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Mechanical Properties of Concrete Containing of Eggshell (0%, 5%, 10% and 15%) as Replacement Material by Using Simulation of Abaqus Method

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Abstract: Eggshell is classified as a waste material by the food industry in any countries. Unfortunately, it is in fact eggshell appertain in highly sophisticated composite and have poor degradable waste. Therefore, identification of suitable percentage of eggshell as a substitute of aggregate in making concrete is necessary to conduct as recycling eggshells into the useful product gives good potential benefit on controlling food waste and construction industry. This study focusses on the mechanical properties of concrete containing of eggshell of concrete. The normal concrete mix consist of basic constituent such as Portland cement, fine and coarse aggregate, and water were considered as a control mix without addition of ESA that means it consists of 0.0 % of ESA. Three series of concrete mix design with ESA as cement replacement were composed as an unconventional mix consist of 5.0 %,10.0 % and 15.0 %. This result will be done by using Abaqus method. This software was to analyze the compressive strength of the concrete by using Abaqus method.

Keywords: Eggshell, Abaqus Method, Concrete

1. Introduction

Concrete is an important material that widely used in the construction of building. Most of the building around us were built using concrete as its main material. In Malaysia, there is common waste disposal systems which is; land filling, compositing, ocean dumping, incineration and open burning. Almost all the waste in Malaysia are dispose by using landfill method unfortunately, almost all of the landfill sites are poorly managed. Due to the large amount of waste production, the number of landfilling sites has increased and the number of landfilling sites is expected to increase as result to growth in

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population, economy and agriculture [1].

This aim of this research is to measure the effectiveness of eggshell as partially cement in concrete. In order to achieve this aim, several methods and techniques were used to collect all the data required. Several experimental tests are need to be done in this research. To get the best result by using Abaqus method will give the good performance for the concrete. Besides that, the strength of the concrete also will be improved.

1.1 Objective

Nowadays, there are many materials that can be recycled are being used in the construction industry. It is considered as an efficient way to reduce the waste problem by recycling the construction materials in construction industry. Besides that, cost can be cut in order to increase the concrete structure strength by using waste material. The aim of this is research is to:

i. To find the compressive strength of the concrete by using Abaqus method.
ii. To determine the defect pattern of concrete with different replacement percentage as 0.0 %, 5.0 %,10.0 and 15.0 % of crushed egg shells as replacement of cement.

1.2 Scope of Study

This study focusses on the mechanical properties of concrete containing of eggshell of concrete. The normal concrete mix consist of basic constituent such as Portland cement, fine and coarse aggregate, and water were considered as a control mix without addition of ESA that means it consists of 0.0 % of ESA. Three series of concrete mix design with ESA as cement replacement were composed as an unconventional mix consist of 5.0 %,10.0 % and 15.0 %. Before that, concrete that have already been mixed must pass through the slump test to check the workability of concrete before pouring into the 150 mm x 150 mm x 150 mm mould. The fresh concrete will be placed into the mould and the hardened concrete was detached from the mould after 24 hours. Then, all of the hardened concrete mixes were cured in curing tank for 28 days.

This result will be done by using Abaqus method. This software was to analyze the compressive strength of the concrete by using Abaqus method.

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study.

2.1 Materials

2.1.1 Eggshell Composition

It has scientifically proven that the eggshell is mainly composed of compounds of calcium with a composition of 93.7 % for calcium carbonate, 4.2 % for organic matter, 1.3 % for magnesium carbonate and 0.8 % for calcium phosphate. Calcium trioxocarbonate (IV) such as the calcium carbonate became the main composition of the eggshell with 93.7 %. Calcium trioxocarbonate also act as an important component of eggshells, seashells and other calcium-based shells. Similar figures were shown in the production of cement, which is the primary raw material is the calcium carbonate.

The calcium trioxocarbonate that available in both eggshell and cement were also found abundantly in earth's rocks and minerals such as lime stone, marble, chalks, dolomite, calcite and et cetera. It is also composed in bones and the external skeletons of organisms. [2-3]

2.2 Methods

2.2.1 Concrete

Concrete is an important material that widely used in the construction of building. Most of the building around us were built using concrete as its main material.[4] The strength and permeability of the concrete depends solely on its water/cement ratio. If the water/cement ratio is low then the concrete strength will be high and its permeability will be low. Although concrete is considered as a strong material in terms of compression but it is weak in tension and it needs to be strengthen by using reinforcement bars.

