 0.1, and $\mu_{i,max}$ is the membership function with the highest condition rating (value 1). The condition rating value for each local and global damage type is determined using the Centroid Method.

Structure element critical weight values are used to determine the building concrete condition rating value. Concrete damage condition rating for building structure condition as a whole is determined with the weighted average method formula as follows:

$$BCR = \frac{\sum_{se=1}^{n} w_{se}.CR_{se}}{\sum_{se=1}^{n} w_{se}}$$

where BCR is building condition rating, w is critical weight, CR is condition rating, and se is structure elements. Concrete damage condition rating characteristics for the building is determined based on building condition rating (BCR) values.

The type of concrete damage on structure element will result in different effects on building structure. Therefore, concrete condition rating on a building will be affected by the critical weight of each structure element against the building structure. Structure element critical weight against building structure is determined on Table-1 [20, 25].

Table-1. Structure element critical weight.

Structural Elements	Critical Weight
Shearwall	1
Column	1
Beam	0,7
Slab	0,5

Rating method has been validated on existing buildings and the results are in agreement with the appraisal consultants, which makes it a method that is quantitatively measured.

3. RESULTS AND DISCUSSIONS

The building structure could be on the lowest rating, meaning demolition is required. So, a worst-case scenario approach should be used for the condition rating. The condition rating of concrete must refer to the relevant codes. There is a code already available for concrete damage testing, which can be used for reference, but such a code is not yet available for visual assessment. To determine the condition rating of concrete damage when conducting a visual assessment, the code used for testing will be applied, so that the same condition rating is used for both examination results. To accommodate that problem, damage rating characteristics such as those shown in Table-2 [19-22] are used.

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Table-2. Concrete damage condition rating characteristics.

Condition Rating	Description	Criteria and Measure
1	Very Good	No damage. No repairs needed, but routine maintenance needed.
2	Good	Light damage. Repair is needed in routine maintenance.
3	Medium	Medium damage. Further testing is needed as soon as possible.
4	Bad	Heavy damage. Structure needs to be strengthened, or weight needs to be reduced.
5	Very Bad	Very heavy damage or critical damage. Cannot be maintained or demolished.

These concrete damage condition rating characteristics are used as a reference in determining the condition rating of each concrete damage type and building condition rating. This condition rating scale and reference can describe all kinds of building conditions, from buildings with very good conditions where the building is perfectly undamaged, to buildings with very bad conditions where the building can't be maintained anymore, and has to be demolished.

In order to determine concrete damage condition rating, concrete damage type is identified, which can be assessed visually such as in Table-3.

Table-3. Concrete damage type.

No	Damage Type
1	Craze Crack
2	Crazing
3	D-Cracks
4	Hairline Crack
5	Maping Crack
6	Random Cracks
7	Transverse Crack
8	Delamination
9	Honeycomb
10	Pop-outs (small)
11	Pop-outs (medium)
12	Pop-outs (large)
13	Scaling (light)
14	Scaling (medium)
15	Scaling (severe)
16	Scaling (very severe)
17	Spall (small)
18	Spall (large)
19	Distortion
20	Stratification

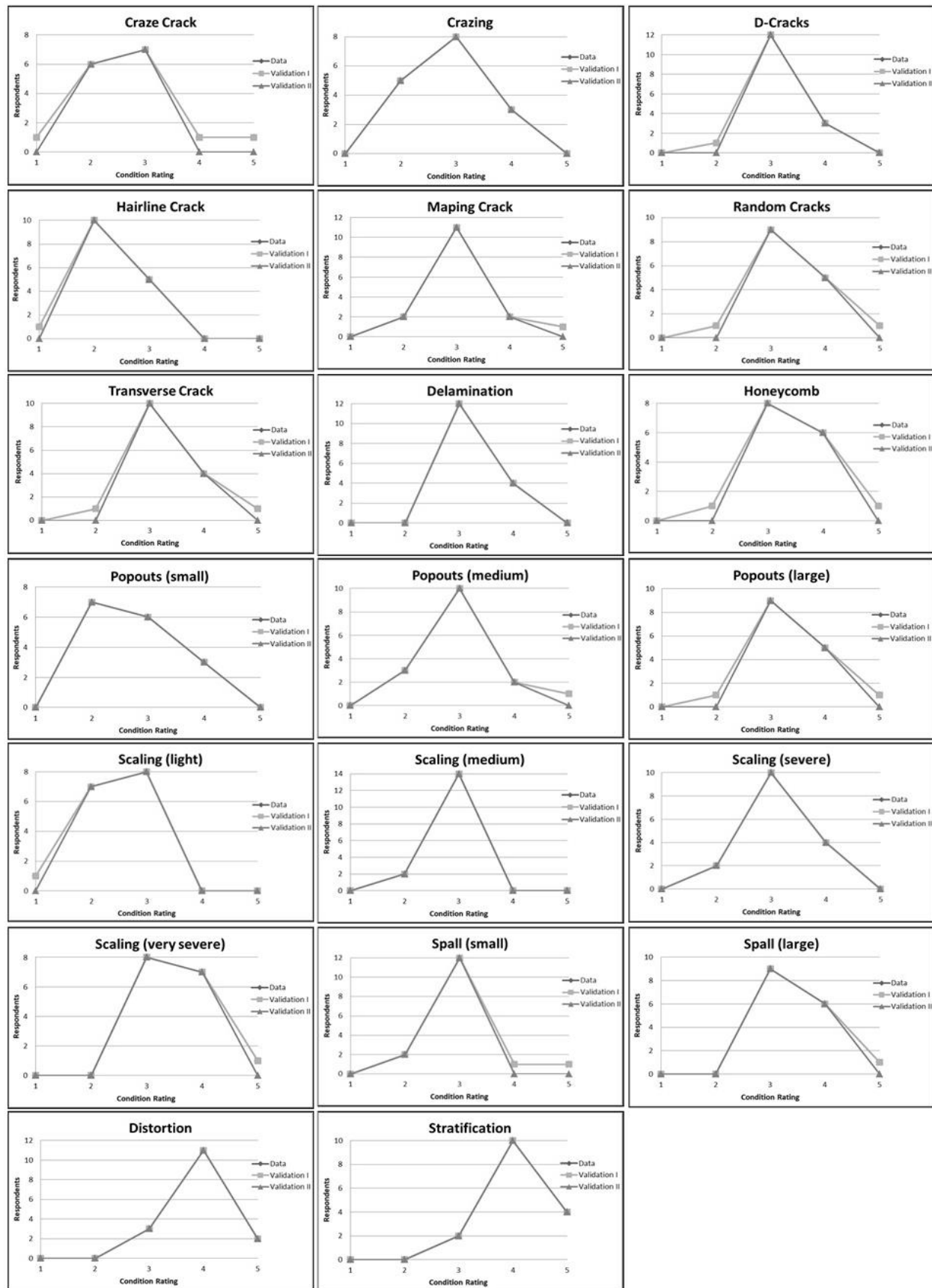Responses on each damage type and validation results can be seen on Figure-1.

