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Impact of Fine and Coarse Aggregates from Distinctive Sources on the Compressive Strength of Concrete

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Abstract— *One of the essential factors in improving the performance of concrete in terms of compressive strength is the proper selection of aggregates sources. This research compared the compressive strengths of concrete produced using fine and coarse aggregates from five different locations. Various physical tests were performed to assess the suitability of these aggregates on the compressive strength of concrete, such as specific gravity and absorption, sieve analysis, abrasion test, workability test, and compressive strength test. The results revealed that the concrete produced with fine and coarse aggregates from natural river quarry sites gave the highest compressive strength average of 23.465 MPa, followed by supplied crushed fine and coarse aggregates with average compressive strength 19.555 MPa. River source of aggregates with periodic saline water intrusion yielded a lower compressive strength average of 18.54 MPa. Compressive strengths were monitored for 7, 14, and 28 days. The study revealed that all selected aggregates sources were applicable for concrete construction work.*

Keywords— *Dinstinctive Sources, Fine Aggregates, Coarse Aggregates, Concrete, Compressive Strength.*

I. INTRODUCTION

The quality of material ingredients such as cement, aggregates, admixtures, and water plays a key role in the development of the physical and strength properties of concrete[1][23]. Aggregate (fine and coarse) is considered an inert filler, which accounts for 60 to 80 percent of the concrete mix and 70 to 85 percent of the concrete weight. Aggregate is divided into two categories: Coarse aggregates are usually larger than 4.75 mm in size and are retained on a No. 4 sieve or bigger sieve sizes, while fine aggregates are usually lesser than 4.75 mm in size and must pass the No. 4 sieve or smaller sieve sizes [8]. Natural sand or river sand and crushed sand constitute 35% of concrete used in the concrete construction industry [2][3][5]. On the other hand, over one-third of the the volume of concrete is occupied by coarse aggregate, and any changes in coarse aggregate type can affect its strength and fracture properties [4][19].

There is the effect of aggregates on the mechanical properties of high-performance concrete as the strength, stiffness, and fracture energy of concrete for a given water/cement ratio depend on the type of aggregate [7][18][20]. It is also essential to ascertain other physical properties of aggregate such as shape, size, texture, moisture contents, specific gravity, unit weight, and soundness before using it for concrete production to obtain a desirable mixture. The combination of information derived from these properties, along with the water/cement ratio, helps for more accuracy in determining the strength, workability, and durability of the concrete. All these properties have an important influence on the quality of fresh and hardened concrete [9][20].

The physical shape and texture of aggregate affect the properties of fresh concrete more than hardened concrete. The smoothness and roundness of the aggregate in concrete determine its workability. Smooth and round aggregate produces more workable concrete than the rough and irregular-shaped aggregate. The effect of fine aggregate fineness, physical shape, and surface texture on mechanical qualities is generally overlooked in traditional concrete, even though these properties might increase water demand. The hydrated cement paste and the transition zone around the aggregate are relatively weak for this concrete. Consequently, the water/cement (w/c) ratio controls the mechanical properties of concrete for the same degree of hydration [10]16].

Concrete is a composite building material that consists of water, fine aggregate, coarse aggregate, and cement. Our construction firm mainly relies on conventional construction materials such as sand, granite, and cement for concrete production [9][17].

When choosing aggregates for concrete, the compressive aggregate strength is taken into accoun. The compressive strength of concrete depends on the water to cement ratio, cement to aggregate ratio, degree of compaction, the bond between aggregate and mortar, strength, shape, and size of the aggregates [11][12][13][22]. Concrete's compressive strength is largely determined by the type of aggregate used. Fine aggregate is one of the most important materials that affect the strength of concrete. Its combination with cement fills up the spaces and voids created by coarse aggregate during concrete production [14][15][22].

In this paper, the researcher used five different sources to measure the compressive strength of concrete in order to discover good quality aggregates, which are abundantly available, notably in the Central Visayas, Philippines, and are intended for concrete structures.

II. Materials And Methods

2.1 Materials

The following materials used in this research were as follows:

2.1.1 Cement: Ordinary Portland Cement with a specific gravity of 3.15 was purchased from a local construction supply store in Cebu City, Philippines.

2.1.2 Fine and Coarse Aggregates: Four different types of fine and coarse aggregates were collected from two river quarry sites, crushed fine and coarse aggregates from two supply sources, and fine and coarse aggregates collected from a river with periodic saline water intrusion in Cebu, Central Visayas, Philippines.

