

CRACK DETECTOR – THE CRACK DETECTION IN THE SNOTTY BUILDING BASED ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING SMART SOLUTION TO STRUCTURAL COLLAPSE

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ABSTRACT

Crack Detector – The Crack Detection In The Snotty Building Based Artificial Intelligence And Image Processing Smart Solution To Structural Collapse is a device designed by the building's design team by implementing artificial intelligence science and image processing to detect the cracks and dimensions autonomous. Data obtained was sent to the user's computer in real time. The purpose of the construction of the device is to facilitate communities especially construction and construction safety committees (KKK) the building's security system hopes to detect cracks in high rise and can provide data on the level of damage, data obtained from a crack detector among other images and videos from the state of the building, the dimensions of cracks and the positions of cracks. Based on these data can be determined an ordinance of the building structure. Toolmaking begins with observing a multistory building on the campus and a literature study of both national and international journals and books. Next is the tool design using Solidworks 2020. Once the design is finished it continues to the stage of procuring the components needed to make the prototype. The building of the prototype is divided into three stages of assembly of the frame, assembly of the electronic components and program building. Once completed, the tool was tested for performance knowing.

Keywords: Drone, crack, artificial intelligence, image processing, structural collapse

1. INTRODUCTION

The emergence of high-rise buildings such as office buildings, shopping centers, hotels, apartments, flats is a form of development development. This development development aims to encourage the achievement of objectives and the implementation of the main functions of optimal use, including facilities and infrastructure. Aspects that need to be considered during the economic life of the building is during its operation.

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Usually the appearance of the damage that occurs is seen after the building begins to operate (Ariyanto, 2020: 45).

The appearance of the damage that occurs needs to be identified as early as possible regarding the existence of other damages that can cause a bad effect on the building. Identification of building elements needs to be done because there is a lot of damage to buildings with different causes (Adeswastoto and Islah, 2018: 58). Based on data from the ministry of education and culture, the directorate general of early childhood education and public education (2019: 25) the total number of damage to buildings in Indonesia is 18.86% with the level of damage still below 30%, which means the building suffered minor damage.

The level of damage to the building can be determined by measuring the width of the crack in the cracked element. The wider the crack that occurs, the higher the level of damage that occurs (Ariyanto, 2020: 50). Multi-storey buildings not only have a positive impact, but can also have a negative impact. One of the negative impacts is the collapse of the building. The collapse of the building occurs due to the decrease in the strength of the building. Therefore, it is necessary to check the physical condition of the building periodically. In the process of checking the physical condition of high-rise buildings, it is difficult for humans to do it directly due to limited human views. In addition, this work has a high risk of accidents. So we need a tool that can replace the job.

Based on the explanation above, the author took the initiative to create a tool, namely Crack detector Detection of Cracks in Multi-storey Buildings Based on Artificial Intelligence and Image Processing Intelligent Solutions to Overcome Building Collapse to facilitate checking the robustness of buildings. Crack detector is a type of UAV vertical take off and landing (VTOL) equipped with a camera that will capture images of the building structure and can calculate the dimensions of the existing cracks so that users can find out how big the crack is without having to measure it. It is hoped that with this Crack Detector it can overcome the collapse of high-rise buildings.

2. LITERATURE REVIEW

Drones

According to Herry (in Rendyantoro, 2018:10) Drone is an unmanned aircraft that is controlled remotely called the Unmanned Aerial Vehicle (UAV) is a flying machine that functions remotely controlled by the pilot or is able to control himself, using the laws of aerodynamics. to lift itself, can be reused and capable of carrying a load of both weapons and other cargo. The drones that will be discussed are drones that use GPS (Global positioning system).

