REVIEW ON STRENGTH PROPERTIES OF HIGH PERFORMANCE CONCRETE UNDER SHOCKWAVE COMPACTOR

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ABSTRACT:- The shockwave compactor is an efficient technique to increase the strength properties of the concrete. The major outcome of this project is to enhance the strength properties of the concrete. The shock waves are allowed to pass through the concrete and those specimens are tested for compressive strength, split tensile strength and flexural strength at the age of 7 and 28 days in comparison with the standard control specimen. Thus, as a result of shockwave application, we shall expect the increase in strength properties of the concrete which will be more beneficial to the construction industries. For this experimental study and investigation, M45 grade concrete is used which is also mostly utilized for various construction applications such as beams, columns, roof slabs etc. of industrial structures. This strategy upgrades the performance of the concrete as a whole and such concrete can be implemented even in large- scale construction such as bridges, dams, roads, pavements and embankments. In this investigation, a unique technique of compaction of concrete by applying shock waves to these concrete specimens is followed. This technique helped in achieving high strength characteristics of concrete especially compressive strength when compared with conventional. Level of compaction of concrete can be varied by altering the intensity of shock waves produced in the Shock tube.

Keywords:, Shock wave, Compressive Strength, Compaction.

1.0 INTRODUCTION

Concrete is immensely used in building construction and has the composition of many materials such as cement, coarse aggregate, fine aggregate and water. Concrete has the hard substances that are chemically inert and are referred to as aggregate. Compressive strength is the numerical based denotation of a structure or a material to withstand loads that might even reduce the size of the structure. Compressive strength of concrete confides on certain factors such as quality of concrete ingredients, cement strength, water-cement ratio and quality control during the preparation or production of the concrete. For an engineer, the strength properties of the concrete are the basic and the most important consideration that has to be done while planning the structures. The concrete is classified into different grades based on the compressive strength after 28 days. This grade has a great impact on structures lifetime. The Samples of cube or cylinder are usually casted and allowed to cure in the curing tank for 28 days and then the CTM (Compression Testing Machine) is used to test the compressive strength of the concrete in general. The test methods and requirements differ country to country based on the design code. In this experiment, shock waves are applied to the concrete with the shock tube instrument soon after casting in the mould. This process of application of shock waves in concrete has increased its strength properties providing a great opportunity to research further in this field.

1.1 SHOCK WAVE

In physics, a shock wave (also spelled **s**hockwav**e**), or shock, is a type of propagating disturbance that moves faster than the local speed of sound in the medium. Like an ordinary wave, a shock wave carries energy and can propagate through a medium but is characterized by an abrupt, nearly discontinuous, change in pressure, temperature, and density of the medium.

1.2 SHOCK TUBE

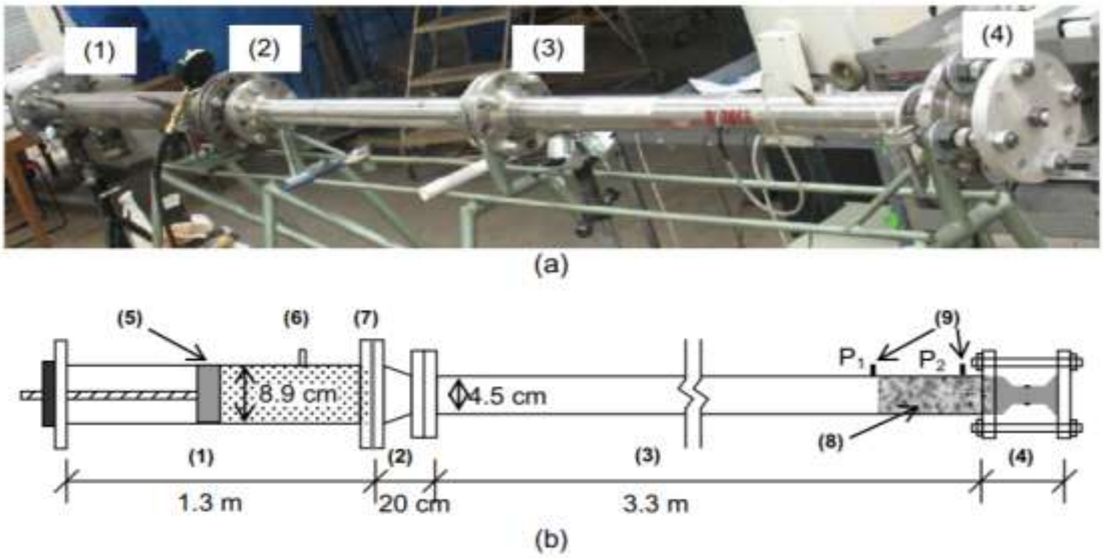
In physics, a shock wave or shock, is a type of propagating disturbance that moves faster than the local speed of sound in the medium Shock waves can be created in the laboratory by using a Reddy Tube, Detonation, Very high pressure gas cylinder, using small charge of explosives and Combustion. The most common method of producing shock waves are using shock tube with very high pressure gas cylinder. The Shock tube is used to replicate and direct blast waves at a sensor or a model in order to simulate actual explosions and their effects, usually on a smaller scale. A shock wave inside a shock tube may be generated by a small explosion (blast driven) or by the buildup of high pressures which cause diaphragm(s) to burst and a shock wave to propagate down the shock tube (compressed-gas driven). A simple shock tube is a tube, rectangular or circular in cross-section, usually constructed of metal, in which a gas at low pressure and a gas at high pressure are separated using some form of diaphragm. The material of the diaphragm and its thickness are dictated by the pressure ratio between the sections. On abrupt rupturing of the diaphragm, pressure waves emanating from the diaphragm station coalesce to form the shock front which propagates in to the low pressure section.