2.1.3 Water: Potable water was used for concrete mixing from water supply sources.

2.2 Methods

The following methods were adopted in this research were as follows:

2.2.1 Mixture proportion: 1:2:3 (cement: fine aggregates: coarse aggregates) were used in the mix. A water-cement ratio of 0.6 was also used for the mix.

2.2.2 Laboratory tests

Specific gravity and the amount of water absorption: Specific gravity is one of the important properties of fine and coarse aggregates needed in the computation of mix design. The standard test method ASTM C128 was used in the determination of the specific gravity.

Sieve Analysis: Standard test method ASTM C136 was used for sieve analysis of fine and coarse aggregates.

Abrasion Test: The hardness of the coarse aggregates was determined by the Los Angeles abrasion test. Standard test method ASTM C131 was used in the test.

Slump Test: Separate test of a slump for the four sources of aggregates. Standard test method ASTM C143 was used for the test.

Compressive Strength Test: Compressive strength of concrete was determined under a normal curing period of 7 days, 14 days, and 28 days. Standard test method ASTM C39 was used for the test.

III. Results And Discussion

TABLE 1. Specific gravity of fine aggregates

Source	River quarry 1	River quarry 2	River source w/saline water intrusion	Crushed Stone quarry 1	Crushed Stone quarry2
Fine	2.65	2.638	2.612	2.61	2.64
Specific Gravity	2.7	2.73	2.584	2.68	2.60

Table 1 shows the specific gravity of fine aggregates used in the production of concrete. Natural fine aggregates from two quarries supply recorded a maximum specific gravity with an average value of 2.644, followed by crushed supply with an average value of 2.625. On the other hand, fine aggregates from a river with saline water intrusion showed a minimum value of 2.612.

TABLE 2. Specific gravity of coarse aggregates

Source	River quarry1	River quarry2	River source w/saline water intrusion	Crushe d Stone quarry 1	Crushe d Stone quarry2
Specific Gravity	2.7	2.73	2.584	2.68	2.60

Table 2 also shows the specific gravity of coarse aggregates used in the production of concrete. Natural coarse aggregates from two river quarries supply recorded a maximum specific gravity with an average value of 2.715, followed by crushed stone aggregates supply with an average value of 2.640. Furthermore, coarse aggregates from a river with periodic saline water intrusion showed a minimum value of 2.584. The value of the specific gravity of all aggregate sources is within the range of 2.5 to 3, normally used in construction.

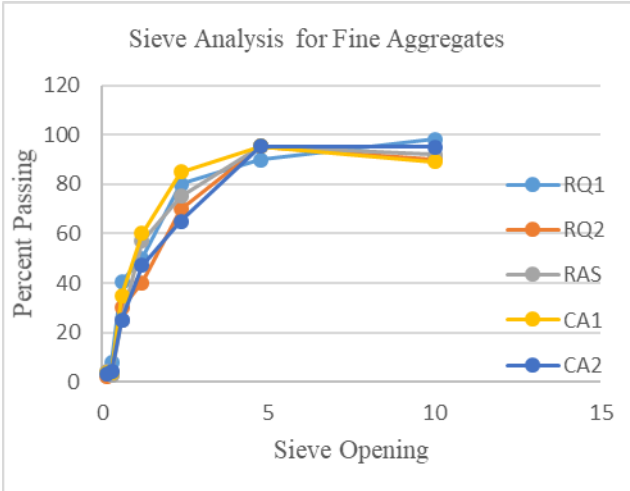

Fig. 1. Sieve Analysis of Fine Aggregates

Figure 1 shows the fine aggregate particle size distribution curve, which shows that particle sizes are scattered over a wide range, showing that the aggregates from the five sources are not badly graded. This fine particle characteristic is a reliable indicator of concrete compressive strength.

The particle size distribution curve of the coarse aggregates, as shown in Figure 2, also indicates that the particle sizes are distributed over a wide range, indicating that the aggregates from the five sources are of a good grade. This parameter of coarse aggregates is a good measure of the compressive strength of concrete.

Slump test results are shown in Table 3. The average slump yielded 86.5 mm from river quarry source 1 and river source 2. This maximum slump is due to the physical characteristics of natural aggregates from the river supply that has a smooth surface with a rounded shape.

