

Performance of High-Strength Concrete Properties for Two Locally Available Aggregates: Partial Gradation Approaches

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Abstract

The aggregates in a concrete play a role in both strength and durability. Without a change of doubt, aggregates have a significant impact on mechanical, fresh and long-term performance properties of concrete. Low quality aggregates will give low behaviours that affect the condition of the concrete. In this investigation, improvement of local's aggregate - natural mount sand and uncrushed mount gravel taken from Lumajang, Pasuran and Bangkalan, used as the parameter study. This study is conducted to support the low characteristics aggregate in terms of water absorption, sorptivity and compressive strength concrete. Three mixes variables are used based on w/c content, 0.40, 0.35 and 0.30 reflected the concrete quality. On the other hand, concrete mixes with locally grading group are 80 % aggregate from Bangkalan and 20 % aggregate from Lumajang or Pasuruan + Bangkalan (M4 and M5). The results indicated that the M4 and M5 grading group concrete mix had the maximum compressive strength out of the eight different concrete mixes. This particular mixture also improves the water absorption and sorptivity of the concrete.

Keywords: Concrete, Combined grading aggregate, Low characteristic aggregate, Compressive strength, Water absorption, Sorptivity

Introduction

The aggregates, which make up between 70 and 90 percent of the volume of conventional concrete, are undoubtedly the most important components of conventional concrete [1]. To understand the condition of concrete both in fresh concrete and hardened concrete, physical and mechanical properties of each materials need to be studied. Those characteristics play a role in the aggregates' strength and durability of the concrete [2], fresh and long-term performance of the concrete [3]. As the matter of fact, concrete quality will result in high distribution of used aggregates; fine and coarse aggregate that meet requirements, their selection is very important in the mix design process [4,5]. All combined aggregate in the mixture of concrete need to be well-graded to achieve the desired workability because portion of fine and coarse aggregate relate to the high-water requirements due to their high specific surface area and inadequate amount aggregate sizes cause mixtures to become stiff and segregate [3,6].

Based on various studies, the concrete matrix plays a big role. The utilization of coarse particles is of the utmost importance in the production of concrete due to the robustness, durability, and strength they impart to the concrete [7,8]. The mechanical properties and functionality of concrete are also significantly influenced by the quality of the constituent elements, the quality of the constituent materials, and the mixtures. Both normal strength concrete and high strength concrete need to have a proper matrix classified by fine and coarse aggregate. However, for high strength concrete, it is essential that the constituent elements possess particular characteristics, such as w/c, portion of cementitious materials, low water content, grading design of coarse aggregate, forms and small portion of high range water reducer [9,10].

In addition, in normal-strength concrete, the role of coarse aggregate sizes in the development of strength is extremely minor compared to that of high-strength concrete [3,11]. Other features of coarse aggregates, such as their textures and shapes, may considerably contribute to the development of strength [12]. However, if the water to cement ratio of water to cement exceeds 0.40, the effect of aggregate forms, sizes, and textures on the material's workability and strength begins to diminish [4,13,14]. Compared to high-performance concrete with a smaller maximum aggregate size, high-performance concrete with a larger maximum aggregate size was found to have increased microcrack propagation when it is tested under flexural test. The variable of mixing proportions using different types of maximum aggregate size 10, 14 and 20 mm, respectively, significantly influence the fracture behavior. The larger size of the

aggregate, the more significant the deflection of propagating crack [4,15,]. Small sizes of coarse aggregates aid greatly in the development of compressive strength and reduce the water permeability of concrete, which aids in the development of greater compressive strength and durability of concrete [16]. Larger coarse aggregate sizes tend to make concrete appear nonhomogeneous and have a smaller surface area, both of which can contribute to the generation of weaker bonding forces, both of which contribute to the development of lower strengths [2]. This aspect of limited to concrete strength below 30 MPa without additional additive on the mixtures [17,18].

The optimization of aggregate gradation is both economically and technically advantageous. Using two distinct segments of aggregate (i.e., fine aggregates and coarse aggregates) and complete aggregate gradation, also known as combined aggregate gradation, are two of the most popular and well-known ways of aggregate gradation. These approaches involve the use of two sizes of aggregate. There has been an increase in interest in the latter method in recent years. Utilizing a combined fineness modulus is the method of combined aggregate grading that has garnered the most traction among the available options [4,19]. This technique dominantly implied to enhance the concrete strength especially when the additional material in the concrete matrix is not able to achieve.

This research conforms to the actual circumstances in East Java, where the majority of aggregate is dispersed from Pasuruan and Lumajang. Due to their excellent physical and mechanical characteristics for both fine and coarse aggregates, these two common aggregates are predominantly used in construction. This circumstance is problematic in Bangkalan, Madura Island, where the locally accessible aggregates are abundant but not uniformly dispersed as concrete components. High cost due to the transportation also the reason to develop the study into the improvement of concrete matrices using locally available fine and coarse aggregate in Bangkalan [4,14,20]. However, reasons for not specifying this aggregate include its low specific gravity, high clay content, and high-water absorption and sorptivity, all of which contribute to the concrete's strength and longevity. The proper evaluation of physical and mechanical properties including their matrices need to be conducted to produce more efficient alternative using local materials. Input evaluation in the beginning of study under combined grading approach is required.