2.2.2 Portland Cement

Raw materials such as lime, silica, alumina and iron is required in the manufacture of Portland cement. Clay, limestone and sand will be acquired before the process begins. The limestone will be crushed in two crusher which is primary and secondary to reduce its size. All of the raw materials are stored and proportioned before going through the grinding mill.

2.3 Methodolgy

In order for an experimental research to get a good result, raw materials must be choosing well enough to ensure the quality of the end product. This chapter will discuss thoroughly regarding on the techniques and materials that should be implemented to achieve the targeted result. In this chapter also will discuss on the tests used on the sample material. This test will be done by using Abaqus method to meet the specified standard.

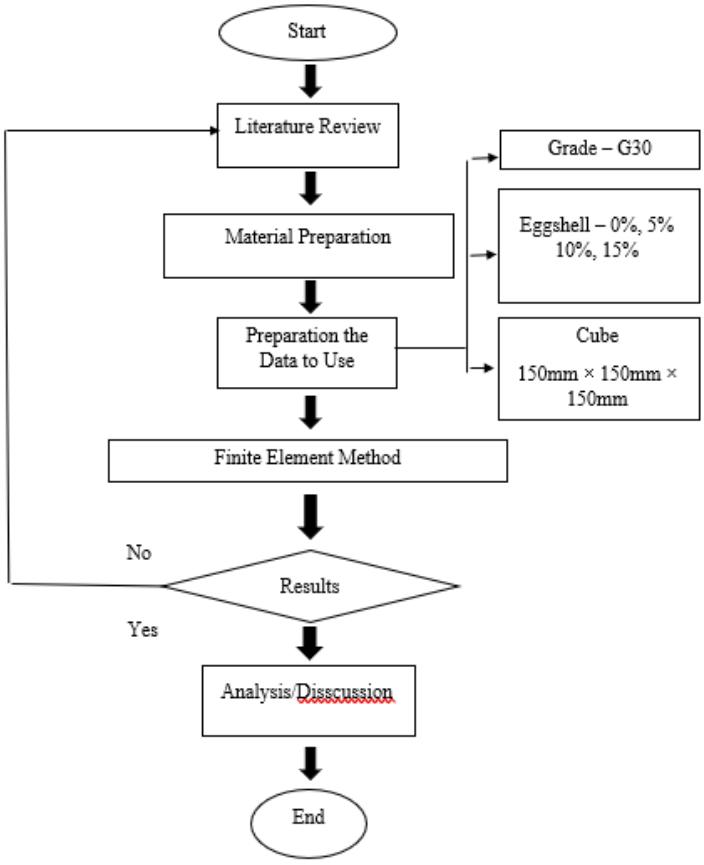

Figure 1: Research Flowchart

2.3.1 Abaqus Sofware

This study will be presenting the methodology to use the ABAQUS software to conduct an analysis based on previous research and study on the concrete cube. Finite element analysis has three phase of process which includes pre-processing, solution, and post-processing.

3. Results and Discussion

A stress-strain curve is a graphical representation of the behavior of a material when it's subjected to a load or force. The two characteristics that are plotted are stress on the y-axis and strain on the x-axis. Stress is the ratio of the load or force to the cross-sectional area of the material to which the load is applied.