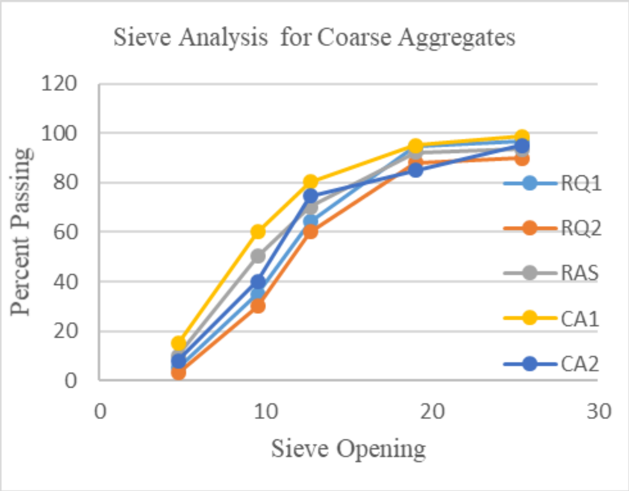

Fig. 2. Sieve Analysis of Coarse Aggregates

TABLE 3. Slump test results

Types of Aggregates	Average Slump per Source	Average Slump
River quarry 1	85	86.5
River quarry 2	88	
River source with saline water intrusion	86	86
Crushed stone 1	66	63
Crushed stone 2	60	

The river source of aggregates with periodic saline water intrusion yielded almost the same as of natural river supply because of the same physical properties. Crushed stone aggregates yielded a minimum average slump of 63 mm since it has an angular shape and rough surface and absorbed more water. The results show that the natural river supply of aggregates is more practical than the other two options. The aggregates from other sources will require additional mixing water to yield good mix and compaction.

TABLE 4. Compressive Strength of River Quarry 1 Aggregates

fc'	Compressive Strength in MPa		
Curing Time	7 days	14 days	28 days
RQ1 Sample 1	13.71	18.03	22.76
RQ1 Sample 2	12.86	19.36	23.88
RQ1 Sample 3	13.05	16.23	21.56
Average	13.21	17.87	22.73

TABLE 5. Compressive Strength of River Quarry 2 Aggregates

fc'	Compressive Strength in MPa		
Curing Time	7 days	14 days	28 days
RQ2 Sample 1	14.25	21.82	24.02
RQ2 Sample 2	15.00	23.85	25.00
RQ2 Sample 3	13.98	22.20	23. 58
Average	14.41	22.62	24.2

Table 4 and Table 5 showed the compressive strength of concrete using fine and coarse aggregates from river quarry source one and river quarry source 2. The compressive strength on the 28th day of both sources showed a minimum difference since these sources were located within nearby municipalities in the southern part of Central Visayas, Philippines area. The average compressive strength of the two river quarry aggregates is 23.465 MPa.

TABLE 6. Compressive Strength of River Aggregates with Saline Water Intrusion

fc'	Compressive Strength in MPa		
Curing Time	7 days	14 days	28 days
RAS Sample 1	9.24	16.58	18.95
RAS Sample 2	8.83	18.34	19.68
RAS Sample 3	10.08	15.42	17.00
Average	9.38	16.78	18.54

Table 6 showed the compressive strength of concrete using fine and coarse aggregates from a riverside with periodic saline water intrusion when high tide occurred. Because of the salt concentration, the compressive strength is reduced when compared to two other sources.

TABLE 7. Compressive Strength of Crushed Aggregates Source 1

fc'	Compressive Strength in MPa		
Curing Time	7 days	14 days	28 days
CA1 Sample 1	12.18	19.45	20.50
CA1 Sample 2	10.42	16.09	19.24
CA1 Sample 3	9.60	17.25	18.50
Average	10.73	17.60	19.41

TABLE 8. Compressive Strength of Crushed Aggregates Source 2

fc'	Compressive Strength in MPa		
Curing Time	7 days	14 days	28 days
CA2 Sample 1	13.29	13.28	21.00
CA2 Sample 2	11.37	16.54	18.87
CA2 Sample 3	10.84	16.15	19.20
Average	11.83	15.32	19.70

Table 7 and Table 8 showed the compressive strength of concrete using fine and coarse aggregates from crushed aggregates sources. The compressive strength on the 28th day of both sources showed a minimum difference since these sources are located within nearby municipalities on the southern side of the Central Visayas, Philippines region. The average compressive strength of the two crushed aggregates is 23.465 MPa.