The Vertical Take Off Landing (VTOL) method is a method of launching and landing an Unmanned Aerial Vehicle (UAV) which is carried out vertically. This allows the UAV System to be operated on virtually any type of terrain, requiring no runways, or complicated catapult equipment. The launch is carried out independently and the UAV System can be airborne for several minutes to arrive at the intended location (Austin, 2010). Vertical Take Off Landing (VTOL) Aircraft is a type of aircraft that can take off and land perpendicular to the earth so that it can be carried out in a narrow place. Helicopters, tricopters, quadcopters, and similar multirotors belong to this category (Rangku, 2014: 5).

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Quadcopter is a development of a helicopter that only uses a motor. The quadcopter has four main propulsion motors. Quadcopters are used in surveillance, search and rescue, inspection purposes and several other applications (Tamtomi, *et al.*, 2016: 194). According to Tamba (2014: 5) quadcopter is a type of rotorcraft that has four rotors as propeller drives that produce lift. The quadcopter can take off and land vertically. Quadcopter can move up, down, forward, backward, left, right, and rotation. These movements are better known as pitch (moving forward or backward), roll (moving left or right), and yaw (rotating left or rotating right).

Building Crack

In general, the word building means something that is built or built to carry out activities. Building according to Law No. 28 of 2002 concerning buildings defines a building as a physical form of construction work that is integrated with its domicile, partially or wholly located above or in the ground or water, which functions as a place for humans to carry out their activities. both for housing or residence, religious activities, business activities, social activities, culture, and special activities (Simanjuntak and Bernard, 2013: 186).

According to (Adeswastoto and Islah, 2018: 61) cracks are symptoms due to working forces or many combinations that exceed the capacity of the building or its material components. The factor that causes cracks in the wall is due to the load acting on the wall exceeding its flexural strength. Cracks are divided into two types, namely structural cracks are cracks that occur due to settlement of the support plane which can be in the form of soil, foundation, or other building structural elements. Non-structural cracks are cracks that are generally harmless but sometimes reduce the aesthetic value of the building (Hidayat, 2009: 61-63).

Open Computer Vision (OpenCV)

Computer Vision is the science of programming computers to process and understand images or videos in real time. OpenCV requires images in BGR (Blue Green Red) or grayscale to be displayed or saved (Abdullah and Pane, 2020: 1). OpenCV is an API (Application Programming Interface) library which is very familiar in computer vision image processing. Computer vision itself is a branch of the field of image processing that allows computers to see like humans. With this vision the computer can make decisions, take action, and recognize an object.

Image processing or image processing is a system where the process is carried out with the input (input) in the form of an image (image) and the result (output) is also an image (image). Initially, image processing was carried out to improve image quality, but with the development of the computing world, which is marked by the increasing capacity and speed of computer processing, as well as the emergence of computer sciences that allow humans to retrieve information from an image, image processing cannot be separated from the field of image processing. computer vision (Mulyawan, *et al.*, 2011: 2).

Raspberry Pi

The Raspberry Pi is a Single Computer Board (SCB) or microprocessor that has been equipped with a GPIO (General Purpose Input Output) pin so that in addition to being

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able to function as a PC computer, it can also function as a data receiver through its input-output pins. The raspberry pi operating system is linux and its basic programming uses the python language which is open source software (Sanjaya, *et al.*, 2018: 73). The Raspberry pi consists of many important pieces of hardware with several important functions. The main part of the raspberry pi is the processor. Each raspberry pi has a broadcom BCM2835 chip embodying an ARM1176JZF-S core CPU. This chip has a clock speed of 700MHz and is a 32-bit system. Raspberry pi has an SD card slot for SD cards that act as storage media, everything including the operating system and other files are stored on the SD card (Baskoro, 2014: 2).



Figure 1. Raspberry Pi (Source: news.ralali.com)

Artificial Intelligence

Artificial intelligence is a part of computer science that is specifically aimed at designing the automation of intelligent behavior in computer intelligence systems. The main part of artificial intelligence is the knowledge base, which is an understanding or understanding of the subject area obtained through education and experience (Kristanto in Azzary, *et al.*, 2016: 48). Artificial intelligence is intelligence added to a system that can be managed in a scientific context or can be called AI which is defined as the intelligence of scientific entities. According to Kaplan and Haenlein (in Siahaan, *et al.*, 2020: 2) define artificial intelligence as the ability of the system to interpret external data correctly. Such systems are generally thought of as computers. Intelligence is created and incorporated into a machine or computer so that it can do work as humans can.

