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The Effect of Aggregate Size on Energy Dissipation of Plain Concrete Members Subjected To Static Cyclic Loading

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Abstract:- When concrete structures are subjected to cyclic loading they tend dissipate the generated energy. The performance of concrete structures is widely measured by the concept of energy dissipation, which usually expressed as non – dimensional ratio defined as the energy dissipated per cycle to the total input energy, this paper presents an experimental works were conducted to investigate the effect of aggregate size and type of applied loads (constant or gradually) on energy dissipation. The results showed that , the smaller aggregate size gave the lesser in energy dissipation, and also when the load is applied gradually increase in each cycle gave less energy dissipation than when the load is applied as constant for all cycles.

Keywords:- Energy Dissipation, Cyclic Load, Aggregate Size.

I. INTRODUCTION

Factors which affect the durability of concrete are numerous. Some of these relate to concrete mix component, others relate to the type of loads, climate, curing ,methods and conditions, and some are influenced by method of construction, and relate workmanship. For a given set of raw material strength of concrete is the most influenced factor on durability of the concrete and is governed to a large extent by the water-cement ratio (w/c), and the requirement of water for concrete mix design is strongly influenced by the source and characteristics of the aggregates. Several authors investigated the effect of aggregate on strength of concrete Abbasi etal [1] studied the influence of each component of concrete mix on strength of concrete by using the reduced factorial experimental technique and they reached to a general empirical equations can which be used in mix concrete design. Walken and etal [2] studied the effect of aggregate size on properties of concrete. Walken and etal [3] also studied the effect of maximum size of aggregate on strength of concrete. In the past there have been a few investigations on the energy dissipation properties of plain concrete elements. Jordan [4] studied the effect of the mix proportioning on energy dissipation, and he concluded that, if a mix is weaken it will show a higher value of energy dissipation than the strong mix. Flesch [5] carries out a study to determine tensile effect on energy dissipation for reinforced concrete members.

MATERIALS:

The material used in this study are ordinary Portland cement, coarse aggregates, these materials were widely used as local aggregates for construction and the mechanical and physical properties of these used aggregates are given by suliman [6]

II. SCHEME OF TESTS

The experimental work in paper is divided two stages as shown in fig (1). In the first stage a total of 36 concrete mixes are prepared with various factors of water cement ratio, coarse aggregate to total aggregate and total aggregate to cement. The main objectives of the first stage as presented by Elazhari and etal [7] in details were to develop the empirical relationships between concrete mix components and compressive strength, modulus of rupture and energy dissipation, the high strength, and suitable workability will be investigated in the second stage, to determine the effect of the aggregate size on energy dissipation as out lined in fig (2) and as follow: Eighteen concrete cubes (150 x 150 x 150 mm) and eighteen concrete beams (150 x 150 x 750 mm) were prepared from optimum concrete mix result (w/c = 0.5, CA/TA = 0.67, TA/C=5) which has been reach by [7].