This study focuses on combining Bangkalan's aggregate with Pasuruan's and Lumajang's aggregate with the concentration under the compressive strength and workability of concrete with varied aggregate gradations. Five distinct aggregate gradation methods were selected for comparison in this study as the result of proposed alternative combine grading using in the concrete matrix. The aims of this study were to compare various aggregate gradation methods and based on this comparison, to identify the ideal aggregate gradation for concrete, which will assist in determining the use of locally accessible aggregate. In addition, variety design of compressive strength concrete, which is dominated by 35, 45, and 60 MPa, was introduced as a parameter study.

Partial gradation approach

According to Shetty [21], the coarse aggregates that have a rough texture or surface provide superior strength than the coarse aggregates that have smooth surfaces because the bonding of the rough edges is more effective. When compared to angular and cubical shaped coarse aggregates, it is well knowledge that rounded shaped coarse aggregates produce a weaker interlock at the interface of cement paste and coarse aggregate phase. This is the case in both laboratory and field settings. Rock hardness, particle size, the porosity of the aggregate, the crushing method, and past exposure all play a significant role in determining the textures and shapes of aggregates. These attributes not only have an effect on the growth of the material's strength, but they also have an effect on its workability, economy, pumpability, and paste demand [21]. For the purpose of developing strength, angular aggregates are more preferable to rounded aggregate for one or both of the following reasons: angular aggregates provide a better interlocking effect in concrete, and angular aggregate show better bond [22,23]. Rounded aggregates have a smoother surface area, which makes them less effective at interlocking. When it comes to high-strength and high-performance concrete, the shapes, textures, and sizes of the aggregates become increasingly significant characteristics for the concrete's strength, durability, and low water permeability [24].

It is common knowledge at this point that the gradation of the aggregate has a significant role in both the fresh and the hardened properties of concrete. An aggregate gradation that has been optimized can result in a large reduction in the amount of cement used, which is the most important component of concrete. In the record of concrete and aggregate history, there are various different aggregate gradation methods extant. These methods were used to produce the optimal gradation. However, there was never any attempt made to evaluate different gradation methods against one another in the interest of improving the qualities of the concrete. In addition, it is possible that carrying out experiments in a laboratory is the most appropriate

course of action to take in order to investigate the impact that aggregate gradation has on concrete. As a result, here a number of trial concrete mixes with various aggregate gradations were created in order to acquire a relatively superior aggregate gradation method in accordance with the prerequisites of concrete qualities, primarily compressive strength and workability [24].

Current aggregate gradation practice is to compute the quantity of coarse aggregate by weight of the materials or volume fraction of each material. This illustration method can be seen in **Figure 1** under typical grading conditions both of fine and coarse aggregate. Therefore, w/c content is found to be the most considerable parameter that provides the workability, permeability and strength of the concrete. It may be improved by the addition of supplementary cementitious materials, high water reducing agents or using combined concept of aggregate gradation system [25,26].

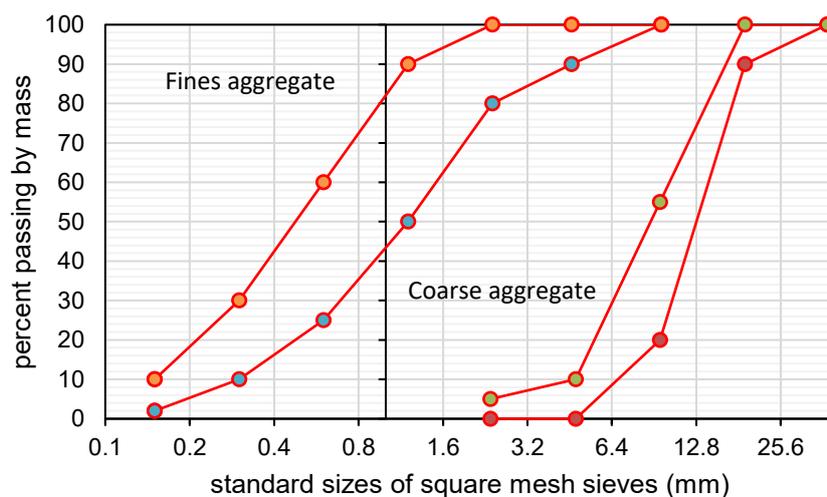


Figure 1 Typical grading chart. Red lines indicated limit specified in ASTM C33 for fine aggregate and for 25.0 mm coarse aggregate [27].

This method is heavily criticized because when fine and coarse aggregates are mixed, the entire aggregate may be gap graded due to a lack of intermediate particles [28]. **Figure 1** illustrates the fine and coarse aggregate limits in accordance with ACI E1-07 [29]. Mixing 20 mm and 10 mm single-sized aggregate in 1:2 ratio defines coarse aggregate limit. ACI E1-07 mix design approach uses fines modulus, w/c ratio, maximum aggregate size, and needed slump to determine fine/coarse aggregate mixing ratio (60 to 180 mm). This graph shows that the proportion of intermediate particles (0.6 to 2.36 mm) is low (46 %). BS 822 mix design is similar.

