Paper ID: 132

Effect of Various Combination of Aggregates from Different Sources on Properties of Concrete

Ahmad Raza Khokhar*[1], Faiza Khalid[2], Khawar Ali[3] and Muhammad Farjad Sami[4]

1*. Ahmad Raza Khokhar, Student, Abasyn University Islamabad Campus
Email: ahmad.auic@gmail.com
2. Faiza Khalid, Lecturer, Abasyn University Islamabad Campus
Email: faizakhalid_1707@yahoo.com
3. Khawar Ali, Lab Engineer, Abasyn University Islamabad Campus
Email: khawar.ali187@gmail.com
4. Muhammad Farjad Sami , Lecturer, Abasyn University Islamabad Campus
Email: farjadsami@gmail.com

Abstract

Concrete is a fundamental constitute of construction industry across the globe. The bulk of concrete is made up of aggregates, hence structural behaviour of concrete significantly relies on the quality and properties of aggregates. This paper presents best combination of fine and coarse aggregates that yields the maximum compressive and tensile strength. A research is carried out on coarse and fine aggregates from different sources in Pakistan. Primary laboratory analysis was conducted to establish the suitability of the aggregates from various sources in construction work. Tests conducted include sieve analysis, bulk density, and specific gravity. Nominal mix (1:2:4) was adopted for this work and mix compositions were calculated by absolute volume method were cast to compute the compressive strength to be monitored at 28 days. Test result show that concrete made from has the highest workability followed by and crushed granite aggregates. Experiments were conducted on eighteen different combinations concrete and a constant W/C ratio of 0.59 for each batch sample. Highest compressive strength at all ages was noted with concrete made from Margallah crush with blend of 50% Lawrencepur sand and 50% Kashmore sand. Also, the combination of Haripur crush with Kashmore sand yields second best value. A common practice is to mix Chenab sand with Lawrencepur sand to attain good strength and workability.

Keywords: Concrete, Aggregate, Potential Sources in Pakistan, Strength.

1. INTRODUCTION:

Concrete is composed of the combination of cement, coarse aggregate, fine aggregates and water. It can be said that concrete is a combination of a material that consists of a binding medium which are embedded particles of aggregates (Li, 2011). Moreover, it is most economical construction material, good in compression, durable and good fire resistance, environment friendly and the maintenance of concrete is also easy to conduct. Pakistan is a developing country and there are lots of construction projects currently running in different areas so there is a huge demand of coarse and fine aggregates for those projects. Research has been carried out on chemical and

mechanical properties of aggregates available in the country. At the start, bio-materials like leaves, branches and so on were utilized, which later on changed to more tough materials like mud, stone and timber (Khitab et al. 2015). The most extensively used coarse aggregate source in most of the Pakistan is Margallah Hill Limestone, most of the quarrying activity is observed in the Margallah hill source located at Hassan-Abdal and Taxila regions of Punjab. The Sakesar limestone of Salt Range is also feeding most of the southern Punjab and vicinity. There are a lot of construction material sources situated in Azad Jammu and Kashmir. Khurshidabad Dist. Haveli and Bakot area near Kohala has millions of tons of limestone (Afzal, 2017). Takial and Khairabad in KPK has huge resources of coarse aggregates similarly Khairpur Mir's, Sind has vast potential of coarse aggregates which are used for local construction needs. The sand from Lawrencepur is one of the best sand available to be used for construction works. Other sand types are also used in construction works in their relevant areas (Ghaffar et al., 2016). Margallah aggregates resulted in better concrete mechanical properties, while Sargodha aggregates showed improved physical characteristics (Abbas, et al., 2017). Bara River, Basai, LoyeKhawar and Zangali/JaniKhawar can be safely used in structure concrete works. Out of these four sources, Basai is found as the best source for coarse aggregates (Ayub, et al., 2012). The Chattan Shah Quarry aggregates showed the higher specific gravity compared to all other aggregates, therefore higher compressive strength (38.2 MPa) was achieved as expected (Aslam et. al, 2015).
Despite of the availability of number of researches on the utilization of coarse aggregates of different sites/areas, the most suitable and economical combination of coarse aggregates of different quarrying sites is still not envaulted. This research work will be helpful in finding the optimum combination of coarse aggregates of different sites.