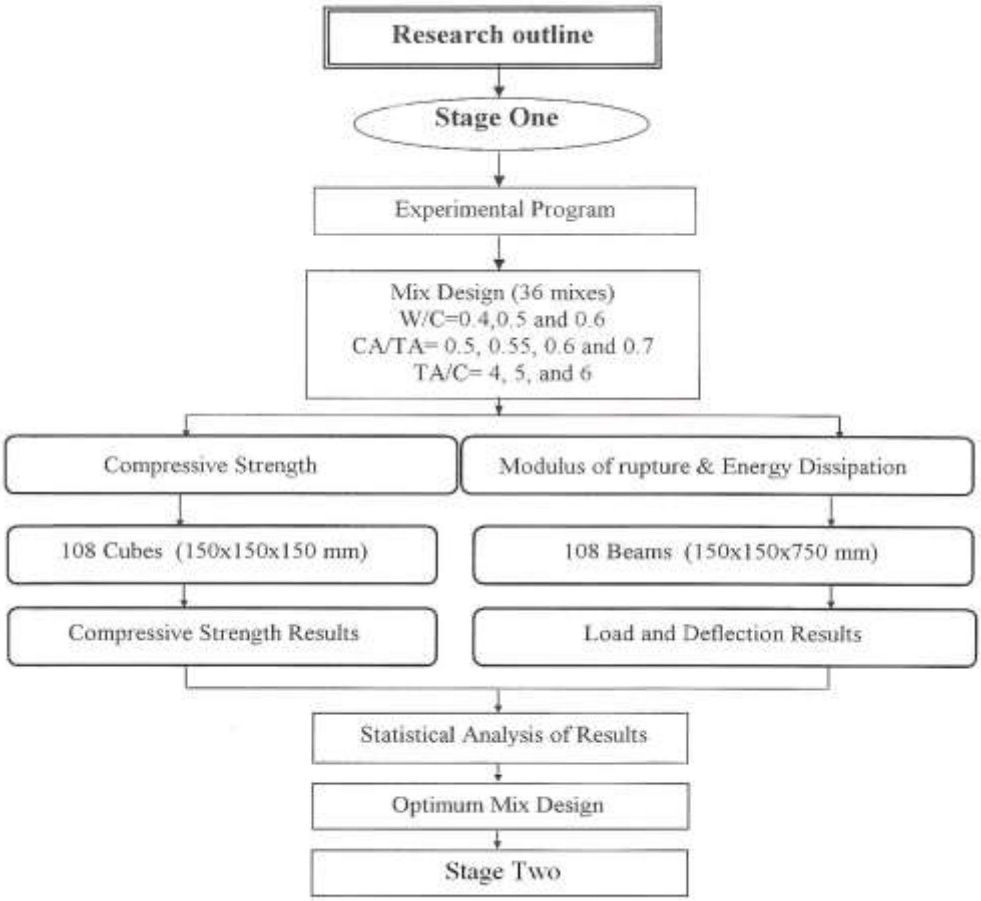

Fig 1 Experimental Plan Chart for Stage One

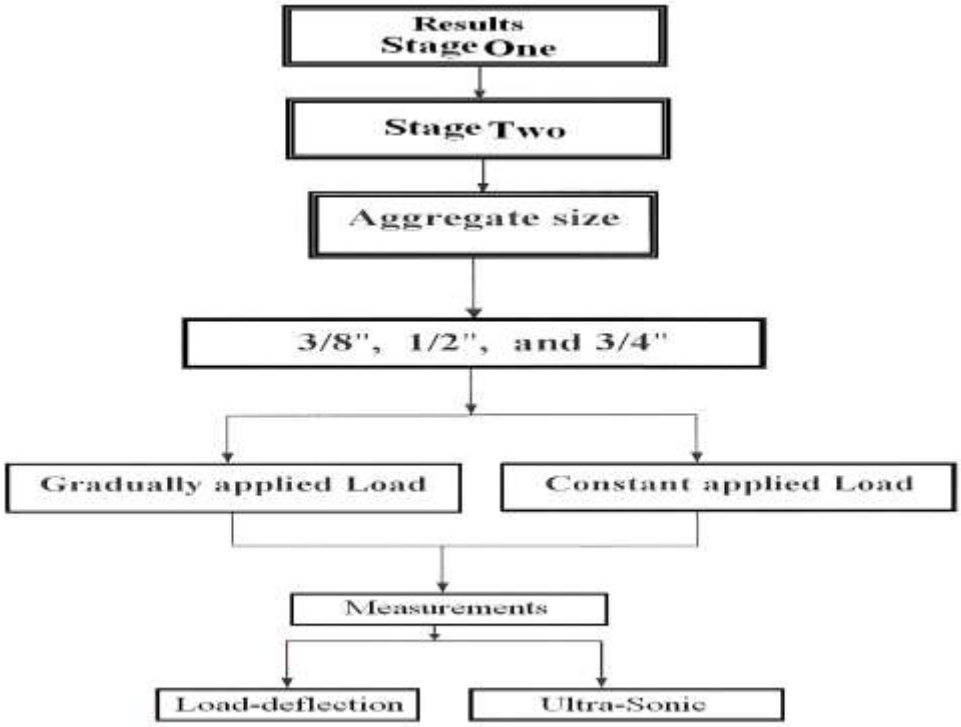

Fig 2 Flow chart for stage two

III. METHODS OF MEASURING THE ENERGY

DISSIPATION RATIO:

Energy dissipation was calculated by means of the specific energy dissipation ratio [9], R_n defined as the ratio of the strain energy loss per cycle to the total strain energy of the specimen for that cycle. Or, $R_n = \frac{\Delta U}{U}$ Where ΔU is the energy, which is transformed into heat, or internal strain energy, and U is the total strain energy. The value of R_n can be determined directly by measuring the area in closed by the load-deflection loop of the specimen under cycle loading to the total area as indicated in fig (3).