Materials and methodology

Materials

For this investigation, the following aggregate types were used: coarse aggregates (such as crushed gravel), fine aggregates, ordinary Portland cement, and fine aggregates (sharp sand). Locally occurring pit-run gravel was used to obtain crushed gravel in Lumajang and Pasuruan. Considering the aggregate quality, this type of aggregate is utilized extensively in the construction industry in East Java. Due to the low quality of Bangkalan's aggregate, partial replacement is possible with the help of the city's abundance of unused material. This investigation is based on previous studies which used variable materials of Bangkalan aggregate. The result shows that Bangkalan aggregate needs to partially be added with high characteristic aggregate to give a proper distribution of quality [14]. To identify the difference, physical and mechanical properties of materials can be seen on **Tables 1** and **2**.

Although the investigation did not directly assess the effectiveness of all variety of mixtures distribution of Bangkalan aggregate from 10 to 90 % from the beginning, investigation proposed by Pertiwi provide some recommendations to maximize the potential using of locally available materials by Lumajang aggregate less than 30 % [20]. The partially aggregate can enhance the concrete strength to 30 % performance compared to the concrete without replacement [4,14,20]. In this study lesser portion is used to

support the massive use of locally available materials, Bangkalan aggregate. 1/5 presentation is accommodated into the concrete mixes in all variations between Bangkalan, Lumajang and Pasuruan aggregate. The key point to provide a combined aggregate is grading parameter, which is fully investigated in accordance with the ASTM C33. Another research proposed by another researchers, also illustrating, in order to achieve optimal gradation of low aggregate, the portion of fine and coarse aggregate must be regulated [3,30].

Before grading, visual inspection revealed that the majority of aggregates from Lumajang have a smooth surface, are granular in shape, and are dark brown in color, whereas aggregates from Pasuruan have a greyish hue, a texture that is close to being rough, and are irregular in shape. The Bangkalan aggregate looks to be deeper in color, rougher in texture, and more angular than the other two. All items were cleaned to eliminate clay and other contaminants. The aggregate was then left outdoors for several days before being sieved under the condition of a saturated, dry surface.

Table 1 Physical, mechanical properties and chemical compound of ordinary Portland cement.

Specific gravity 3.15			Initial setting times 120 mins			Final setting times 260 mins			Compressive strength 45 MPa			
CaO	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	SO ₃	K ₂ O	Na ₂ O	Pb ₂ O ₅	TiO ₂	MnO	Cl	LOI
62.76	19.72	6.35	2.07	1.98	2.52	1.53	0.2	0.13	0.12	0.04	0.13	2.45

Table 2 Physical properties of aggregates.

Aggregate type	Specific gravity	Water absorption %	Fines modulus	Maximum size (mm)
Lumajang	3.05	0.31	4.1	20
Pasuruan	2.72	0.98	3.9	20
Bangkalan	2.65	1.8	4.3	20
Fine aggregate*	2.48	5.42	2.3	4.75

*Aggregate taken from Bangkalan

Table 3 Concrete mixture ingredients (concrete type 1).

Mixture type	Cement (kg/m ³)	Fine aggregate			Coarse aggregate			w/c
		Lumajang (kg/m ³)	Pasuruan (kg/m ³)	Bangkalan (kg/m ³)	Lumajang (kg/m ³)	Pasuruan (kg/m ³)	Bangkalan (kg/m ³)	
M1-1	410.76	-	-	523.79	1305.44	-	-	0.40
M1-2	410.76	-	-	523.79	-	1305.44	-	0.40
M1-3	410.76	-	-	523.79	-	-	1305.44	0.40
M1-4	410.76	-	-	523.79	-	254.56	1044.35	0.40
M1-5	410.76	-	-	523.79	254.56	-	1044.35	0.40
M1-6	410.76	523.79	-	-	-	-	1305.44	0.40
M1-7	410.76	-	523.79	-	-	-	1305.44	0.40
M1-8	410.76	-	-	523.79	-	-	1305.44	0.40
M1-9	410.76	104.758	-	419.032	-	-	1305.44	0.40
M1-10	410.76	-	104.758	419.032	-	-	1305.44	0.40

Table 4 Concrete mixture ingredients (concrete type 2).

