EXPERIMENTAL STUDY ON CONCRETE USING SEA SAND AS FINE AGGREGATE

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Abstract: *Concrete is the most popular building material in the world. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for river sand that is preferably sea sand. The Land Reclamation and Development Board (Sri Lanka) plans to popularize the use of sea sand as an alternative to river sand. According to the experts in the global construction trade, Sea Sand is being used in the construction industry in the Asian Region and some leading European countries. Civil Engineering Department of University of Moratuwa (Sri Lanka) and the National Building Research Organization [NBRO] (Sri Lanka) have confirmed that the sea sand pumped from a distance of about ten kilometers is very suitable for building construction industry. This study is to experiment the suitability to use beach/sea sand as a substitute for river sand as fine aggregate for concrete.*

Keywords: Concrete, Sea sand and Fine aggregate.

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1. INTRODUCTION

Sand is a unique raw material for the construction industry at present, but contractors say that they have to spend more allocations for obtaining bulk loads of sand for their construction work. Quarry dust is one of alternative raw material for the construction industry, but most contractors and the house owners are not showing any interest in using quarry dust for their constructions. According to the industry sources, the price level of the river sand has skyrocketed. Tractor load of river sand will cost over Rs5000. Meanwhile, the Land Reclamation and Development Board (Sri Lanka) plans to popularize the use of sea sand as an alternative to river sand. According to the experts in the global construction trade, Sea Sand is being used in the construction industry in the Asian Region and some leading European countries. Civil Engineering Department of University of Moratuwa (Sri Lanka) and the National Building Research Organization [NBRO] (Sri Lanka) have confirmed that the sea sand pumped from a distance of about ten kilometres is very suitable for building construction industry. “It has less Chloride if we compare with sea sand in beaches” the experts said. According to the industry figures, the price of river sand has increased by over 40 per cent consequent to the ban imposed on river sand mining. The tsunami is another reason for the price increase, they said. Due to the government restrictions/regulations on the removal of river sand, the construction industry faces lots of difficulties to obtain river sand in time. The Land Reclamation and Development Board (Sri Lanka) says that their institution is now pumping bulk load of sea sand for industrial purposes. The institution further states that their Sea Sand stocks are available at the Muthurajawela site (Sri Lanka). According to the Board’s sources, the washed sea sand is ideal for concrete and plastering activities.

2. UTILITY AND SOURCE OF SEA SAND FOR CIVIL CONSTRUCTIONS

2.1 Society's Need for Sand

Sand has become a very important mineral for the expansion of society. Not only is it used for glass but more so for making concrete, filling roads, reclamations, building sites, and for renourishing beaches. Each has its own requirements in respect of the quality of the sand. Although the main constituent of sand, quartz, is found in every soil and locality, it occurs mostly as loam, a mix of sand + silt + clay. Clean sand is indeed a rare commodity on land, but common in sand dunes and beaches. On average, people 'use' over 200kg of sand per person per year. This sand is taken from what are essentially non-renewable resources.

2.2 Sand for Glass

Glass is made chiefly from high quality, clean sand. It is a hard, clear, inert substance which is formed at high temperatures, and is extremely resistant to wear, tear, and ageing. Glass is used extensively by society for window-glazing, liquid containers, and glassware. Small quantities of specialty glass are used for optics, electronics (lasers, fibre-optics, and semiconductors).

2.3 Sand for Concrete

Liquid stone, or concrete as it is named, was invented before the first world war, but became popular in the second world war. It was used in the construction of military bunkers, airfield tarmac and roads. Concrete is basically made from hard rock. Rock is broken (crushed) into small pieces (between 20 and 40mm maximally), then sieved (graded) into various size grades from 'dust' to 40mm aggregate. Mixed with cement and water, the mixture is poured in place and left to harden. This hardening is a chemical process of growing cement crystals, consisting of long, microscopic fingers which enmesh the rock grains, while securely attaching to them. Within 7 days most of the strength is attained, but hardening takes another three weeks to reach design strength. The more cement added, and the harder the rock, the stronger the concrete becomes. Sand is needed (about one third) because the broken rock, does not fit neatly together again. Like the aggregate rock, the sand must also be strong and clean, for the cement crystals to attach to. Unlike the broken rock, sand can become polluted by its environment, rendering it less suitable. Inclusions of mud, silt, clay and organic matter affect concrete strength considerably. Hence the need for clean ('sharp') sand. Beach sand, being washed over and over again by every wave pounding on the beach, is preferred. It consists mainly of extremely hard quartz (SiO_2, silicon dioxide). In order to predict concrete quality reliably, sand must also be of consistent size. Sea sand, containing over 10% moisture by weight, needs to be washed to remove its salt.

