Investigational Study to Relate Number of Blows and Impact Strength of Concrete having Partial Replacement of Natural Sand by Manufactured Sand and Cement by Pozzolanic Materials with Respect to First Crack in Specimens

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***Abstract** – Due to its exceptional strength and durability, concrete is the primary extensively utilized building material in today's civil construction. The widespread usage of cement and Natural Fine Aggregate in civil engineering has resulted in a variety of negative social and environmental effects. To address this, industrial residues referred to as by-products (pozzolanic materials) like silica fume, GGBFS, fly ash, metakaolin has been utilized in place of cement in certain instances. In contrast, fine natural aggregate has been substituted with manufactured sand (M-sand). NFA is replaced with M-sand varying from 0 to 100 % in steps of 10 %, and 20 % cement is substituted with pozzolanic materials. The ratio of water to cement has been maintained at 0.45, and the quantities of M30 concrete have been taken into account in accordance with I.S. 10262:2019. Impact strengths have been computed for various concrete mix proportions. The purpose of this study is to investigate and analyze the relationship between the number of blows and impact strength of concrete made with a portion of natural sand replaced by artificially manufactured sand and a portion of cement replaced by pozzolanic materials in reference to the occurrence of the 1st crack in the test specimens.*

Key Words*:* *Pozzolanic materials, manufactured sand, Impact strength.*

1.INTRODUCTION

Concrete is the most widely used building material on the planet; therefore, it is at the heart of every country's infrastructural development. It has performed admirably throughout the world. Globally, concrete is manufactured at a rate of nearly 1 m3 / person/year. Portland cement is the primary ingredient of concrete. Cement production globally was approximately 2.6 billion tonnes in 2008. By 2020, the cement requirement was expected to reach approximately 3.5 billion tonnes. This will undoubtedly have an equal impact on the demand for commodities such as sand, aggregate, and other components necessary to manufacture massive amounts of concrete. This will undoubtedly affect the annual decrease of all-natural raw materials used to manufacture concrete. Three major issues are connected to cement manufacturing: environmental and ecological concerns, sustainability concerns, and high energy requirements. Because of the limestone's calcinations, the burning of fossil fuels, the manufacturing of cement releases approximately an equivalent amount of CO2 into the atmosphere. In light of this, and to reduce CO2 emissions coupled with composites of O.P.C., mixed cements containing pozzolanic materials such as silica fume (S.F), ground granulated blast furnace slag (GGBFS), rice husk, fly ash (F.A), and metakaolin were recommended.

Additionally, due to the anticipated increase in construction in the coming years, it is projected that superior aggregates useful for use in concrete will become insufficient or prohibitively expensive. Due to the anticipated shortage of fine natural aggregate, manufactured sand is a viable alternative to fine natural aggregate. Manufactured sand must meet the technical requirements of concrete, such as strength and workability. Due to the scarcity of data on this characteristic of concrete made with artificial sand, it is critical to study concrete made up of manufactured sand.

Presently, concrete is the most utilized building resource in civil engineering due to its exceptional durability and strength. However, the excessive use of natural sand and cement in civil engineering has several unfavourable social and ecological repercussions. As a solution, industrial wastes referred to as by-products (pozzolanic materials) such as GGBFS, silica fume, metakaolin, and fly ash may be used to partly replace cement and superior natural aggregate in concrete by manufactured sand (M-sand). In this laboratory activity, the natural fine aggregate was partially replaced by M-sand in various percentages, with a water to cement ratio of 0.45 and cement partially replaced by 20 % pozzolanic materials. The percentages of M30 concrete were considered as per I.S. 10262:2019 guidelines. The impact strength of various concrete mix amounts is computed and compared to ordinary concrete. The purpose of this research is to examine and evaluate the relationship between the number of blows and impact strength of concrete concerning the first fracture when natural sand is partially substituted by manufactured sand and cement is partially substituted by various pozzolanic materials. This will be a highly beneficial, reliable, systematic, and time-saving way for testing the impact strength of various concrete mixes in the future. Additionally, it will be environmentally beneficial, as pozzolanic materials reuse industrial waste materials.