Fig 1.1 Shock Tube

1.2.1 APPLICATIONS OF SHOCK WAVES

- Cell information
- Wood preservation
- Use in Pencil Industry
- Kidney stone treatment
- Gas dynamics studies
- Shock wave assisted needleless drug delivery
- Treatment of dry bore wells

1.2.2 EXPERIMENTAL SETUP OF SHOCK WAVE INSTRUMENT



(a) photo and (b) schematic diagram. 1) driver section; 2) nozzle; 3) driven section; 4) instrumented step rod and flanges; 5) screw-driven piston; 6) high pressure gas inlet; 7) diaphragm coupling;8) pressure transducer P1; 9) pressure transducer P2.

FIG 1.2 Shock Tube Test Facility

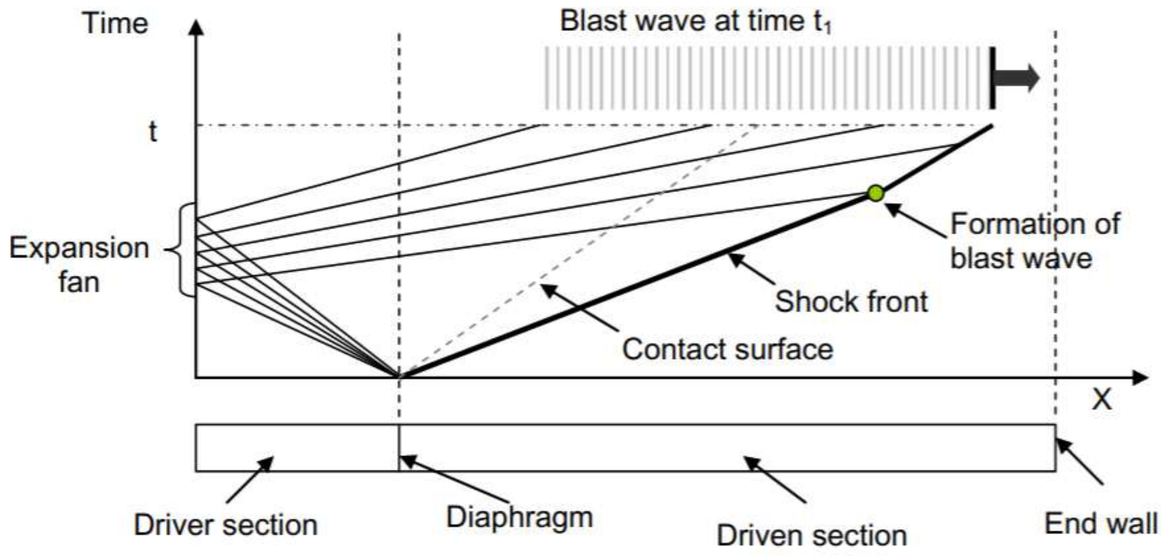


FIG.1.3 FORMATION OF SHOCK WAVE OR BLAST PRESSURE WAVE IN SHOCK TUBE

1.3 OBJECTIVE

The main objective of this experiment is to investigate the compressive strength, flexure strength, split tensile strength of shockwave compacted concrete and to obtain greater compressive strength which can be used to replace the conventional reinforced concrete columns

1.4 SCOPE

The scope of the project is to increase the strength properties of concrete by using shock wave compactor. The compressive strength of shockwave compacted concrete greater than that of nominal concrete, this finally reduces the materials requirement like concrete, aggregates etc.

2.0 LITERATURE REVIEW

WEIMIN NIAN (2016) evaluated the result of crushing strength of foam concrete compacted under blast load using shock tube. A compaction front is produced in the foam when the blast pressure amplitude is higher than the crushing strength. The length of the foam is significantly smaller than the required l_{cr}, the compaction in the material produces densification and the stress enhancement is higher than the applied blast pressure amplitude.