Mixture type	Cement (kg/m ³)	Fine aggregate			Coarse aggregate			w/c
		Lumajang (kg/m ³)	Pasuruan (kg/m ³)	Bangkalan (kg/m ³)	Lumajang (kg/m ³)	Pasuruan (kg/m ³)	Bangkalan (kg/m ³)	
M2-1	512.22	-	-	495.08	1254.84	-	-	0.35
M2-2	512.22	-	-	495.08	-	1254.84	-	0.35
M2-3	512.22	-	-	495.08	-	-	1254.84	0.35
M2-4	512.22	-	-	495.08	-	244.69	1010.15	0.35
M2-5	512.22	-	-	495.08	244.69	-	1010.15	0.35
M2-6	512.22	495.08	-	-	-	-	1254.84	0.35
M2-7	512.22	-	495.08	-	-	-	1254.84	0.35
M2-8	512.22	-	-	495.08	-	-	1254.84	0.35
M2-9	512.22	99.016	-	396.064	-	-	1254.84	0.35
M2-10	512.22	-	99.016	396.064	-	-	1254.84	0.35

Tables 3 - 5 give the concrete mixing proportions for various concrete types. These concrete mixtures also illustrate the range of water-to-cement ratios (w/c) for the suggested aggregate grade. w/c determined taking into account normal consistency with the ratio in line with SNI 7656-2012 [31] under the condition of 0.3 to 0.4. This concrete type is related to the concrete strength ratio, in order from 35, 45 and 60 MPa. Based on previous investigation when using no replacement of Bangkalan aggregate, the design concrete strength is not acceptable. Since higher compressive strength is required in this study, the use of high range water reducer is necessary. Sustainability is also specified by defining minimum cement content relate to maximum free w/c [32,33]. For each concrete type polycarboxylate is added at a maximum of 1 % of the total cement weight in order to meet workability requirements. No additional supplementary cementitious are used in this study to determine the normal distribution concrete strength quality [14,34-36].

Integrated materials and construction practice for concrete varied from high strength concrete also considered in this design matrices as the process of determining required and specifiable properties of a concrete mixture, in particular using combined local aggregate. This variable M1 to M10 for each concrete type illustrates based on gradation and surface textured of aggregate.

Table 5 Concrete mixture ingredients (concrete type 3).

Mixture type	Cement (kg/m ³)	Fine aggregate			Coarse aggregate			w/c
		Lumajang (kg/m ³)	Pasuruan (kg/m ³)	Bangkalan (kg/m ³)	Lumajang (kg/m ³)	Pasuruan (kg/m ³)	Bangkalan (kg/m ³)	
M3-1	572.67	-	-	465.69	1194.67	-	-	0.30
M3-2	572.67	-	-	465.69	-	1194.67	-	0.30
M3-3	572.67	-	-	465.69	-	-	1194.67	0.30
M3-4	572.67	-	-	465.69	-	232.96	961.71	0.30
M3-5	572.67	-	-	465.69	232.96	-	961.71	0.30
M3-6	572.67	465.69	-	-	-	-	1194.67	0.30
M3-7	572.67	-	465.69	-	-	-	1194.67	0.30
M3-8	572.67	-	-	465.69	-	-	1194.67	0.30
M3-9	572.67	93.138	-	372.552	-	-	1194.67	0.30
M3-10	572.67	-	93.138	372.552	-	-	1194.67	0.30

Laboratory investigation

Sieve analysis

In this stage, fine and coarse aggregate are retained on the standard sieve shaker motor operated by electricity power. The aggregate then allocated by the contains size differently in suitable proportions when it is proposed by the design in accordance with **Tables 3 - 5**. One of the reasons to support this particular step is to make sure that the compactness of the mixtures. Well-graded aggregate eventually increases the workability. Increasing fine aggregate content increases workability but an excessive amount can cause mixtures to become sticky. Spherical, smooth surfaced aggregates will increase workability whereas angular, rough surfaced aggregates will decrease workability [37-39]. While single size aggregate makes the concrete harsh and does not work well with trowel and between the reinforcement or sheathing. The fines aggregate is defined by its nominal size i.e., 9.5, 4.76, 2.36, 1.19, 0.6, 0.3 and 0.15 mm. For example, a graded aggregate of nominal size 4.76 mm means an aggregate most of which passes the 4.76 mm IS sieve.

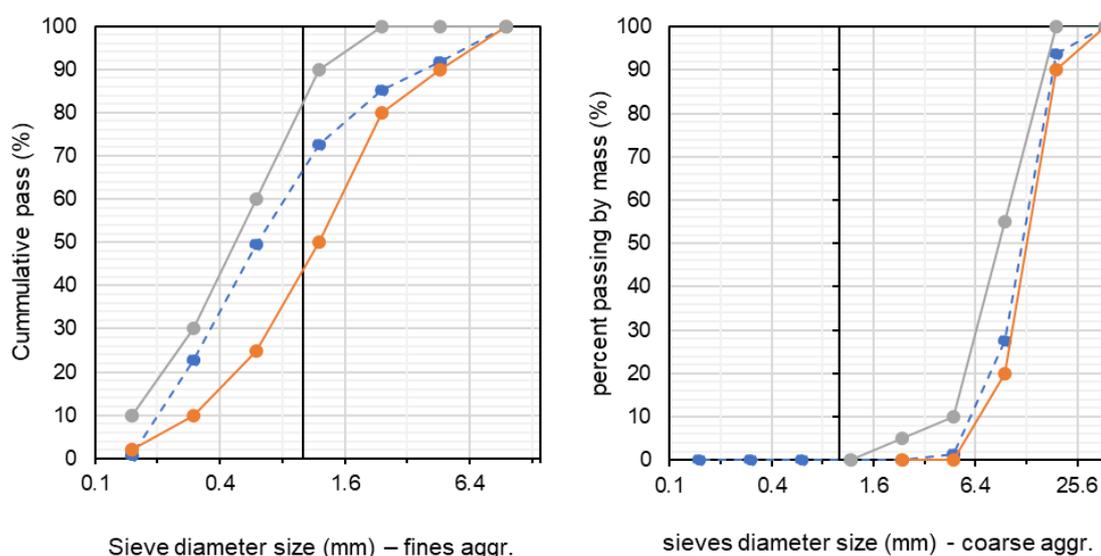


Figure 2 Cumulative grading aggregate - fines and coarse aggregate under mixture proportions.