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Figure-1. Response on each damage type and validation result.

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Based on validation results from Figure-1, a membership function is determined on each concrete damage type which can be seen in Table-4. This membership function will be used to determine the local and global concrete damage membership function.

Table-4. Membership function.

No	Damage Type	Membership Function (μ_i)				
		1	2	3	4	5
1	Craze Crack	0	0,86	1	0	0
2	Crazing	0	0,63	1	0,38	0
3	D-Cracks	0	0	1	0,25	0
4	Hairline Crack	0	1	0,5	0	0
5	Maping Crack	0	0,18	1	0,18	0
6	Random Cracks	0	0	1	0,56	0
7	Transverse Crack	0	0	1	0,4	0
8	Delamination	0	0	1	0,33	0
9	Honeycomb	0	0	1	0,75	0
10	Popouts (small)	0	1	0,86	0,43	0
11	Popouts (medium)	0	0,3	1	0,2	0
12	Popouts (large)	0	0	1	0,56	0
13	Scaling (light)	0	0,88	1	0	0
14	Scaling (medium)	0	0,14	1	0	0
15	Scaling (severe)	0	0,2	1	0,4	0
16	Scaling (very severe)	0	0	1	0,88	0
17	Spall (small)	0	0,17	1	0	0
18	Spall (large)	0	0	1	0,67	0
19	Distortion	0	0	0,27	1	0,18
20	Stratification	0	0	0,2	1	0,4

Condition rating with membership function (u) is determined on each point that exists between each condition rating using linguistic hedges known as the Vertex Method. Membership function for local and global condition rating is determined based on condition rating data validation results for each concrete damage type, and is processed with formulas 2 and 3. Local and global membership functions are used to determine the local and global condition rating of each concrete damage type. Membership function total value on each local and global condition can be seen in Table-5.

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Table-5. Membership function total value on each local and global condition.

No.	Concrete Damage Type	$\sum\limits_{i=1}^{n} \mu_i i$ **Local**	$\sum\limits_{i=1}^{n} \mu_i i$ **Global**
1	Craze Crack	22.81	29.32
2	Crazing	25.12	32.17
3	D-Cracks	28.38	32.68
4	Hairline Crack	18.97	24.27
5	Maping Crack	27.60	32.13
6	Random Cracks	29.09	34.61
7	Transverse Crack	28.66	33.56
8	Delamination	28.53	33.16
9	Honeycomb	29.86	36.07
10	Popouts (small)	20.98	29.02
11	Popouts (medium)	26.99	32.04
12	Popouts (large)	29.09	34.61
13	Scaling (light)	22.66	29.21
14	Scaling (medium)	27.59	31.49
15	Scaling (severe)	27.90	33.35
16	Scaling (very severe)	30.52	37.07
17	Spall (small)	27.48	31.47
18	Spall (large)	29.50	35.43
19	Distortion	37.06	41.81
20	Stratification	37.80	42.71