Numbers of ways are tested for cement replacement. Research on the effects of impact was conducted using rubberized self-compacting concrete (SCC) RSCC-10, RSCC-20, RSCC-30, and RSCC-40 specimens were used for testing. Compressive, flexural and splitting experiments have been carried out to determine the influence of rubber on concrete behaviour. Rubber % enhanced impact resistance, but specimen strength and modulus of elasticity decreased [1]. The rice husk ash and metakaolin are utilized for replacement. Metakaolin has been obtained with calcinations of uncontaminated or sophisticated kaolin clay at a temperature between 650 °C and 850 °C. The resulting material has high pozzolanity. These two materials R.S.H. & Metakaolin have been incorporated with concrete with varying percentages of 2 %, 4 %, 8 %, & 10 %. A Series of tests were conducted on these specimens like split tensile, Flexural, Compressive strength, Normal consistency test, etc. The strength of concrete increased by incorporation of Rice Husk Ash & Metakaolin [2]. The possibility of replacing fine natural aggregate with M-sand and 20 % of pozzolanic materials like fly ash, silica fume, GGBFS, and metakaolin as concrete substitutes was tested for better results. Natural superior aggregate was in part replaced by M-sand in a range of percentages in 10 % steps with a water cement ratio of 0.45, and cement was partly replaced by 20% of pozzolanic materials. It was noticed that partial replacement of 60 % M-sand and 20 % silica fume yields the maximum impact and shear strength than conventional concrete [3]. The results obtained from replacing NFA by MS were significantly better. That provides extremely strong accurateness to forecast flexural strength of concrete with fractional replacement of cement with pozzolanic materials and NFA by MS [4]. Cement has been substituted with three combinations of the Fly Ash (15 %, 20 % and 25 %) and two combinations of GGBS (40 % and 50 %) and in both cases 50 % natural sand has been replaced by crushed sand. Compared to the other two materials studied, compressive strength and workability can be improved by using S.C.M., which has a lower w/c ratio [5-6].

The primary objective of this paper is to investigate the relationship between the number of blows and impact strength of concrete made with a portion of natural sand replaced with manufactured sand and a portion of cement replaced with pozzolanic materials concerning the occurrence of the very first crack in the test specimens.

2. MATERIAL COMPOSITION AND TESTING

2.1 Materials Used

O.P.C. 43 cement grades meet IS 8112-2013 requirements for specific gravity (S.P.) 3.15. Concrete is mixed and cured using potable water. Natural fine aggregate (sand) readily available in the vicinity is used and falls into zone II with a S.P. of 2.61 and a fineness modulus (F.M.) of 2.24. Sand produced locally by vertical shaft impact (V.S.I.) crushers falls into zone II with a S.P. of 2.82 and an F.M. of 2.91. The coarse aggregates used in this research were 10 & 20 mm in size and had a S.P. of 2.94 (BIS 1970). Fly ash was collected from the J.S.W. processing facility from Maharashtra, India. It contained 58.54 % silicon dioxide (SiO2), 4.59 % calcium oxide (CaO), and a S.P. of 2.15 %, all of which were categorized as class F.Silica flume was received from E.S.A. (ELKEM South Asia) Pvt Ltd., Mumbai, India, and was termed Elkem-micro silica. It contained 91.14 % silicon dioxide (SiO2) with a specific gravity of 2.2, while GGBFS was collected from the J.S.W. plant in Karnataka, India. It contained 41.61 % silicon dioxide (SiO Metakaolin). It contains 54.66 % silicon dioxide (SiO2), has a specific gravity of 2.2, and is based on naphthalene. The admixture utilized in this research was Fosroc Conplast SP430, which enhances the concrete workability. The I.S. 456:2000 (BIS 2000) and I.S. 10262:2019 standards were used to create the concrete mix (BIS 2009).

2.2. Preparation of Specimens

It was created by substituting fine natural aggregate for the reference mix. An approximate range for the proportion of fine natural aggregate substituted by manufactured sand is 0 to 100 % in the step of 10 %. In addition to the natural sand & 20 % of the cement, other mineral admixtures were included by weight in the mixture.