Coarse aggregate is defined by its nominal size as 25, 19, 9.5, 4.75 and 2.36 mm. For this aggregate, because the aggregate is formed due to natural disintegration of rocks, they derive many of the properties such as chemical and mineral composition including pores and its structure. This is normally followed by high water absorption. In general, may consider the given effect on the quality in fresh and hardened states.

Compressive test and water absorption

The required specimens were subjected to a compression test in accordance with ASTM C39 [40]. The sample cylinder is designed to fit a 150 mm × 300 mm iron or non-absorbent material cylinder mold. This involved preventing fresh concrete from leaking. Before pouring the concrete mixture into this mold, the inner surface of the cylinder must be treated with an oil that facilitates the removal of hardened concrete. all illustrated step to maintain the specimen illustrated in **Figure 3**. Each layer of the mixed concrete is crushed to minimize air pockets. The specimens are kept undisturbed for 24 hours in a location with at least 90 % relative humidity and a temperature of 25 ± 2 °C. The samples are then submerged in clean, fresh water until the testing age is attained. For a reliable indication of the results, at least three test specimens per variation must be analyzed. The diameter of the cast cylinder must be measured in at least two sites perpendicular to each other at its mid-height, and then the cross-sectional area must be determined by averaging this value. If the measured diameter variance exceeds 2 %, the cylinder must not be tested. To get the compressive strength of a concrete cylinder, divide the maximum load by the cross-sectional area.

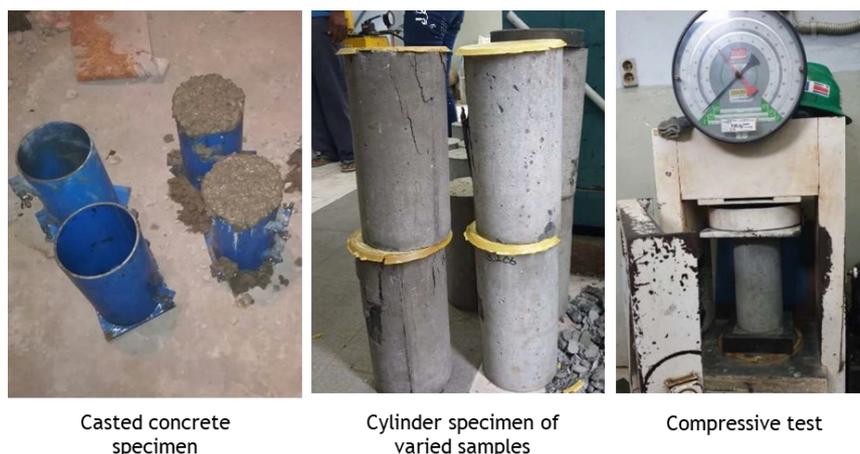


Figure 3 Concrete specimen; casting, specimen preparation and testing scheme

The water absorption test measures the water absorption rate (sorptivity) of both the exterior and interior surfaces of concrete. The test measures the increase in mass of concrete samples due to water absorption as a function of time when only one side of the specimen is exposed to water. The water absorption test was carried out in accordance with ASTM C642 [41] as a general means to obtain the percentage of absorption and voids in hardened concrete. In this test, specimen of concrete cylinders was sliced into three equal parts (150 mm / 3 parts, ± 50 mm thick); each of sliced parts weighed for mass measurement. All specimens with a variety of concrete mixtures under grading parameter were dried inside the oven at temperature of 100 ± 10 °C for at least 24 hours. This condition determines the oven-dry mass of the specimen. After being taken out from the oven, the measurement is taken place under the room temperature. This weight is recorded as the initial mass. Upon this procedure, the specimen was positioned under box container and immersed in the water at approximately 20 ± 2 °C for 174 hours until two successive values of mass at intervals of 24 hours.

This test is to determine the moisture content of concrete as a percentage of its dry weight. The sliced concrete is weighed, dried in an oven, then reweighed, which is equal to weight of the container with wet sliced concrete minus weight of the container with dry sliced concrete, divided by weight of the container with dry sliced concrete minus the weight of the container, then multiplied by 100 to express its percentage. This condition is necessary when the aggregate has different types, shape, surface and sizes.