2. MATERIALS AND METHODOLOGY

2.1 Materials

Material testing is the process to determine the engineering properties and the characteristics of material. Aggregate play important role in the strength of concrete so their properties really matter a lot. Therefore, it is necessary to test them in the lab for determining their shape, size, gradation, fineness modulus, specific gravity and the water absorption. This article describes the procedure as well as the mix proportion of the materials used in the research work. The section also elaborates the material properties of concrete mix. Ordinary Portland Cement (OPC), provided from Fauji Cement Company according to the requirements of ASTM C-150 was used. The following Table lists both chemical and physical properties of OPC.

Table 7:Chemical Composition and Physical Characteristics of OPC

Constituent (wt. %)	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3^{--}	Cl^-	Na_2O	K_2O	L.O..I	Total
Mass (%)	21.26	4.49	3.49	63.81	2.02	3.11	0.03	0.14	0.09	1.57	99.98

Physical Characteristi	Specific gravity	Consistency	Blaine's specific surface	Initial setting time	Final setting

cs			(cm^2/kg)	(min)	time (min)
Values	3.15	24%	2415	27	134

2.2 Sieve Analysis Test

Sieve analysis id widely used test in civil engineering for finding the gradation of aggregates to check whether they can be capable to be used in concrete or not. The sieve analysis of fine aggregates was performed as per ASTM C 136 and the gradation results are shown in the figure 1.

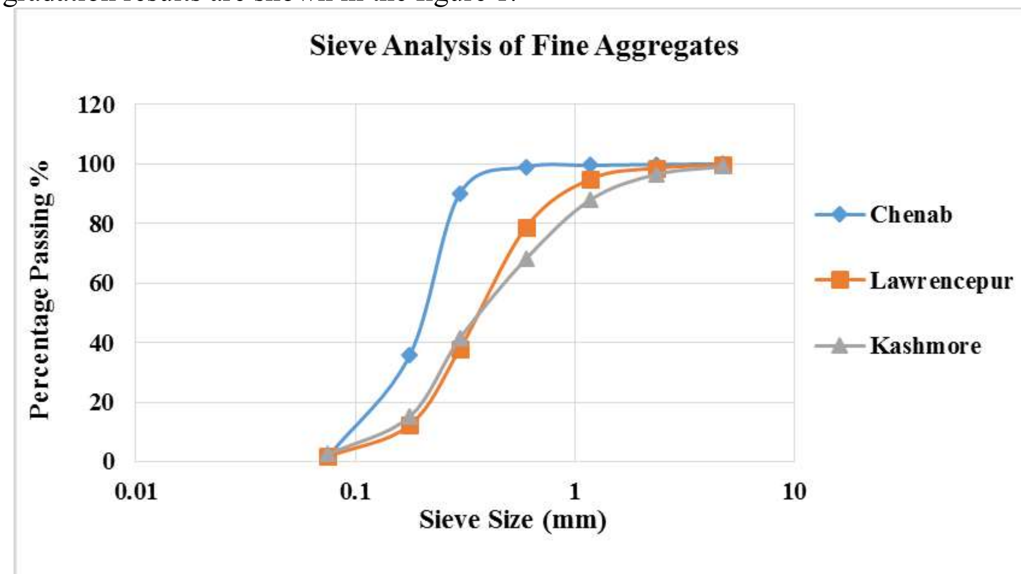

Figure 9: Gradation of Fine Aggregates from various sources

The graph shows that the Chenab sand is gap graded and has a large number of fine particles lesser than size of 0.17mm. Also the fineness modulus of this sand is obtained as 1.74 which shows that the average size of particles is in between sieve 200 and 100. This sand is not best for use in concrete due to very fine particles but can be used with mixing some coarse grained quantity of fine aggregate. A good cement sand mortar can be made using this sand. The Lawrencepur sand is obtained as coarser sand with almost 40% particles retained on sieve 80. Also the fineness modulus is 2.76 which tells its good capability to be used in concrete for better results. The Kashmore sand is well graded sand with having particles of all sizes due to which it can make very good bonding with coarse aggregate when used in concrete. The fineness modulus of this sand is obtained as 2.89 so this is very suitable for high strength concrete. The sieve analysis of coarse aggregates was performed and the gradation is shown in the figure 2.