Concrete's ability to withstand dynamic loads is evaluated indirectly via the impact test. Concrete is rated on its capacity to withstand a rapid shock load or other external force, known as its impact strength. The concrete specimen's impact strength is represented in N-m as the amount of energy necessary to generate the specimen's initial fracture and ultimate failure (with no rebound state). Fig. 1 shows the experimental setup. To determine the impact strength, cylindrical specimens with a 150 mm diameter and a 60 mm height were casted based on the recommendation of A.C.I. Committee 544.2 R-89 (A.C.I. Committee 1989). Specimens were stored at room temperature for twenty-four hours after casting; then, it was removed from the mould, the solidified concrete specimens were soaked in water for 28 days to cure. The impact testing machine from Schruder was employed in the experiment (A.C.I. Committee 1989). A 4.54 kg hammer was dropped on the specimen from a height of 457 mm. The number of blows necessary to generate the first crack and ultimate failure wererecorded by putting the specimen in Schruder's impact testing equipment. The following equation was used to compute the impact strength (energy) corresponding to the number of blows.

Impact strength (Impact energy) Is = w*h*n.

Where,

Is=Impact strength in N-m.

w=Hammer weight=45.4 N.

h=Falling height=0.457 m.

n=Required total number of blows to cause a first crack or final failure.

Fig 1: Impact strength test machine.

2.3 Methodology

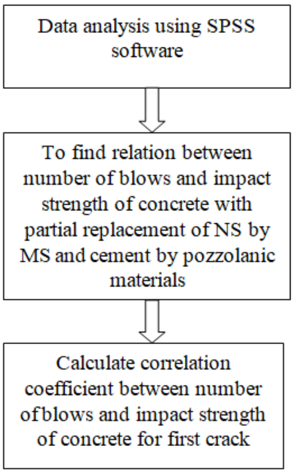

Figure 2: Flowchart

Fig 2 shows the flowchart of the experimentation. In this research work, the objective was to find the relation between the number of blows and impact strength of concrete made with partial replacement of natural sand by manufactured sand and cement with pozzolanic materials. For this, the correlation coefficient between the number of blows and impact strength of concrete concerning the first crack has been calculated. The master chart has been prepared by using MS-Excel. Impact strength for each combination has been measured in terms of Mean ± S.D. Karl Pearson's correlation coefficient is used to calculate the correlation between the number of blows and impact strength. Data analysis has been performed by using SPSS (23.0) statistical software.

3. RESULTS AND DISCUSSION

Table 1 shows the correlation between the number of blows and impact strength values. NFA is replaced with MS in varied percentages and cement is replaced with no pozzolans concerning the first crack.

It has been observed that, for 0 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 10% replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 20 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 30 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 40 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 50% replacement of NFA by MS, correlation coefficient (r) = 1,there is perfect positive correlation which is statistically significant(p<0.0001). For 60 % replacement of NFA by MS, correlation coefficient (r) = 0.9995, there is positive correlation which is statistically significant (p=0.0203). For 70 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 80 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 90% replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 100% replacement of NFA by MS, correlation coefficient (r) = 0.9318, there is positive correlation which is statistically not significant (p=0.2366).

Table -1: Impact strength results with various percentage replacement of NFA by MS and with no pozzolanic materials with respect to first crack.

% Replacement of Natural sand By Manufactured sand	No of blows	Impact Strength (N-m)	Correlation Coefficient (r)	P value
0	52	1078.88	1	p<0.0001**
	53	1099.63		
	50	1037.39		
10	72	1493.84	1	p<0.0001**
	72	1493.84		
	74	1535.33		
20	83	1722.06	1	p<0.0001**
	84	1742.81		
	86	1784.31		
30	148	3070.67	1	p<0.0001**
	152	3153.66		
	150	3112.17		
40	156	3236.65	1	p<0.0001**