Results and discussions

After clarifying the grading parameter in accordance with **Figure 2**; relationship between proportion of fines and coarse aggregate, are evaluated. With reference to **Figure 4**, it is apparent that, in general, partially graded aggregate improved the compressive strength of the concrete. It is approved by the variation of fines and coarse aggregate 80 + 20 % (Bangkalan and Pasuruan / Lumajang). This type of variations highlighted as the type of MT4 and MT5 for coarse aggregate and MT8 and MT9 for fines aggregate. When it comes to the comparison of the concrete type with different of w/c, the same behaviour also informed. It is exhibited that local aggregate with low characteristic can be improved with any other materials with having high quality of aggregate. The difference may vary in accordance with the aggregate conditions. MT1 and MT2 illustrate non used local coarse aggregate, where MT6 and MT7 illustrate non used local fines aggregate. It is also compared with the linear distribution the slump flow vs compressive strength in each mixture, can be seen in **Figure 5**, to determine the probability and workability based on concrete quality.

With regard to **Figure 6**, it is evident that the percentage of water absorption of the concrete is under variation of grading with concrete type quality. The higher the concrete type of quality the lower cumulative water absorption is informed. It is presented that the water absorption of the concrete with high percentage of Bangkalan aggregate illustrating higher capillary suction of the water. It is also evident that in the percentage **Tables 6 - 8** illustrating in each cycle of times.

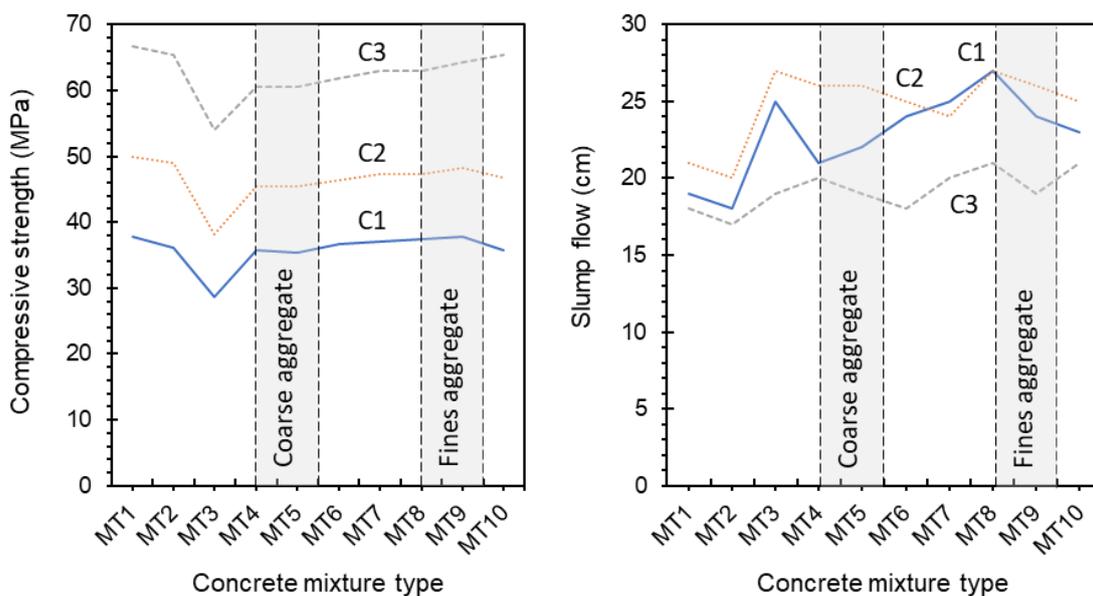


Figure 4 Compressive strength characteristics.

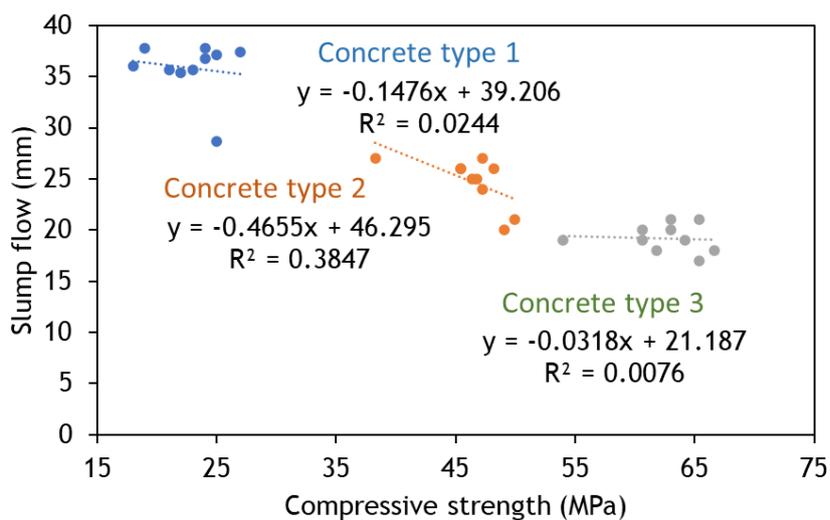


Figure 5 Compressive strength vs slump flow under linear model distribution.

Table 6 Water absorption under varied amount of time (concrete type 1).