The condition rating of each local and global damage type is determined using the Centroid Method (formula 1), with a total μi value of 9.96. Based on the membership function for each damage type, the local and global condition rating for each damage type has been obtained, which can be seen in Figure-2.
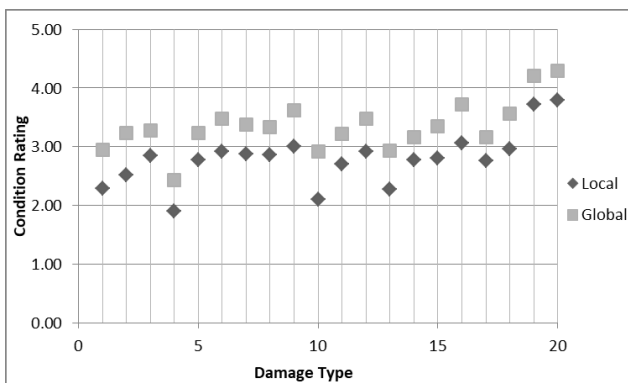
Figure-2. The local and global condition rating for each damage type.

In Figure-2, the concrete damage type which is the damage type with bad condition rating can be seen, which means this damage type has a high risk and affects the existing building negatively. On the contrary, there is no damage type with value nearing one, which means that the small damage done on the existing building cannot be ignored. Because no matter how small the damage is, it still poses a risk that can cause further building damage if proper building maintenance isn't practiced.

To explain this resulted method, concrete condition rating assessment is performed on a 8-floor building with 13 years of operation which functions as a mall. Visual assessment results show the structural concrete damage condition on a number of building structure elements, and concrete damage condition rating assessment based on local and global damage area. There are several concrete damage types on the building structure elements in each floor. The concrete damage types identified in this building are Craze crack, Random cracks, Scaling, Spalling, and Popouts.

The description for building visual assessment in the form of concrete damage type and area on each structure element, concrete damage type condition rating value, and building concrete damage condition rating value determination can be seen in Table-6.

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Table-6. Concrete damage condition rating assessment.

No	Concrete Damage		CR_{se}	w_{se}	$w_{se}CR_{se}$
	Type	Area			
1	Craze Crack	L	2.29	1	2.29
2	Random Cracks	L	2.92	0.5	1.46
3	Scaling (severe)	L	2.80	0.7	1.96
4	Spall (small)	L	2.76	0.7	1.93
5	Spall (small)	L	2.76	1	2.76
6	Random Cracks	G	3.48	0.5	1.74
7	Scaling (light)	L	2.28	0.5	1.14
8	Scaling (severe)	L	2.80	0.5	1.40
9	Scaling (light)	G	2.93	0.5	1.47
10	Random Cracks	L	2.92	1	2.92
11	Spall (large)	L	2.96	1	2.96
12	Popouts (medium)	L	2.71	0.7	1.90
13	Scaling (medium)	L	2.77	0.7	1.94
14	Spall (small)	L	3.44	1	3.44
15	Spall (small)	L	2.76	0.5	1.38
16	Scaling (severe)	L	2.80	0.7	1.96
17	Spall (small)	L	2.76	0.7	1.93
18	Spall (small)	L	2.76	0.7	1.93
19	Scaling (light)	L	2.28	1	2.28
20	Spall (small)	L	2.76	1	2.76
21	Spall (small)	L	2.76	0.7	1.93
22	Scaling (severe)	L	2.80	0.7	1.96
23	Random Cracks	G	3.48	0.5	1.74
24	Spall (small)	L	2.76	0.7	1.93
25	Spall (small)	L	2.76	0.7	1.93
26	Scaling (severe)	L	2.80	1	2.80
27	Scaling (severe)	L	2.80	1	2.80
28	Random Cracks	L	2.92	0.7	2.04
			$\sum$	20.9	58.68
			BCR	2.81	

The building condition rating (BCR) value, presented in Table-6 is the building condition rating with concrete damage characteristics that refer to Table-2. The building condition rating (BCR) value of this building shows a medium concrete damage condition rating, or more specifically, a good condition rating which is nearing medium. This means that concrete testing needs to be implemented as soon as possible, especially on the structure elements that are nearing medium condition rating. Aside from that, reparation also needs to be implemented on structure elements that are damaged, so the damage won't spread and worsen. This reparation is part of a building's routine maintenance.

Based on this explanation, it can be seen that building condition rating assessment results are a number that describes concrete damage condition rating with concrete damage criteria as well as the follow-up action that needs to be taken on each condition rating. Therefore, this visual assessment based concrete damage condition rating assessment method is a method that is quantitative for existing buildings.

4. CONCLUSIONS

This resulted condition rating assessment method is a concrete damage condition rating assessment method that is measured quantitatively, by taking into account the structure element critical weight and the damage area for existing buildings. This method is presented to accommodate the need for concrete damage condition rating assessment. The critical rating of each structure element is surely different based on the function of each structure element on the building. The same concrete damage type can result in different effects on building structure if it happens on different structure elements, so the critical rating of structure elements against building structure can't be considered the same. Therefore, structure element critical weight against building structure needs to be considered in concrete damage condition rating assessment. Concrete damage surface on structure element also affects the concrete damage condition rating, therefore local and global damage area on a given structure element must be taken into account in concrete damage condition rating assessment.

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