IMPLEMENTATION STAGE

Tool Design

The design of this tool uses the Solidworks application. In designing we take measurements and layout of all components.

Procurement of Tools and Materials

The selection of electronic components and the procurement of supporting equipment are stages that must be carried out before the VTOL Crack Detector assembly process.

Making VTOL Crack Detector To Detect Cracks

The Crack Detector Vector assembly process is carried out by dividing the tasks with each member. The assembly is carried out at the 4th Floor of the Spikology Building. The steps taken in the assembly process are as follows: preparing the necessary work support

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equipment and materials, making mechanical Crack Detector VTOL, assembling Crack Detector VTOL components.

Trials

After making the Crack Detector VTOL program, then we will test the tool aiming to find out whether this VTOL Crack Detector can work properly or not.

Tool Revision

Tool revision is carried out to correct errors after testing the tool.

Tool Socialization

If the trial is successful, the tool will be disseminated to the public. Tool socialization was carried out by practicing the use of tools by the writing team in high-rise buildings.

Acceptance Level Survey

During socialization, the writing team also carried out periodic monitoring to see the level of tool work activity and the level of acceptance of the tool among the community

3.10. Evaluation

The evaluation stage is carried out to see the level of success of program implementation from beginning to end.

3. EXPERIMENTAL

Table 2. The composition of the chemical compounds of natural zeolite.

The oxide	Percent (%)
SiO ₂	46.57
Al ₂ O ₃	16.58
Fe ₂ O ₃	10.21
CaO	8.77
MgO	4.81
Na ₂ O ₃	2.97
K ₂ O	0.87
MnO	0.14
TiO ₂	0.83
P ₂ O ₅	0.14
Loss of ignition	7.75

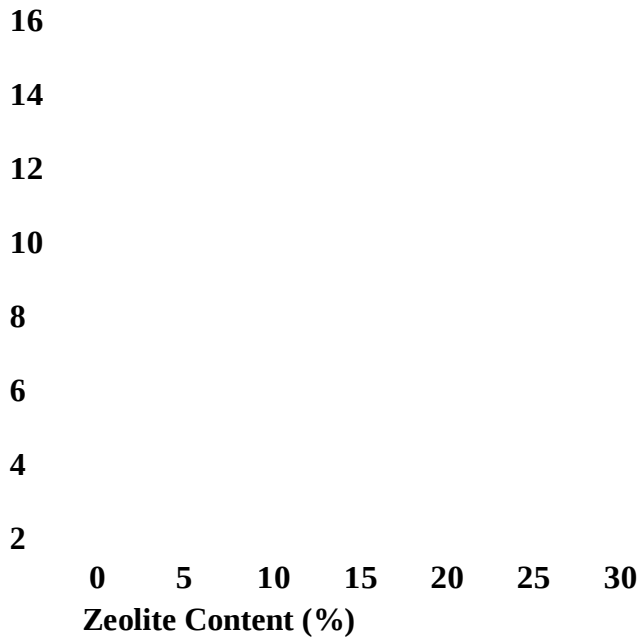


Fig 2. Compressive strength of SFP (Source: news.ralali.com)