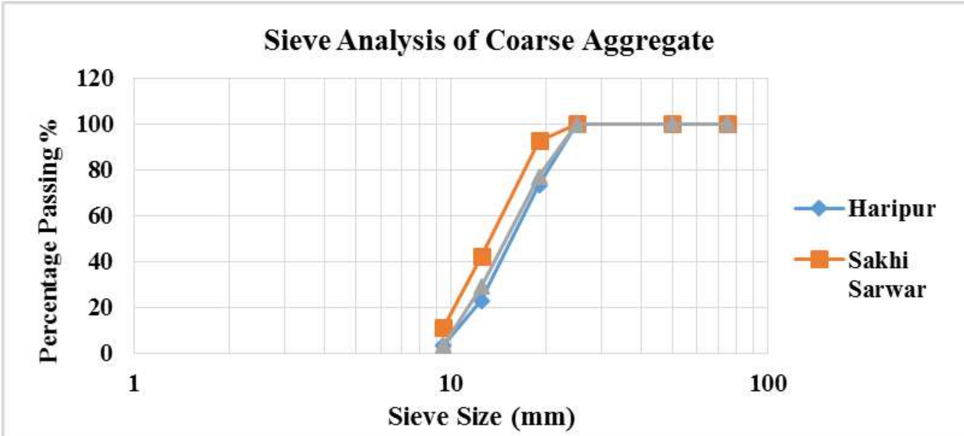

Figure 10: Gradation of Coarse Aggregates from different sources

The sieve analysis of Haripur and Margallah crush has almost the same gradation with well graded nature. Sakhi-Sarwar aggregate also has well gradation.

2.3 Water Absorption, And Specific Gravity Test

Specific gravity (G_s) is the ratio of density of a material to the density of water. This test is used to find out the specific gravity and the water absorption of aggregates. Water absorption values are helpful in determining the water absorbed by the pores available in aggregate particles. The Tests were performed as per ASTM C127 – 15. The values of specific gravity and water absorption of both coarse and fine aggregates are presented in table 2.

Table 8: G_s and water absorption of fine and coarse aggregates

Source Name	Specific Gravity	Water absorption
Margallah Crush	2.61	0.97
Haripur Crush	2.88	0.81
Sakhi-Sarwar Crush	2.63	0.70
Kashmore Sand	2.77	1.28
Chenab Sand	2.60	1.21
Lawrencepur sand	2.69	1.01

2.4 Preparation Of Mixes:

Six combinations were prepared for each type of crush. On these combination tensile strength and compressive strength test were performed.

For Margallah crush the combination used are

1. Margallah-Lawrencepur(ML),
2. Margallah Chenab(MC),

3. Margallah-Kashmore(MK),
4. Margallah-Lawrencepur-Kashmore(MLK),
5. Margallah-Lawrencepur-Chenab(MLC),
6. Margallah -Chenab-Kashmore(MCK).

Likewise, six combinations were prepared for Haripur crush. These combinations are

1. Haripur-Lawrencepur(HL),
2. Haripur-Chenab(HC),
3. Haripur-Kashmore(HK),
4. Haripur-Lawrencepur-Chenab(HLC),
5. Haripur-Lawrencepur-Kashmore(HLK),
6. Haripur-Chenab-Kashmore(HCK).

Six combinations were prepared with Sakhi-Sarwar Crush. These combinations are

1. Sakhi-Sarwar – Lawrencepur(SSL),
2. Sakhi-Sarwar – Chenab(SC),
3. Sakhi-Sarwar – Kashmore(SK),
4. Sakhi-Sarwar - Lawrencepur-Chenab(SLC),
5. Sakhi-Sarwar -Lawrencepur-Kashmore(SLK),
6. Sakhi-Sarwar-Chenab-Kashmore(SCK).

2.5 Slump Test

Slump tests were carried out for each combination prior to the pouring for having best workability of concrete according to ASTM C 143. Figure 3 depict the variation in slump values by using different combination of fine and coarse aggregates. All the slump values were in range of 45mm to 75mm.