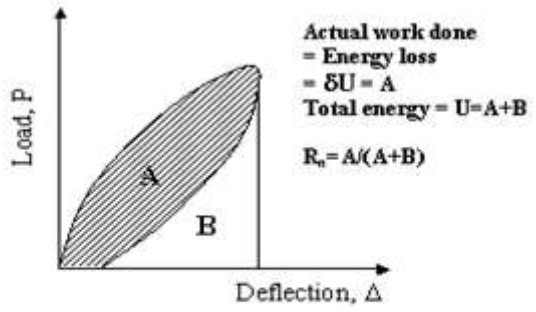

Fig. (3) Determination of (R_n) for the hysteresis loop

TEST PROCEDURE:

In order to study the effect of aggregate size on the energy dissipation, concrete cubes and concrete beams, were prepared from concrete mix as (W/C=0.5, CA/TA=0.67, TA/C=5). The concrete cubes and beams with different aggregates size (3/8'', 1/2'', and 3/4'') were casted in standard curing laboratory room condition and demolded after (24hr.) The cubes were tested for compressive strength (in order to find fr to be used in tests) and the beams were tested for cycle loading test, during the testing of concrete beams, the propagation growth of microcracks were measured by using the ultrasonic pulse velocity test. Two types of tests were conducted on the concrete specimen as shown in fig (4), the first type was a constant upper limit of cycle loading (in this case the load was taken as a constant load which equals to 75 % of flexure load), and the second type of applied load is an increasing cycle loading, in which the load was increased gradually in each cycle up to 75 % of flexural load in each case of loading, deflection was measured by using dial gage and growth of the propagation of cracks was measured by using ultrasonic method.

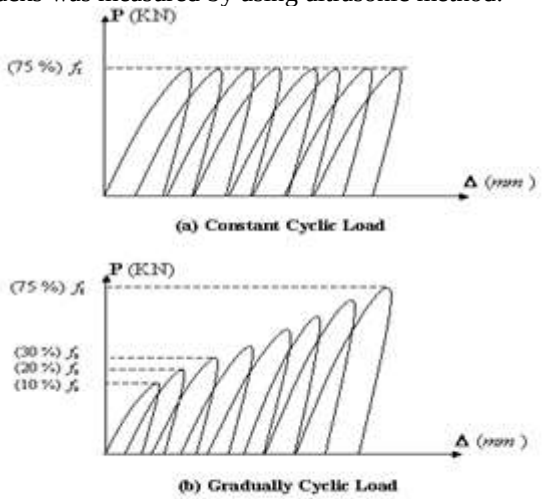

Fig. (4) Types of applying loads

IV. TEST RESULT SAND DISCUSSION

The Effect of Aggregate Sizes on Energy Dissipation:

Figure (5) shows the relation between the energy dissipation ratio and the number of cycle for different size of coarse aggregate from this curve one can notes that the aggregate size 3/8'' has less energy dissipation, and aggregate size 3/4'' has more energy dissipation, this because of size 3/8'' has a large number of particles and hence the voids between particles are less and therefore the internal friction between these particles are less, this leads to less energy dissipation.

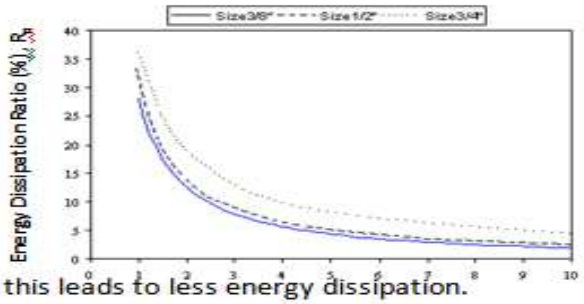

Fig.(5) Energy Dissipation versus number of cycles

Crack Propagation:

Figure (6) and figure (7) represent the curve for ultrasonic pulse velocity versus number of cycle for constant and gradually applied load respectively, from these figures one can conclude that the bigger size of coarse aggregate, the larger cracks for both types of applied loads.

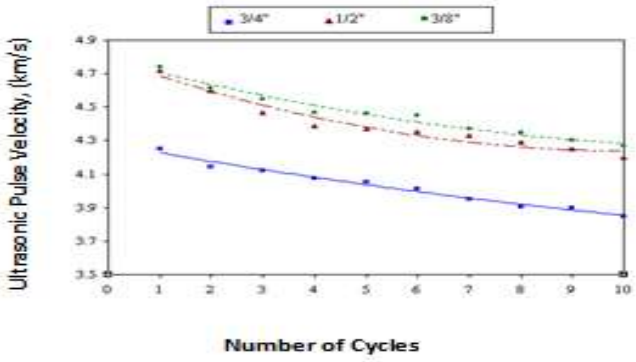

Fig.(6) Pulse velocity with gradually applied cyclic load versus number of cycles