3.1 Results

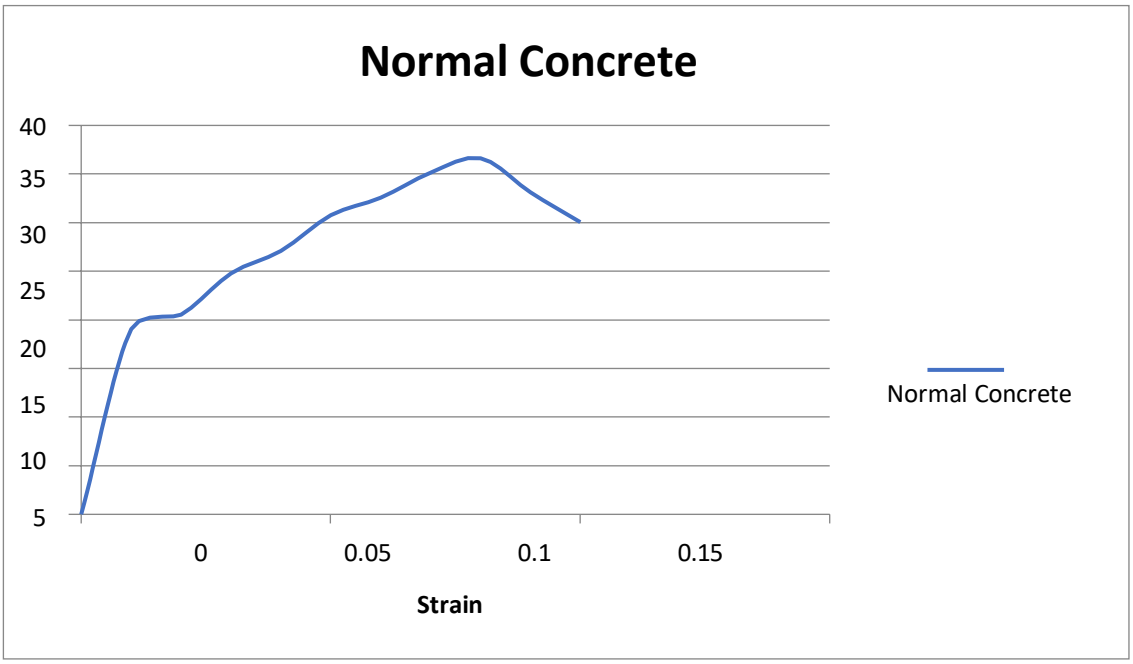

Figure 2 : Graph normal concrete strain and stress

Figure 2 show the result normal concrete for strain and stress. Maximum value of stress is 36.62 N/m^2 and for the maximum of strain value is 0.10002017. The grade for normal concrete is 30 MPa. Generally, for normal concrete the result was accepted as the result exceed 30 MPa. This result for minimum of stress the value is 19.06 N/m^2 while for strain the value is 0.010002005.