Time (minutes)	Mass (gram)									
	MT1	MT2	MT3	MT4	MT5	MT6	MT7	MT8	MT9	MT10
1	9.3	9.5	11.8	10.4	10.6	10.8	11.2	11.1	11.7	11.6
5	17.8	18.2	22.6	19.9	20.3	20.7	21.5	21.3	22.3	22.1
10	22.6	23.0	28.7	25.2	25.7	26.2	27.2	26.9	28.3	28.0
20	27.9	28.4	35.4	31.1	31.8	32.4	33.6	33.3	35.0	34.6
30	31.5	32.1	40.0	35.2	35.9	36.6	38.0	37.6	39.5	39.1
60	37.7	38.5	47.9	42.2	43.0	43.8	45.5	45.0	47.3	46.9
120	44.5	45.4	56.5	49.7	50.7	51.7	53.6	53.1	55.8	55.3
180	48.8	49.7	61.9	54.5	55.6	56.7	58.8	58.2	61.2	60.6
240	52.1	53.2	66.2	58.3	59.4	60.6	62.9	62.3	65.4	64.8

Time (minutes)	Mass (gram)									
	MT1	MT2	MT3	MT4	MT5	MT6	MT7	MT8	MT9	MT10
300	55.2	56.3	70.1	61.6	62.9	64.1	66.6	65.9	69.2	68.5
360	57.3	58.5	72.8	64.1	65.4	66.6	69.2	68.5	71.9	71.2
1800	79.5	81.1	101.0	88.9	90.6	92.4	95.9	95.0	99.8	98.8
3240	84.3	86.0	107.0	94.2	96.1	97.9	101.7	100.7	105.7	104.7
4680	87.0	88.7	110.4	97.2	99.1	101.1	104.9	103.9	109.1	108.1
6120	91.7	93.5	116.4	102.4	104.5	106.5	110.6	109.5	115.0	113.9
7560	93.3	95.1	118.5	104.2	106.3	108.4	112.5	111.4	117.0	115.9
9000	93.3	95.1	118.5	104.2	106.3	108.4	112.5	111.4	117.0	115.9
10440	93.3	95.1	118.5	104.2	106.3	108.4	112.5	111.4	117.0	115.9

Table 7 Water absorption under varied amount of time (concrete type 2).

Time (minutes)	Mass (gram)									
	MT1	MT2	MT3	MT4	MT5	MT6	MT7	MT8	MT9	MT10
1	8.0	8.1	10.1	8.9	9.1	9.3	9.6	9.5	10.0	9.9
5	15.3	15.6	19.4	17.1	17.4	17.7	18.4	18.2	19.2	19.0
10	19.3	19.7	24.6	21.6	22.0	22.5	23.3	23.1	24.3	24.0
20	23.9	24.4	30.3	26.7	27.2	27.8	28.8	28.5	30.0	29.7
30	27.0	27.5	34.3	30.2	30.8	31.4	32.6	32.2	33.9	33.6
60	32.3	33.0	41.1	36.1	36.9	37.6	39.0	38.6	40.6	40.2
120	38.1	38.9	48.4	42.6	43.4	44.3	46.0	45.5	47.8	47.4
180	41.8	42.6	53.1	46.7	47.6	48.6	50.4	49.9	52.4	51.9
240	44.7	45.6	56.8	50.0	50.9	51.9	53.9	53.4	56.1	55.5
300	47.3	48.2	60.0	52.8	53.9	55.0	57.0	56.5	59.3	58.8
360	49.1	50.1	62.4	54.9	56.0	57.1	59.3	58.7	61.7	61.1
1800	68.2	69.5	86.6	76.2	77.7	79.2	82.2	81.4	85.5	84.7
3240	72.2	73.7	91.7	80.7	82.3	84.0	87.1	86.3	90.6	89.8
4680	74.5	76.0	94.7	83.3	85.0	86.6	89.9	89.0	93.5	92.6
6120	78.6	80.1	99.8	87.8	89.6	91.3	94.8	93.8	98.6	97.6
7560	79.9	81.5	101.5	89.3	91.1	92.9	96.5	95.5	100.3	99.3
9000	79.9	81.5	101.5	89.3	91.1	92.9	96.5	95.5	100.3	99.3
10440	79.9	81.5	101.5	89.3	91.1	92.9	96.5	95.5	100.3	99.3

Table 8 Water absorption under varied amount of time (concrete type 3).

Time (minutes)	Mass (gram)									
	MT1	MT2	MT3	MT4	MT5	MT6	MT7	MT8	MT9	MT10
1	6.6	6.8	8.4	7.4	7.6	7.7	8.0	7.9	8.3	8.3
5	12.7	13.0	16.2	14.2	14.5	14.8	15.3	15.2	16.0	15.8
10	16.1	16.4	20.5	18.0	18.4	18.7	19.4	19.2	20.2	20.0
20	19.9	20.3	25.3	22.2	22.7	23.1	24.0	23.8	25.0	24.7
30	22.5	23.0	28.6	25.1	25.6	26.2	27.1	26.9	28.2	28.0
60	26.9	27.5	34.2	30.1	30.7	31.3	32.5	32.2	33.8	33.5
120	31.8	32.4	40.3	35.5	36.2	36.9	38.3	37.9	39.9	39.5
180	34.8	35.5	44.2	38.9	39.7	40.5	42.0	41.6	43.7	43.3
240	37.2	38.0	47.3	41.6	42.5	43.3	44.9	44.5	46.7	46.3
300	39.4	40.2	50.0	44.0	44.9	45.8	47.5	47.1	49.4	49.0
360	41.0	41.8	52.0	45.8	46.7	47.6	49.4	48.9	51.4	50.9