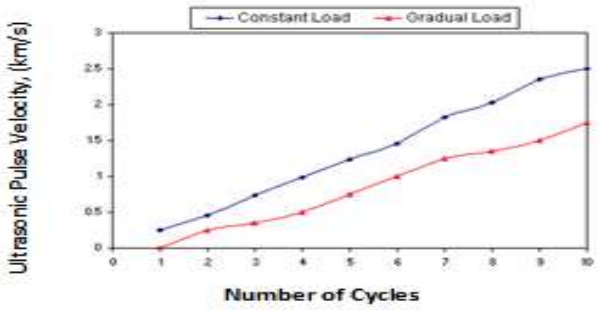

Fig. (7) Pulse velocity with constant applied cyclic load versus number of cycles

Permanent Deflection: During the static test, and when load (constant or gradually) is increase the deflection at mid-span was measured, which leads to the concrete strain or deformation increase after each cycle as shown in fig (8) to fig (10). It is clear from these curves that the measured permanent deflection for constant load more than that for the gradual load for three types of aggregate sizes. The reason behind that is during the gradual load, micro cracks will be growth slowly, because the load is tends to be more static load than dynamic one.

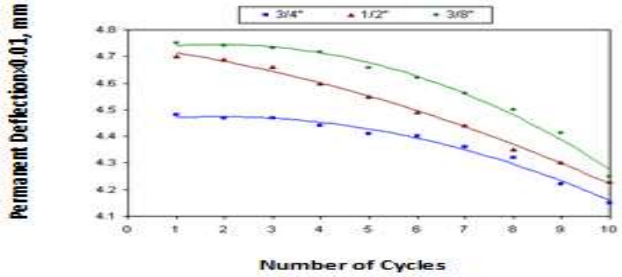

Fig. (8) Permanent deflection versus number of cycles for 1/2" agg. size

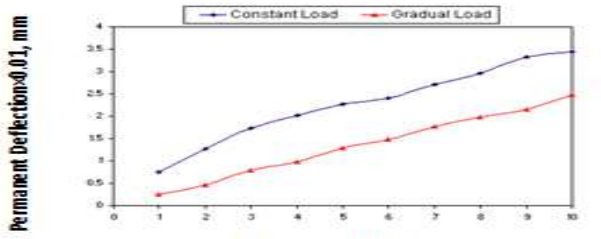

Fig. (9) Permanent deflection versus number of cycles for 3/8" agg. size

Number of Cycles

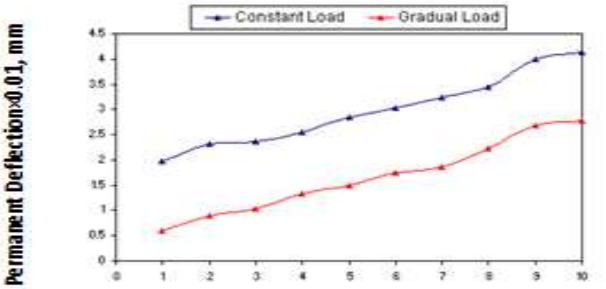

Fig. (10) Permanent deflection versus number of cycles for 3/4" agg. size

V. CONCLUSIONS

Based on the test results obtained from this experimental study, it can be concluded that: The increase in aggregate size shows increase in energy dissipation, and also for all aggregate sizes the ultrasonic pulse velocity in concrete increases with gradually applied cycle load and decreases with constant applied cyclic loading and also the permanent deflection for constant cycle loading applied is greater than the permanent deflection generated by gradually applied load, for all types aggregate sizes.

REFERENCES

[1]. Abbsi, F. Munir Ahmed, and Mohammad Wasim " optimization of concrete mix proportioning using reduced factorial experimental technique " ACI materials journal PP 55 - 62 , 1987

[2]. Walker, Stauton " the effect of aggregate size on properties of concrete " ACI journal (57-13) PP-264-296 , 1960

[3]. Walker, Stauton " Relationship of concrete strength to maximum size of aggregate " proceedings, Highway research board vol. 38 pp. 368 – 379, 1977

[4]. Jordan, R.w " The effect of curing, mix and age upon the damping of concrete " Magazine of concrete reach vol. 32 No 113 pp – 195 – 2001 December 1987

[5]. Flesch, R. " The damping behavior of reinforced concrete element " International Association for Concrete Engineering report vol. 34, pp 83-98, 1981

[6]. Suliman, F. M. " experimental investigation of energy dissipation properties of plain concrete members " MS. Thesis in civil Eng. Alfateh university 2004 Tripoli, Libya.

[7]. Elazhari, s. , Akkari, M. Suliman, M. "The optimum mixed design " local conference 2006 Misrata – Libya