OMARALGASSEM, YANGLI (2019) presented the results of an experimental program which studies the effect of steel fibres on the blast performance of high-strength concrete beams. As part of the study, ten HSFRC beams are tested under either static loads or simulated blast loads using a shock-tube. Test variables include the effects of fibres, fibre content, fibre type, longitudinal steel ratio and combined use of fibres and transverse reinforcement. The results show that the use of fibres in HSC beams increases blast resistance, improves control of displacements and results in superior damage tolerance.

HONGWEIWANG, CHENGQINGWU (2017) investigated blast resistance and residual strength of concrete-filled steel tube (CFST) columns under close-range blast loads. The influence of explosive charge weight, steel tube thickness and cross section geometry on dynamic response of CFST columns was analyzed and failure modes of CFST columns were also investigated. Following the blast tests, an experimental study was conducted to investigate residual strength of blast-damaged CFST columns. It was found that the CFST columns were still able to retain a large portion of their axial load capacities even after close-range blast events.

HUAIBAO CHU, XIAOLIN YANG (2019) investigation of this study is to put forward a blasting-vibration safety standard for young concrete based on the effects of damage accumulation. The ultrasonic wave velocity change process and the vibration damage accumulation process of the young concrete were investigated based on the blasting-vibration damage accumulation experiment. Furthermore, the influence of the damage accumulation effect on the compressive strength and durability of concrete were studied.

SKEWS, B.W (2016) Phenomenological study of the processes occurring when a shock wave interacts with porous concrete, polyester and polyether foams has been undertaken. Plane shock waves generated in a shock tube were reflected off a slab of foam mounted against the back wall of the tube. Tests were conducted with an initial shock wave Mach number of 1.4 and a 70 mm thick slab of foam. The reduction in reflected shock wave strength and substantial increase in the back wall pressure over that for rigid wall reflection, found by other workers, were confirmed. Piezoelectric pressure transducers were used to record the pressure before, alongside and behind the foam specimen.

MONTI R (2009) Experimentally investigated the performed on the interaction between normal shock waves and deformable solid materials, with particular reference to the characteristics of the reflected shock wave the tests have been performed putting a cylindrical model of the material under study at the closed end of a shock tube and creating shock waves of variable strength which impinge on the material. The range of the shock wave Mach number has been $1,2 \leq m_s \leq 2,2$ with initial pressures ranging between $50 \leq p_1 \leq 760$ mm hg

NIAN W (2015) Experimentally investigated on the dynamic response of cellular concrete subjected to blast-pressure loading .The cellular concrete has large entrained porosity in the form of uniformly distributed air cells in a matrix of hardened cement. Under quasi-static loading, once the applied stress exceeds the crushing strength of the cellular concrete, crushing and densification of material results in an upward concave stress-strain response. The shock-tube experimental test setup used for generating blast-pressure loading in a controlled manner is described. Experimental results from the cellular concrete subjected to blast-pressure loading with pressure amplitude greater than its crushing strength indicate that a compression stress wave, which produces compaction of the material due to collapse of the cellular structure, is produced in the material. As the compaction front propagates in the material, there is a continuous decrease in its amplitude. The impulse of the blast pressure wave is conserved. When a sufficient length of the cellular concrete is present, the applied blast pressure wave is completely attenuated to a rectangular stress pulse. The transmitted stress to a substrate from cellular concrete when an applied blast pressure wave is completely attenuated resembles a rectangular stress pulse of amplitude slightly higher than the crushing strength of the material with a duration predicted by the applied blast impulse

WEIMIN NIANA , KOLLURU V.L.SUBRAMANIAM (2012) Experimentally investigated on dynamic compaction of foam under blast loading considering fluid-structure interaction effects the compaction of the porous material continues even after the blast over-pressure decreases below the crushing strength of the foam because of the kinetic energy available in the compacted foam. The energy transferred from the blast pressure wave to weaker foam is higher than the energy transferred to foam with higher crushing strength. There is a critical length of the foam when the energy absorbed by the foam is totally dissipated by the compaction of the material and the kinetic energy in the compacted foam becomes equal to zero.

CONCLUSION

Study of optimum compaction of concrete specimens using various intensities of Shock waves led to the conclusion that maximum compaction is obtained for more exposure of concrete to the Shock waves. Moreover, the ultimate load carrying capacity of shock wave induced reinforced concrete beam with steel plate is high when comparing to other beam. The deflection and cracks gets reduced due to the Shock wave application on Concrete members. Due to that life of the Structural members gets increased and the structures are more durable because of Shock wave application on Concrete. In future, study of durability of shock wave compacted concrete specimens can be done for various grades of concrete.

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