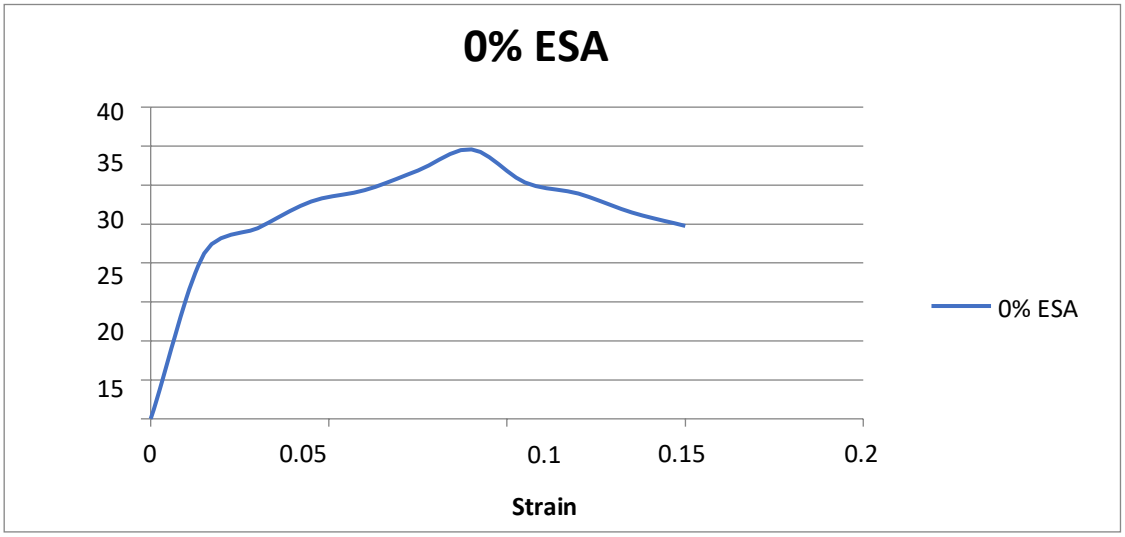

Figure 3 : Graph 0.0 % ESA for strain and stress

Figure 3 show the 0 % ESA for strain and stress. Maximum value of stress is 34.58 N/m2 and for the maximum of strain value is 0.150043. This result for minimum of stress the value is 21.23 N/m2 while for strain the value is 0.015004. For this result, 0 % ESA was accepted as the result exceed 30 MPa.

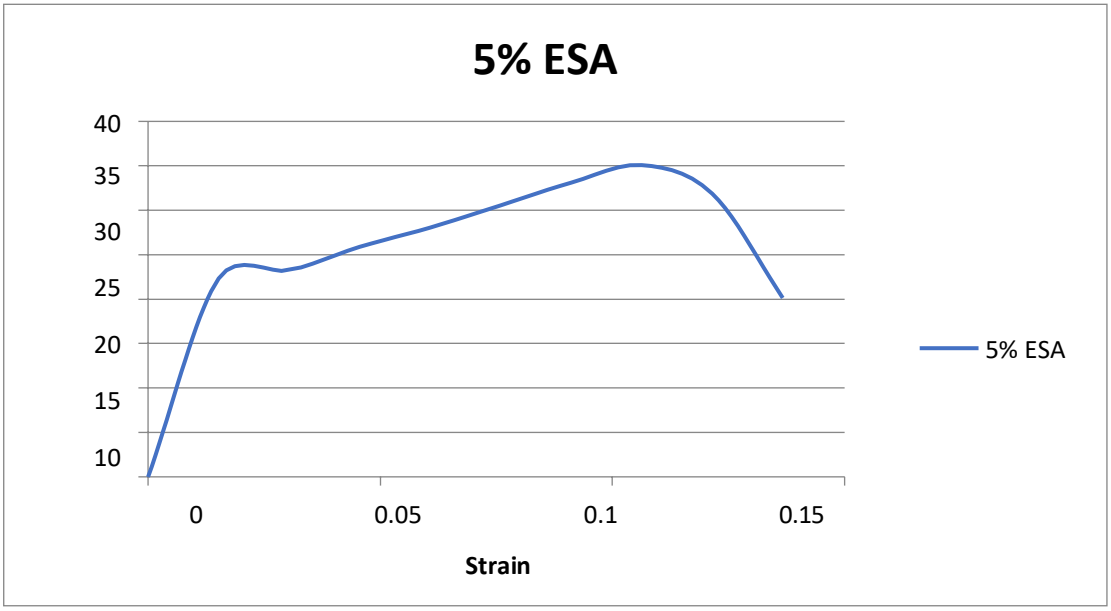

Figure 4: Graph 5% ESA for strain and stress

Figure 4 show the 5.0 % ESA for strain and stress. Maximum value of stress is 35.09 N/m^2 and for the maximum of strain value is 0.136691034. This result for minimum of stress the value is 21.23 N/m^2 while for strain the value is 0.015187892. For this result, 5.0 % ESA was accepted as the result exceed 30 MPa.

