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"Effect of Hammer Weight on Physical Properties of Brick Aggregates"

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ABSTRACT: *Reinforced concrete structure is the most common type of structure found elsewhere in the developing country. Coarse aggregate is one of the major components for this type of structures. Though stone chips are used to achieve higher concrete strength but brick chips are used widely to save the cost of construction. Most of the cases, brick chips are prepared by breaking full size bricks with different types of hammer. Impact load due to hammer has a significant effect on coarse aggregate size. In this research this impact load has been calculated to understand the loss of particle.*

I. INTRODUCTION:

Economic design is one of the major concerns for the designers, especially for the low and middle income countries. To achieve a higher strength concrete, coarse aggregate plays a significant role. Developing country like Bangladesh, coarse aggregate is produced by breaking bricks with hammers. A number of labors need to produce the required volume of coarse aggregate for the construction activity. There is no such specification of hammer size or dropping height of hammer. As a result, volume of effective coarse aggregate produced in this way, is not same as the initial volume of full size bricks. Most of the cases, this loss of materials is ignored. Dibble, H.L. and Pelcin, A. (1995), worked on hammer mass and velocity to find the percentage of flaky particles. In this research hammer of different weight and surface are used to produce the coarse aggregate. Impact energy has been calculated and test on aggregate has been done to understand the behavior of impact loading with aggregate size and quality.

THE EFFECTS OF HAMMER DESIGN:

Waldemar Karwowski et.all. (2002) showed that hammer design differences affect hammering task performance and perceived physical exertion. In general, the horizontally-oriented hammering task was faster than vertically-oriented hammering. However, task accuracy (i.e. number of nails hammered straight) was not statistically different with respect to either hammering orientation or hammer design [2]. In this research, four hammers (see **Table 1**) were used and differed with respect to their weight and softness of handle grip. Ten male subjects participated in the laboratory experiment. They identified handle design, weight, and hammer mass distribution as critical factors that affect hammering task performance.

Table 1: Specification of hammer

Weight of hammer (gm)	Maximum length of handle, L (inch)	Hammer section, $l \times b \times (h_1 \sim h_2)$ (cm×cm×cm)
1660.7	14	14.8×2.2×(4.1~5.7)
1262.7	14	13.9×2.0×(3.8~5.5)
1101.5	14	11.8×2.0×(3.8~5.2)
933.3	14	10.1×1.8×(3.8~5.0)

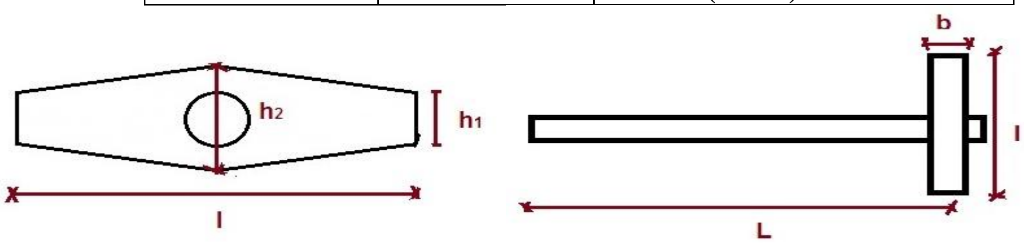

Fig 1: Typical hammer.

II. THE EFFECT OF HAMMER MASS AND VELOCITY ON FLAKE MASS:

Harold L. Dibble and Andrew Pelcin (1994), represent the results of controlled fracture experiments designed to investigate the effects on flake mass of varying the mass and velocity of the hammer. It is found that the contribution of these two independent variables are almost negligible for a given combination of exterior platform angle and platform thickness, though they must be sufficient to initiate production of a flake of a given potential mass. The experiment focuses on the relationship between flake mass and two fundamental aspects of the striking core: the mass and the velocity of the hammer. Rather, flake size appears to governed largely on the basis of particular platform characteristics, principally the exterior platform angle and platform surface area. Likewise, when these aspects are held constant, then flake size remains the same in spite of significant variation in mass or velocity of the hammer.

IMPACT CALCULATION:

Impact means a force that acts within very short duration. The impact on brick exerted by a hammer is determined with the help of a spring balance and a modified platform (see **Fig.2**) to absorb the impact load from hammer. Standard formula is used to derive the impact load.