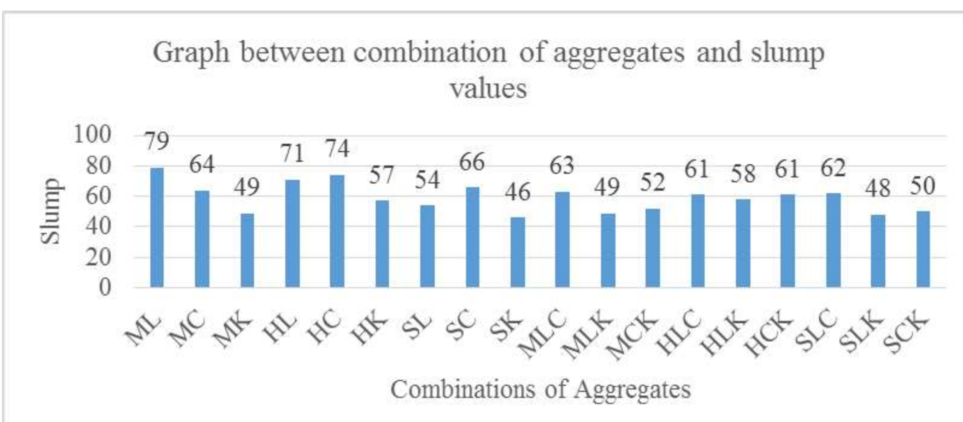

Figure 11: Variation in Slump with different aggregates combinations

2.6 Casting and curing of Concrete Specimens

All the samples were made with standard concrete cylinders of 12" height and 6" diameter. The mix was placed in the mould in three layers of equal depth and compacted using stand size rod with 25 blows on each layer. A total of 108 samples were casted in 6 days with 18 nos. of samples per day. Fig 4 shows the casted samples.

Figure 12: Casting of Test Specimens

The test samples were remoulded after 24 hours and then placed in curing tank for 28 days filled with tap water at room temperature.

2.7 Testing Method

The samples after their curing were tested for their compressive and tensile strengths using compression testing machine and universal testing machine. The compressive strength of 28 days cured hardened cylinders was measured according to the ASTM specification using standard compressive testing machine (CTM) having a loading rate of 100 KN/min For each combination three samples were tested for compressive strength and three were tested for split cylinder test as shown in figure 5..

Figure 13: Testing of Concrete Specimens

3. RESULTS AND ANALYSIS

3.1 Compressive Strength Comparison of Aggregates

Figure 6 present the 28 days compressive strength of all 18 combinations. It can be seen that the combination of Margallah crush with a blend of fine aggregates of Lawrencepur and Kashmore gave highest strength of 4179psi. It is may be due to the presence of all size of particles in Kashmore sand which reduced the voids in concrete and gave very good aggregate interlock.

All other combinations in which Kashmore sand was used gave higher results than the rest of the combinations. The lowest values are from the combinations of Haripur crush which are due to the rounded surface of aggregates which does not give strong interlock of aggregates.

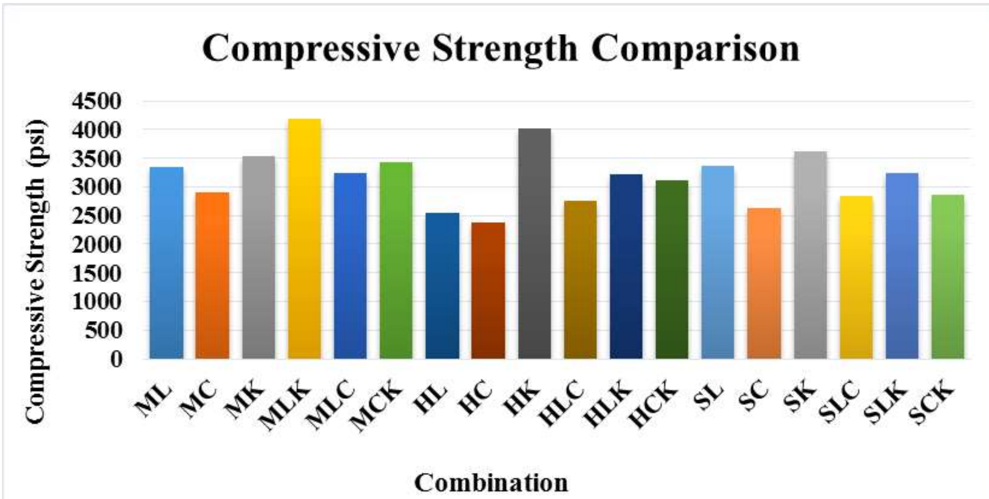

Figure 14 Variation in Compressive Strength with different aggregates combination

3.2 Tensile Strength Comparison of Aggregates

Split tensile strength was determined as per ASTM C 496. Specimens were casted and tested at 28 days of their curing. The results of split tensile strength are shown in figure 7.