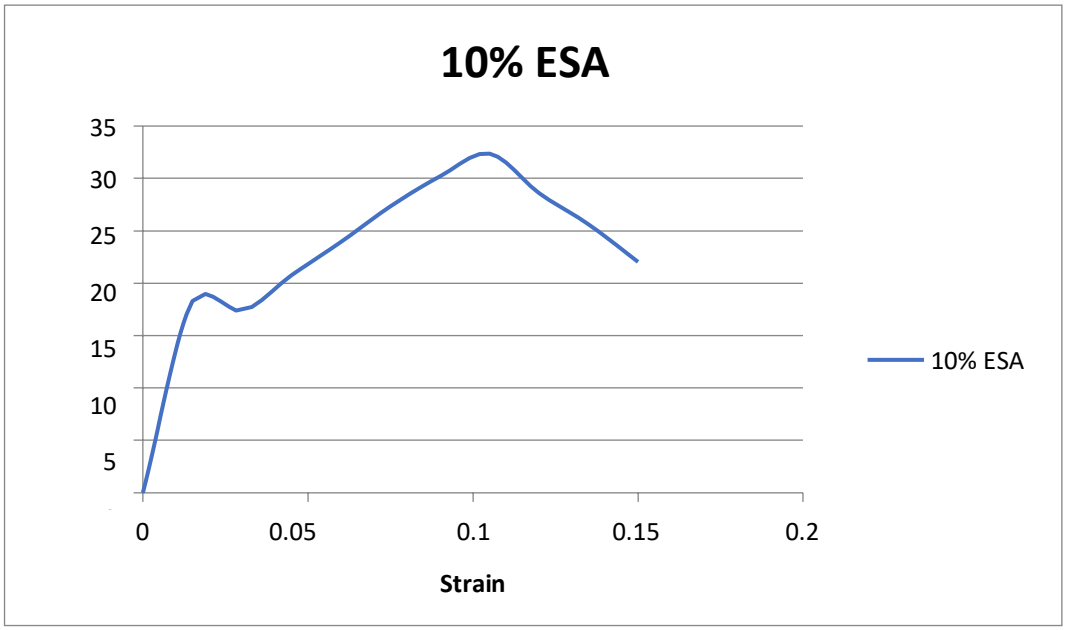

Figure 5 : Graph 10 % ESA for strain and stress

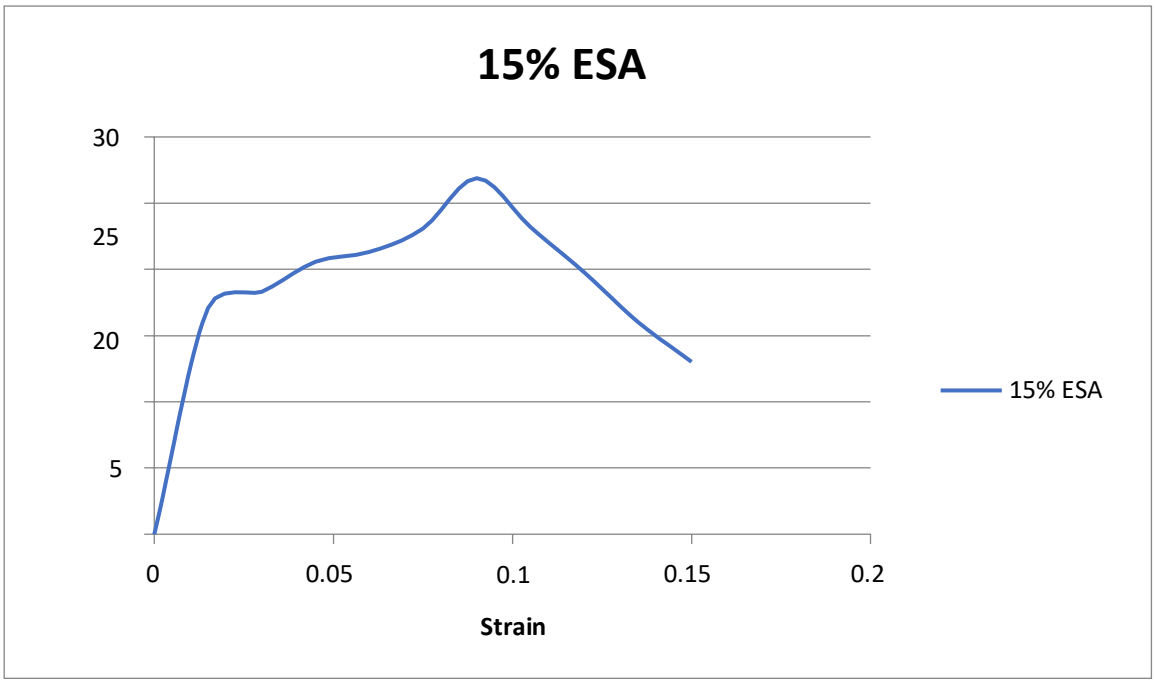

Figure 6 : Graph 15 % ESA for strain and stress

Figure 6 show the 15.0 % ESA for strain and stress. Maximum value of stress is 26.89 N/m^2 and for the maximum of strain value is 0.150047868. This result for minimum of stress the value is 13.03 N/m^2 while for strain the value is 0.015004773. For this result, 15.0 % ESA was less fulfilled as the result exceed 30 MPa