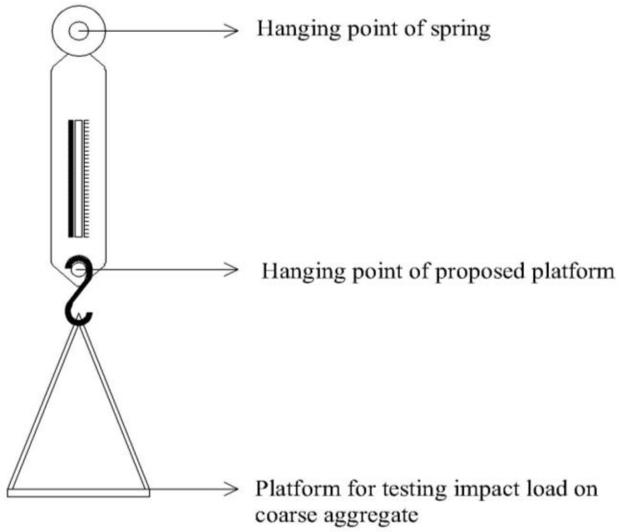

Fig 2: Experimental arrangement for impact load testing.

From Newton's second law of motion, we know, Force (F) is equal to mass (m) times acceleration (a). During impact, kinetic energy is converted to breaking force. Kinetic energy (E_k) is proportional to mass (m) times square of velocity (v). In this research mass of hammer is used to find the kinetic energy, where a video camera is used to calculate the striking velocity. Impact load due to different hammer is shown in **Table 2**.

Table 2: Impact Energy.

Hammer Weight (gm)	Average velocity obtained from test result (m/sec)	Impact Energy (J)
1660.7	2.05	3.49
1262.7	2.05	2.65
1101.5	2.05	2.31
933.3	2.05	1.96

III. TEST ON AGGREGATE:

For comparison of quality of aggregate from different hammers and platforms, some tests were done. Flakiness index test represents the amount of flaky particle produced due to different impact loading. It is observed that (see **Fig. 3**), with the increase of hammer weight, flakiness index (F.I.) decreases. In case of aggregate impact value (A.I.V.), same types of curve are observed (see **Fig. 4**). A.I.V. decreases with the increase of hammer weight.

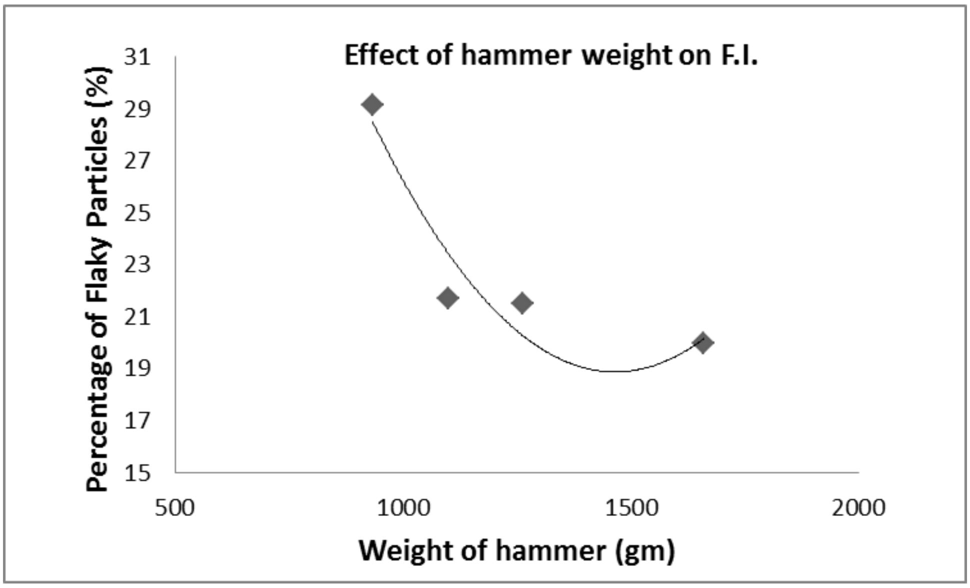

Fig 3: Effect of hammer weight on flaky particles.