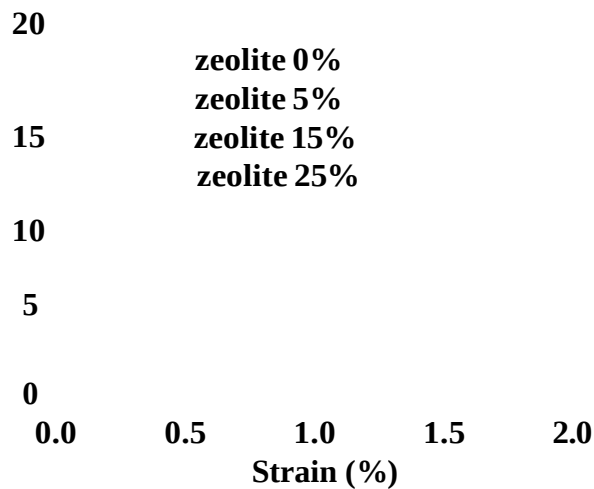


Fig 3. Stress-strain relationship of SFP with an additional 4% WTR.
(Source: news.ralali.com)

4. RESULTS AND DISCUSSION

Compressive strength

The average compressive strength for the SFP from each of the 3 variations of WTR and natural zeolite was plotted in Fig. 7. The results showed that there was a significantly increase of compressive strength with the increase in the zeolite content from 0 to 15% while slightly decrease at percentage of 25%. The increase in the compressive strengths at 10% and 15% were reported to be caused by the presence

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of zeolite in the mortar which made it denser after hardening compared to the composition without the mineral. This is associated with the reaction of the silica (SiO_2) in zeolites with the calcium hydroxide ($\text{Ca}(\text{OH})_2$) which is a by-product of the hydration process of cement in a mortar to form calcium silicate hydrate. This, therefore, led to the increase in the density and compressive strength of mortar, and consequently, for the SFP. However, at 25% zeolite, the amount of SiO_2 in the mixture exceeded the requirement for the reaction leaving some of it unreacted and this weakened the compressive strength of the mortar and the SFP as a consequence. Furthermore, the figure also shows the highest value of compressive strength was recorded at 5% WTR and 15% zeolite.

Flexural strength

The average flexural strength value of the SFP for each variation of WTR and natural zeolite was plotted in Fig. 8. The results showed 5% WTR has the highest value for all the mixture except for 25% zeolite. As with the compressive strength, the substitution of the cement with natural zeolite by up to 15% increased the flexural strength of the SFP but the value decreased at 25%. The highest value was also observed with 5% WTR and 15% natural zeolite.

Initial modulus of elasticity

The initial modulus of elasticity was calculated from the stress-strain relationship data. This involved comparing the stress and strain under linear conditions to obtain the magnitude of the elastic modulus for all the variations as shown in Fig. 13. The results showed the lowest values were obtained at 15% zeolite and this means greater deformation was experienced at this mixture compared to others at the beginning of loading.

Modulus of elasticity after crack

Show the SFP experienced a micro crack as observed from the drastic reduction in its stiffness and the stress-strain relationship subsequently tended to be linear again up to when the maximum stress was reached. Therefore, the modulus of elasticity after crack was calculated based on the slope of the stress-strain curve after the initial crack occurred and the magnitude is shown in Fig. 14. The figure shows the elastic modulus after the crack is almost the same for all mixtures, except for 3% and 4% WTR without zeolite which was found to have higher values.

5. CONCLUSION

Based on the results in this study, the following conclusions can be drawn:

It is possible to replace some quantities of cement with natural zeolite in grout mortar needed in porous asphalt. The mixture with the highest compressive and flexural strengths was found to be 15% zeolite. It was also discovered to have the ability to reduce drying shrinkage and increase the semi-flexible pavement permeability and durability. Moreover, the addition of 5% waste tire rubber was also found to have the best performance.

The stress-strain curve of semi-flexible pavement was linearly elastic with the slope to be equal to the initial elastic modulus up to the start of the microcracks which occurred at 14% to 20% of the compressive strength. After the crack, the

stiffness was observed to have decreased drastically and the curve became linear again with reduced stiffness.

ACKNOWLEDGEMENTS

we would like to thank all those who have contributed to the writing of this paper which we have no mentioned one by one, hopefully this paper will be useful. Thank you.

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