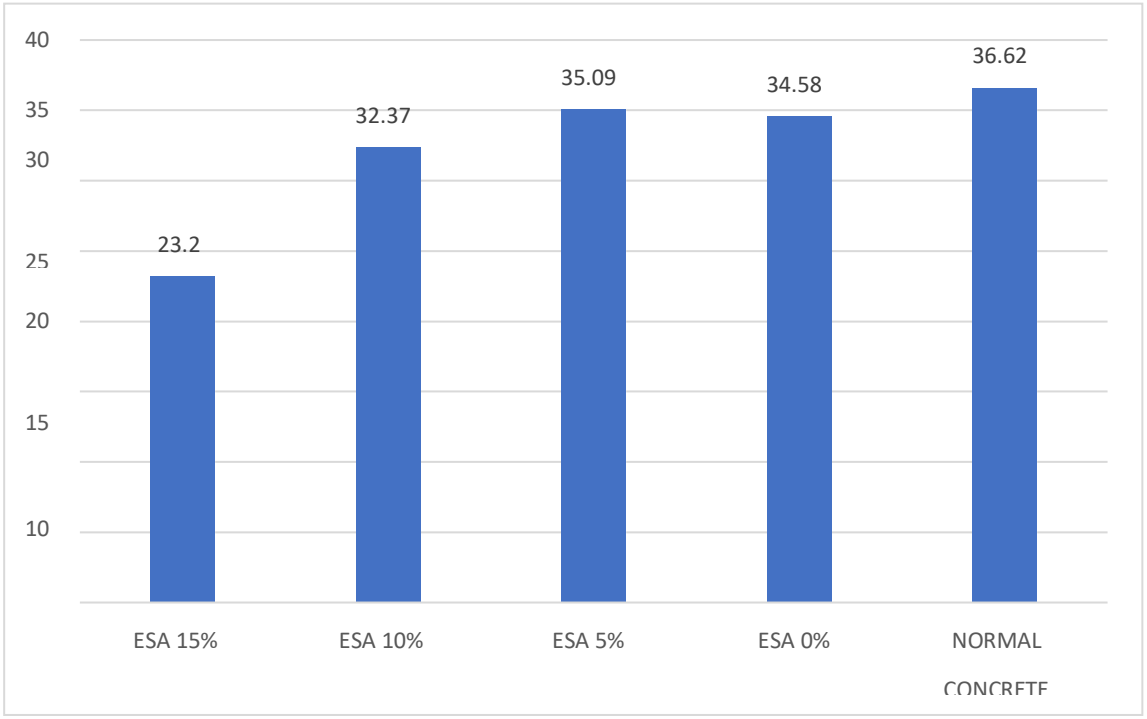

Figure 7 : Graph Highest

Figure 7 shows the comparison of stress value on ESA were achieved the strength. The 15.0 % of ESA replacement show the lowest value of stress compare to other three percentage of ESA with 23.2 MPa. The 15.0 % of ESA replacement not suitable proportion because the value is below 30 MPa. After that, for 10.0 % of ESA replacement show the stress value is 32.37 MPa. The 10.0 % of ESA

replacement is suitable to apply this study. Furthermore, the highest value of stress on ESA replacement was at 5.0 % which 35.09 MPa. That's mean this percentage is the best percentage of ESA to apply in concrete.

4. Conclusion

As for conclusion based on results that have been acquired, addition of ESA into concrete provide some good outcomes by using Abaqus software.

- The outcomes of the research were analyzes of the strain and stress in concrete cube.
- The performance of ESA replacement content was contrasted with standard concrete.
- The highest value of stress on ESA replacement was at 5.0 % which 35.09 MPa.
- That's mean this percentage is the best percentage of ESA to apply in concrete.

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