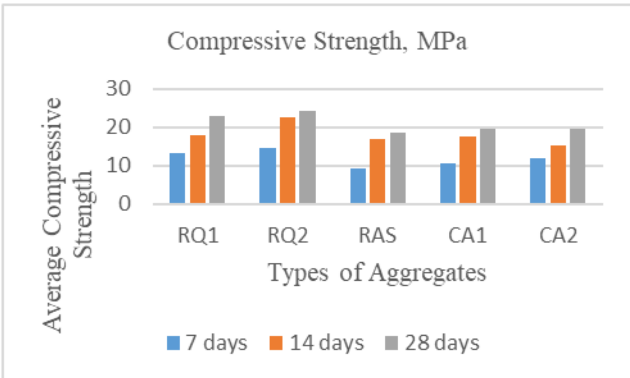

Fig. 3. Average Compressive Test Results

IV. CONCLUSIONS, RECOMMENDATIONS

4.1 Conclusion

4.1.1 It was observed that river quarry aggregates produced the highest compressive strength and were most workable compared to other sources.

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4.1.2 River aggregates with periodic saline water intrusion yielded the lowest compressive strength compared to crushed aggregates and river quarry aggregates.
4.1.3. The physical properties of aggregates, as well as their geological nature and formation, contributed to the quality of the concrete.
4.1.4 Crushed aggregates have the second-highest compressive strength results; however, there is a significant difference between the two crushed stone quarries in the quality of concrete.

4.2 Recommendation

For the future development and betterment of this study, the researcher recommends the following:
4.2.1 To develop test procedures to determine the performance of aggregates, especially with periodic saline water susceptibility.
4.2.2 Based on the conclusions, the compressive strength results of all the selected sources can be used for concrete work production.