Time (minutes)	Mass (gram)									
	MT1	MT2	MT3	MT4	MT5	MT6	MT7	MT8	MT9	MT10
1800	56.8	57.9	72.1	63.5	64.7	66.0	68.5	67.8	71.3	70.6
3240	60.2	61.4	76.4	67.3	68.6	70.0	72.6	71.9	75.5	74.8
4680	62.1	63.4	78.9	69.4	70.8	72.2	74.9	74.2	77.9	77.2
6120	65.5	66.8	83.2	73.2	74.6	76.1	79.0	78.2	82.2	81.4
7560	66.6	68.0	84.6	74.5	75.9	77.4	80.4	79.6	83.6	82.8
9000	66.6	68.0	84.6	74.5	75.9	77.4	80.4	79.6	83.6	82.8
10440	66.6	68.0	84.6	74.5	75.9	77.4	80.4	79.6	83.6	82.8

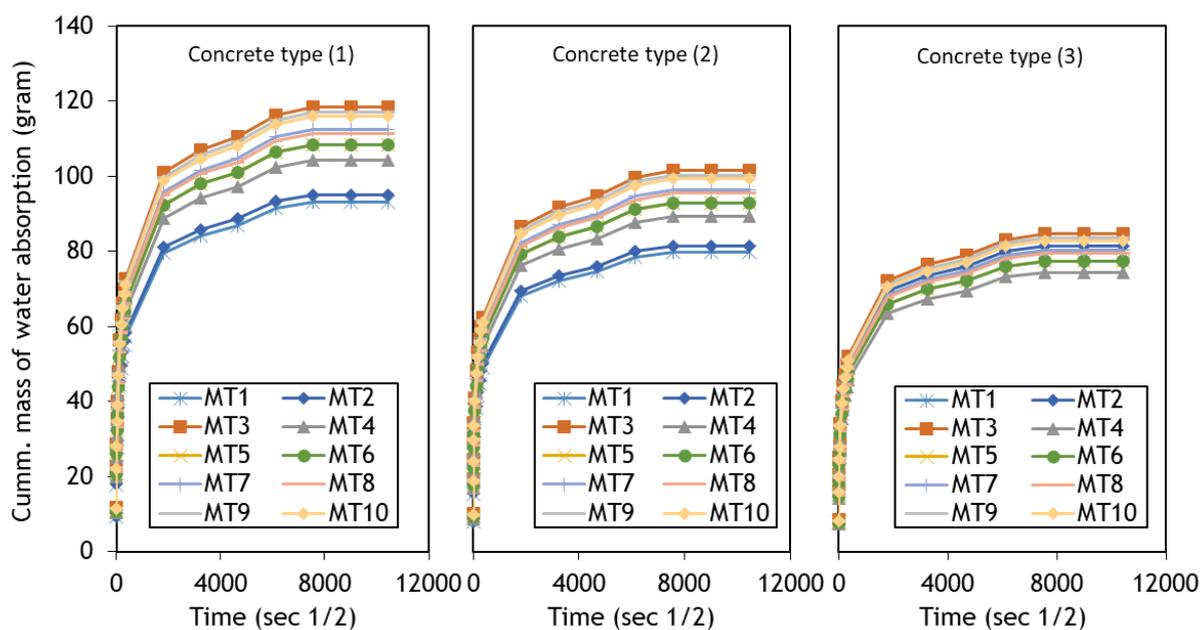


Figure 6 Cumulative water absorption vs variation of grading with different types of concrete strength.

Conclusions

The result of experimental investigation dealing with the partial grading approach of two different aggregate. Presented to address the influence of compressive strength and water absorption on three different concrete type quality that majorly used in the construction in Madura area. Systematic tests on these parameters were thoroughly investigated under variety of mixture proportions following the procedure and recommendation to partially add different aggregate quality. The results experimental program shows that the partial concrete aggregate can improve the behavior of the concrete. This also considers improving its behavior considering sieve analysis and water absorption. From the investigation with it can be highlighted that the compressive strength in each concrete variety can improve in about 30 percent to 35 % closely. It can offer an alternative for making high quality concrete by adding small amounts of high-quality aggregate. In fact, it needs the support of HRWR to provide workability. The condition of the aggregate before grading needs under the condition saturated surfaced dry to make sure the w/c of the mixture in the correct manner, since when the quality of the concrete is higher the portion of water relatively low. This approach also identified based on the evaluation of water absorption of each variety concrete mixture. Where the higher water absorption is illustrated in the concrete type 1, which has lower concrete quality. Following the mixture characteristics, MT3 where both of fines and coarse aggregate using locals aggregate, presents to have higher water absorption. As a result, it has lower compressive strength.

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