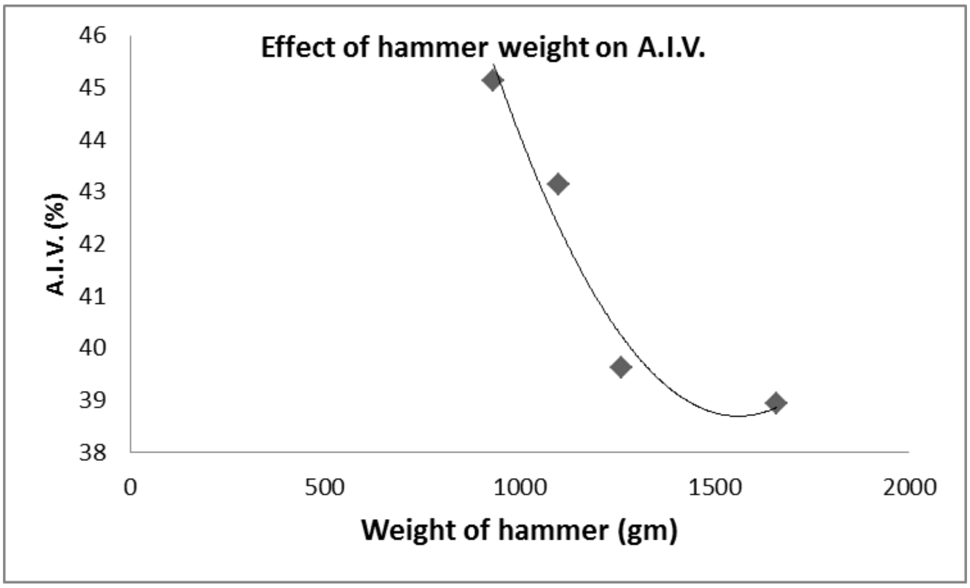

Fig 4: Effect of hammer weight on A.I.V.

IV. EFFICIENCY OF HAMMER:

Hammers of different platforms and weight are used in this research to understand their efficiency. Time required to breakdown 10 full size bricks (9.5″ x 4.5″ x 2.75″) are calculated to find the efficiency of hammer. It is observed that, edged hammers are more effective than heavier flat shaped hammer. **Table 3**, represents that, with the increase of hammer weight, time taken to breakdown the same number of bricks reduced.

Table 3: Efficiency of hammer.

Hammer weight (gm)	Type of platform surface	Required time to breakdown 10 bricks (min.)
1660.7	Flat	22
1262.7	Flat	24
1262.7	Edged	21
1101.5	Flat	26
933.3	Flat	29

CALCULATION OF MATERIAL LOSS:

To reduce the percentage of flaky particle one can use heavy weight, flat shaped hammer. In this research, no. 4 sieve is used to separate the coarse aggregate from the brick chips obtained from different hammer load under the same condition. Increase of hammer weight has a tendency to produce bigger size particle in short time. It is shown that (**Fig 5.),** by doubling the hammer weight, loss of material decreases by 8%.

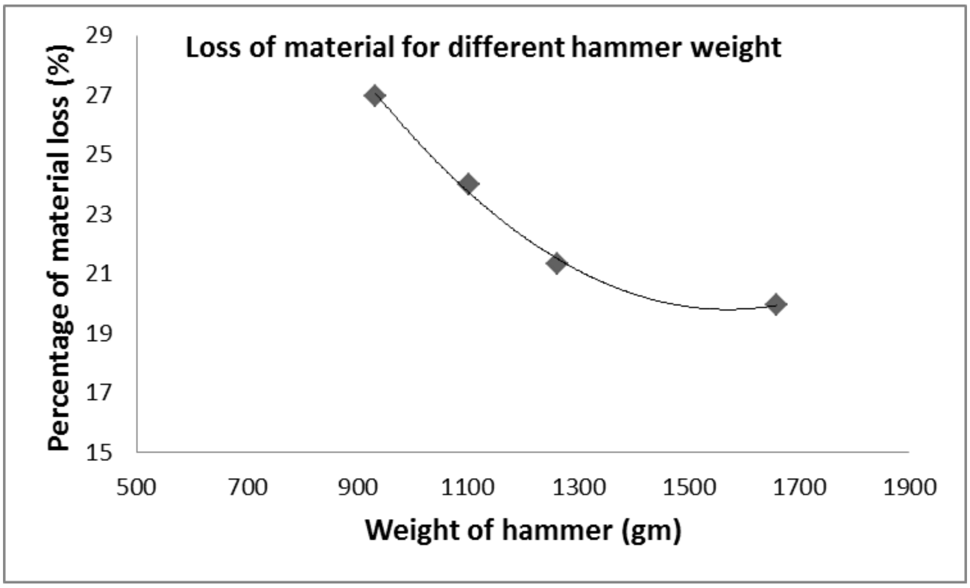

Fig 5: Loss of material for different hammer weight.

V. CONCLUSION:

Strength of concrete depends on size of coarse aggregate. If lower weight hammer is used to break the bricks, possibility of flaky particle increases as well as loss of material will increase the project cost. A range of hammer is used for this study to understand the effect on coarse aggregate property. It is obvious that, to impart the same impact value to breakdown of any substances, we need to increase the amount of force by increasing the impact load. Findings of this research may be summarized as follows:

[1] Percentage of flaky particle decreases with the increase of hammer weight
[2] Aggregate Impact Value (A.I.V) also decreases with the increase of hammer weight
[3] Edged hammer is more efficient than flat shaped hammer
[4] By doubling the hammer weight, loss of material decreases by 8%

This research is limited to the brick chips only, whereas stone chips are also used for construction work. Further research may be conducted by using stone aggregate.

REFFERENCES

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