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REFERENCES

[1] Ngugi, H. N., Mutuku, R. N., & Gariy, Z. A. (2014). Effects of sand quality on bond strength of concrete: a case study in Nairobi City County and Its Environs, Kenya. *Int J Civil Struct Eng Res*, *2*(1), 119-129. Retrieved from: https://www.academia.edu/12087803/Effects of Sand Quality on Bond Strength of Concrete: A Case Study in Nairobi City Country and Its Environs, Kenya
[2] Kosalya Sundaralingam, Arvinthan Peiris, Arulanantham Anburuvel, Navaratnarajah Sathiparan. (2022). Quarry dust as river sand replacement in cement masonry blocks: Effect on mechanical and durability characteristics, Materialia, Volume 21,101324, ISSN 2589-1529Retrieved from: https://www.sciencedirect.com/science/article/pii/S2589152922000114
[3] D. F. Orchard, Concrete technology, properties of material, Fourth Edition ed., vol. Volume 1, London: Applied Science Publishers ltd, 1979, pp. PP 139-150
[4] Quayson, J. & Mustapha, Zakari. (2019). Impact Of Coarse Aggregate On Compressive Strength Of Concrete. 49-58.Retrieved from: https://www.researchgate.net/publication/343656573_IMPACT_OF_COARSE_AGGREGATE_ON_COMPRESSIVE_STRENGTH_OF_CONCRETE
[5] MNSE, A. F., COREN, A. O., Ayegbusi, O. A., & Oderinde, S. A. (2015). Comparison of the Compressive Strength of Concrete Produced using Sand from Different Sources.Retrieved from: https://hrmars.com/papers_submitted/1791/Comparison_of_the_Compressive_Strength_of_Concrete_Produced_using_Sand_from_Different_Sources.pdf
[6] Abdullahi, M. (2012). Effect of aggregate type on compressive strength of concrete. *International Journal of Civil and structural engineering*, *2*(3), 782.
[7] Wu, K-R., Chen, B., Yao, W., and Zhang, D. (1997), Effect of Coarse Aggregate Type on Mechanical Properties of High-Performance Concrete. Cement and Concrete Research, Vol. 31, No. 10, pp. 1421-1425.Retrieved from: https://www.researchgate.net/publication/222142509_Effect_of_coarse_aggregate_type_on_mechanical_properties_of_high-performance_concrete
[8] Mahr, L. (2014). Aggregate Testing Standards: Aggregate Quality and Use. Retrieved from: http://www.enviromineinc.com/research-library/2015/12/24/aggregate-testing-standards
[9] Neville, J. B. (2000), Concrete Technology, Longman, England Retrieved from: https://kupdf.net/queue/concrete-technology-2nd-edition_5afdabf3e2b6f5563bb66eb1_pdf?queue_id=-1&x=1650213406&z=MjAwMTo0NDU1OjRhNTo5MjAwOjhjM2Q6NzE5NToyYmFiOmNkN2U=
[10] Newman, J. and Choo, B. S. (2003), Advanced Concrete Technology, First Published, Elseviers , Great Britain Retrieved from: https://1lib.ph/book/592256/233ddd
[11] Rocco, C. and Elices, M. (2009), "Effect of Aggregate Shape on the Mechanical Properties of a Simple Concrete", Journal of Engineering Fracture Mechanics, Vol. 76, No.2, Pp. 286 – 298.Retrieved from: https://www.researchgate.net/publication/223367339_Effect_of_aggregate_shape_on_the_mechanical_properties_of_a_simple_concrete
[12] Abdullahi, M. (2012), "Effect of Aggregate Type on Compressive Strength of Concrete", International Journal for Computational Civil and Structural Engineering, Vol. 2, No. 3, Pp. 791 – 796.Retrieved from: https://csce.cust.edu.pk/archive/CSCE_Proceedings_2021/CSCE21-PROCEEDINGS.pdf
[13] Elices, M. and Rocco, C. (2008), "Effect of Aggregate size on the fracture and Mechanical properties of a Simple Concrete", Journal of Engineering Fracture Mechanics, Vol. 75, No. 13, Pp. 3829 – 3851.Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0013794408000519#:~:text=When%20aggregates%20are%20well%20bonded,increases%20with%20the%20aggregate%20size
[14] Aziz, M.A. (1995), "Engineering Materials", Z and Z Computer and Printers, Dhaka, Bangladesh. Retrieved from: https://www.academia.edu/20556287/Experimental_Study_on_the_Strength_Behavior_of_Concrete_using_Stone_Dust_as_Fine_Aggregate
[15] Sharmin, R., Ahmed, M., Mohiuddin, A., & Forhat, A. L. (2006). Comparison of strength performance of concrete with uncrushed or crushed coarse aggregate. *ARPN J. Eng. Appl. Sci*, *1*(2), 1-4. https://www.researchgate.net/profile/Mushtaq-Ahmed-7/publication/268267789_
[16] Abbas, S.A.A. and Haider, M.A. (2012), Using different types of fine aggregate to produce high strength concrete. *International Journal of Arts & Sciences*, Vol. 5, No.7, Pp. 187–196. Retrieved from: https://www.researchgate.net/publication/290436986
[17] The Constructor: Concrete Technology. Retrieved from: https://theconstructor.org/concrete/
[18] Yudong Xie, Chunxiang Qian, Yugui Xu, Ming Wei, Wenxiang Du. (20220. Effect of fine aggregate type on early-age performance, cracking analysis and engineering applications of C50 concrete, Construction and Building Materials, Volume 323, 126633, ISSN 0950-0618,Retrieved from: https://www.sciencedirect.com/science/article/pii/S0950061822003245)
[19] MNSE, A. F., COREN, A. O., Ayegbusi, O. A., & Oderinde, S. A. (2015). Comparison of the Compressive Strength of Concrete Produced using Sand from Different Sources.Retrieved from: https://kwpublications.com/papers_submitted/1792/comparison-of-the-compressive-strength-of-concrete-produced-using-sand-from-different-sources.pdf
[20] Shatha Deyaa Mohammed. (2017). Influence of Water Source on the Compressive Strength of High Strength Concrete. *Diyala Journal of Engineering Sciences*, *10*(1), 31–38. Retrieved from: https://www.djes.info/index.php/djes/article/view/219
[21] Ozioko, H. O., & Ohazurike, E. E. (2020). Effect of Fine Aggregate Types on the Compressive Strength of Concrete. *Nigerian Journal of Engineering*, *27*(2). Retrieved from: https://www.ejmanager.com/mnstemps/192/192-1570065612.pdf?t=1650219365
[22] Ahmad, S., Alghamdi, S.A. (2012). A Study on Effect of Coarse Aggregate Type on Concrete Performance. *Arab J Sci Eng* **37,** 1777–1786 (2012). https://link.springer.com/article/10.1007/s13369-012-0282-6
[23] LeBow, C. J. (2018). Effect of Cement Content on Concrete Performance. Graduate Theses and Dissertations Retrieved from https://scholarworks.uark.edu/etd/3000