	160	3319.64		
	161	3340.39		
50	186	3859.09	1	p<0.0001**
	190	3942.08		
	200	4149.56		
60	286	5933.87	0.9995	p=0.0203**
	289	6007.55		
	285	5913.12		
70	100	2074.78	1	p<0.0001**
	101	2095.52		
	100	2074.78		
80	84	1742.81	1	p<0.0001**
	84	1742.81		
	85	1763.56		
90	72	1492.84	1	p<0.0001**
	74	1535.33		
	74	1535.33		
100	68	1410.85	0.9318	p=0.2366(NS)
	70	1576.83		
	65	1348.6		

Table 2 shows the correlation between the number of blows and impact strength values where NFA is replaced with MS in varying percentages and 20 % cement is replaced with F.A. (Fly ash) with respect to first crack. It has been observed that, for 0 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 10 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 20 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 30 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 40 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 50% replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 60 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 70 % replacement of NFA by MS, correlation coefficient (r)=1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 80 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 90% replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 100 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.00010).

Table -2: Impact strength results with various percentage replacement of NFA by MS and replacing 20 % cement by F.A. (Fly ash) with respect to first crack.

% Replacement of Natural sand By Manufactured sand	No of blows	Impact Strength (N-m)	Correlation Coefficient (r)	P value
0	55	1141.12	1	p<0.0001**
	58	1203.37		
	58	1203.37		
10	74	1535.33	1	p<0.0001**
	74	1535.33		
	76	1576.83		
20	85	1763.56	1	P<0.0001**
	86	1784.31		
	88	1825.8		
30	150	3112.17	1	P<0.0001**
	154	3195.16		
	152	3153.66		
40	158	3278.15	1	P<0.0001**
	162	3361.14		
	163	3381.89		
50	188	3900.58	1	P<0.0001**
	192	3983.57		
	202	4191.05		
60	288	5975.36	1	p<0.0001**
	291	6037.61		
	287	5954.61		
70	101	2095.52	1	P<0.0001**
	103	2137.02		
	100	2074.78		
80	86	1784.31	1	p<0.0001**
	86	1784.31		

	87	1805.05		
90	74	1535.33	1	p<0.0001**
	76	1576.83		
	76	1576.83		
100	70	1452.34	1	P<0.0001**
	72	1493.84		
	67	1390.1		

Table 3 shows the correlation between the number of blows and impact strength values where NFA is replaced with MS in varying percentages and 20 % cement is replaced with S.F. (Silica fume) with respect to the first crack.

It has been observed that, for 0 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 10 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 20 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 30 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 40 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 50 % replacement of NFA by MS, correlation coefficient (r) = 1, there is perfect positive correlation which is statistically significant (p<0.0001). For 60 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 70 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 80 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 90 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 100 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001).

Table -3: Impact strength results with various percentage replacement of NFA by MS and with replacing 20 % cement by S.F. (Silica fume) with respect to first crack.

% Replacement of Natural sand by Manufactured sand	No of blows	Impact Strength (N-m)	Correlation Coefficient (r)	P value
0	61	1265.61	1	P<0.0001**
	64	1327.85		
	64	1327.85		
10	80	1659.82	1	P<0.0001**
	83	1722.06		
	83	1722.06		
20	91	1888.05	1	P<0.0001**
	90	1867.3		
	93	1929.54		
30	157	3257.4	1	P<0.0001**
	160	3319.64		
	158	3278.15		
40	164	3402.63	1	P<0.0001**
	168	3485.63		
	169	3506.37		
50	194	4025.07	1	P<0.0001**
	198	4108.06		
	200	4149.56		
60	294	6099.85	1	P<0.0001**
	297	6162.09		
	299	6203.59		
70	107	2220.01	1	p<0.0001**
	109	2261.51		
	108	2240.76		
80	90	1867.3	1	P<0.0001**
	89	1846.55		
	92	1908.79		
90	80	1659.82	1	P<0.0001**
	82	1701.32		
	82	1701.32		
100	76	1576.83	1	P<0.0001**
	78	1618.32		
	75	1556.08		

Table 4 shows the correlation between the number of blows and impact strength values where NFA is replaced with MS in varying percentages and 20 % cement is replaced with GGBFS concerning the first crack. It has been observed that, For 0 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p=0.0002). For 10 % replacement of

NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 20 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 30 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 40 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 50 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 60 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 70 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 80 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 90 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 100 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001).