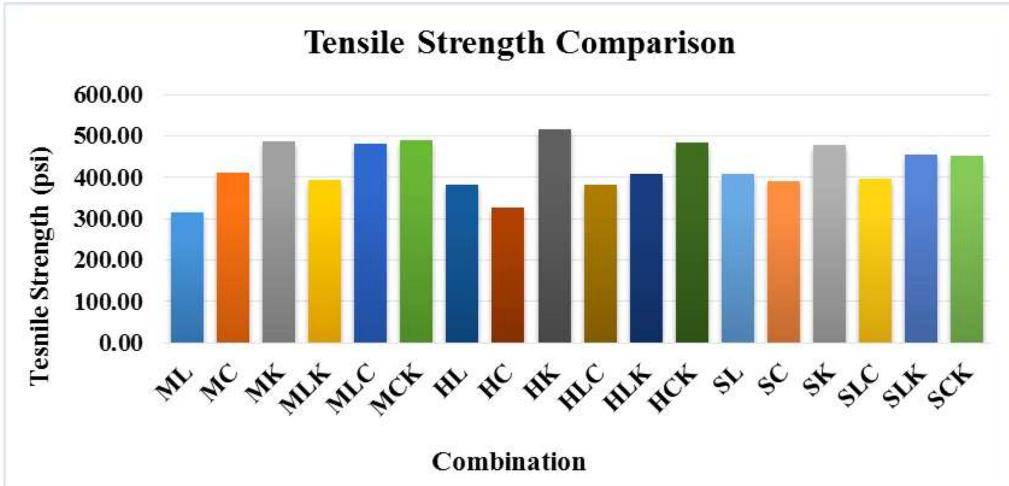

Figure 15: Variation in Split Tensile Strength with different aggregates combination

As for the compressive strength, all other combinations in which Kashmore sand was used gave higher results than the rest of the combinations. The lowest values are from the combinations of Haripur crush which are due to the rounded surface of aggregates which does not give strong interlock of aggregates.

4. CONCLUSION:

- The compressive strength, combinations made using Kashmore sand either fully or partially, gave the best compressive strength values which was due to its well gradation which enables the great aggregate interlock in concrete due to very less air voids.
- The Haripur river gravel gave second best strength when combined with kashmore sand but gave lowest strength with other types of sands which was may be due to its rounded surface type and less angular structure which cannot make strong aggregate interlock with those sands. Also, the paste failure phenomenon was observed during the compressive and tensile strength tests which clears tells that there were poor bonding in between coarse and fine aggregates.
- Kashmore sand has fineness modulus higher than all three sands which showed that it will be suitable to be used for achieving good high strength concrete.
- In region around Kashmore, specifically in the DG Khan area where Sakhi Sarwar sand was widely used, the Kashmore sand can be used for better results. Other aggregates which were Sakhi-Sarwar crush, Lawrencepur sand and Chenab sand gave good results also but sand of Chenab river needs to be used in combined with other coarse-grained sands for better results as this sand was fine grained which causes air voids in concrete.
- The Haripur aggregates which was actually river gravels showed that it meets the engineering properties, parameters and requirements so it can be used as a construction material but not for high strength concrete unless otherwise used with combination of Kashmore sand.

5. FUTURE RECOMMENDATION

This research work will be helpful to the construction industry in assessing the best combination of coarse and fine aggregate for the different areas of the country. They can now decide in a better way keeping the view the material and transportation cost without compromising the concrete structural properties.

6. REFERENCES

Li, Z. (2011). *Advanced Concrete Technology.* New Jersey: JOHN WILEY & SONS, INC.

Khitab, A., Anwar, W., Mansouri, I., Tariq, M., & Mehmood, I. (2015). Future Of Civil Engineering Materials: A Review From Recent Developments. Rev.Adv.Mater. Sci. 42 (2015) 20-27, 20.

Afzal, Z. (2017, January 28). *Classification, properties and extraction of Aggregates*. Retrieved from Slideshare: https://www.slideshare.net/zeeshanafzal12/aggregates-71498067

Ghaffar, A., Siddiqi, Z. A., & Ahmed, K. (2016). Assessing suitability of Margalla crush for ultra high strength concrete. *Pakistan Journal of Engineering and Applied Sciences.*, 38-46.

Abbas, S., Munir, M. J., Kazmi, S. M., Khitab, A., Ashiq, S. Z., & Arshad, M. T. (2017) Engineering Characteristics of widely used Coarse Aggregates in Pakistan: A Comparative Study. Pakistan Journal of Engineering and Applied Sciences.

Ayub, M., Ali, Q., Shahzada, K., & Naseer, A. (2012). Engineering Assessment of Coarse Aggregates Used in Peshawar. International Journal of Advanced Structures and Geotechnical Engineering.

Aslam, M., Shah, S. N., Qureshi, M. A., & Otho, S. H. (2015). Influence of Aggregate Characteristics on the Compressive Strength of Normal Weight Concrete. *Technical Journal, University of Engineering and Technology (UET) Taxila, Pakistan*.