Table -4: Impact strength results with various percentage replacement of NFA by MS and with replacing 20 % cement by GGBFS with respect to first crack.

% Replacement of Natural sand by Manufactured sand	No of blows	Impact strength(N-m)	Correlation Coefficient (r)	P value
0	57	1182.62	1	P=0.0002**
	59	1224.1		
	60	1244.86		
10	76	1576.83	1	P<0.0001**
	77	1597.58		
	78	1618.32		
20	87	1805.05	1	P<0.0001**
	88	1825.8		
	89	1846.55		
30	152	3153.66	1	P<0.0001**
	156	3236.65		
	154	3195.16		
40	160	3319.64	1	P<0.0001**
	164	3402.63		
	165	3423.38		
50	190	3942.08	1	P<0.0001**
	194	4025.07		
	196	4066.56		
60	290	6016.86	1	P<0.0001**
	294	6099.85		
	290	6016.86		
70	103	2137.02	1	P<0.0001**
	105	2178.51		
	102	2116.27		
80	88	1825.8	1	P<0.0001**
	87	1805.05		
	89	1846.55		
90	76	1576.83	1	P<0.0001**
	78	1618.32		
	79	1639.07		
100	72	1493.84	1	P<0.0001**
	74	1535.33		
	70	1452.34		

Table 5 shows the correlation between the number of blows and impact strength values where NFA is replaced with MS in varied percentages and 20 % cement is replaced with metakaolin with respect to the first crack. It has been observed that, for 0 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 10 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 20 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 30 % replacement of NFA by MS, correlation coefficient (r) =1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 40 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 50 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 60 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 70 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 80 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 90 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001). For 100 % replacement of NFA by MS, correlation coefficient (r) = 1, there is a perfect positive correlation which is statistically significant (p<0.0001).

Table -5: Impact strength results with various percentage replacement of NFA by MS and with replacing 20 % cement by metakaolin with respect to the first crack.

% Replacement of Natural sand by Manufactured sand	No of blows	Impact Strength (N-m)	Correlation Coefficient (r)	P value
0	60	1244.86	1	p<0.0001**
	61	1265.61		
	62	1286.36		
10	79	1639.07	1	p<0.0001**
	80	1659.82		
	80	1659.82		
20	90	1867.3	1	P<0.0001**
	89	1846.55		
	91	1888.05		
30	155	3215.9	1	P<0.0001**
	158	3278.15		
	156	3236.65		
40	162	3361.14	1	P<0.0001**
	166	3444.13		
	167	3464.88		
50	192	3983.57	1	P<0.0001**
	196	4066.56		
	198	4108.06		
60	292	6058.35	1	p<0.0001**
	296	6141.34		
	296	6141.34		
70	105	2178.51	1	P<0.0001**
	107	2220.01		
	106	2199.26		
80	89	1846.55	1	p<0.0001**
	88	1825.8		
	90	1867.3		
90	78	1618.32	1	P<0.0001**
	80	1659.82		
	80	1659.82		
100	74	1535.33	1	p<0.0001**
	76	1576.83		
	73	1514.58		

4. CONCLUSIONS

The investigational study done helps us to develop a relationship between the number of blows and impact strength of concrete with respect to the first crack in the specimens made with partial replacement of natural sand by manufactured sand and part of cement with different pozzolanic materials, which will be a helpful, reliable, systematic and time-saving approach in the coming future to test the impact strength of different concrete mixtures. This work is a systematic, helpful, reliable, time-saving approach for all those willing to work in this field and test for different concrete strengths. There exists a perfect positive correlation for almost all different concrete mix proportions. Still, it has been observed that, for each pozzolanic material used as 20 % replacement for cement, the highest impact strength is obtained at about 60 % replacement of N.S. by MS. This research work statistically proves that the strength and workability of the concrete is still maintained even when NFA is replaced by manufactured sand and part of cement is replaced by different pozzolanic materials.

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