2.4 Sand for Fill

Sand has a number of desirable properties for use as foundation underneath parking places, buildings and roads: it drains groundwater freely and it stays put, unlike soil or clay which can slide more easily. Sand does not expand or contract with changing moisture content, and resists high loads without sliding or compacting. Where sand contains high levels of mud, these qualities are compromised. A high lime content from broken shells, may cause the sand foundation to shrink over time due to acid rainwater slowly dissolving this lime.

2.5 Sand for Beach Renourishment

It has become common practice to renourish ailing beaches with new sea sand, particularly in very popular places where the cost can be justified economically by many visitors. In New Zealand the cost of one cubic meter of renourished sand is about NZ$40 (year 2000). It is believed that coarse sand stays on renourished beaches longer than fine sand. It is less prone to be moved by wind, so it won't blow into built-up areas, and being larger than the original sand, stays on top of it. Beach sand needs to be clean, but may include shells.

3. CONCRETE MIX DESIGN

One of the ultimate aims of studying the various properties of the materials of concrete, plastic concrete and hardened concrete is to enable a concrete technologist to design a concrete mix for a particular strength and durability. The design of concrete mix is not a simple task on account of the widely varying properties of the constituent materials, the conditions that prevail at the site of work, in particular the exposure condition, and the conditions that are demanded for a particular work for which the mix is designed.

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The purpose of designing as can be seen is to achieve the stipulated strength and durability. Table 1 presents the mix proportion for M25 Grade concrete.

Table 1. Mix proportion for M25

C	FA	CA	W
425.7 kg	749.32 kg	1124 kg	192 kg
1	1.76	2.64	0.45

Concrete cubes are casted and tested at 3rd, 7th and 28th days to obtain the compressive strength, split tensile strength and flexural strength.

4. TEST RESULTS

4.1 Conventional Concrete

Table 2, 3 and 4 presents the compressive, split tensile and flexural strength of conventional (100% river sand) concrete.

Table 2. Compressive strength of concrete (100% river sand)

Grade of concrete	Age of curing (Days)	
	7	28
	Mpa	Mpa
M25	34.567	35.71

Table 3. Split tensile strength of concrete (100% river sand)

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Grade of concrete	Age of curing (Days)	
	7	28
	Mpa	Mpa
M25	2.405	2.617

Table 4. Flexural strength of concrete (100% river sand)

Grade of concrete	Age of curing (Days)	
	7	28
	Mpa	Mpa
M25	4.356	4.719

4.2. 100% sea sand mixed concrete

Table 5, 6 and 7 presents the compressive, split tensile and flexural strength of conventional (100% sea sand) concrete.

Table 5. Compressive strength of concrete (100% sea sand)

Grade of concrete	Age of curing (Days)	
	7	28
	Mpa	Mpa
M25	30.00	31.95

Table 6. Split tensile strength of concrete (100% sea sand)

Grade of concrete	Age of curing(Days)	
	7	28
	Mpa	Mpa
M25	1.981	2.287

Table 7. Flexural strength of concrete (100% sea sand)

Grade of concrete	Age of curing(Days)	
	7	28
	Mpa	Mpa
M25	3.993	4.304

4.3. 50% sea sand mixed concrete

Table 8, 9 and 10 presents the compressive, split tensile and flexural strength of conventional (50% sea sand) concrete.

Table 8. Compressive strength of concrete (50% sea sand)

Grade of concrete	Age of curing(Days)	
	7	28
	Mpa	Mpa
M25	32.00	33.48

Table 9. Split tensile strength of concrete (50% sea sand)

Grade of concrete	Age of curing(Days)	
	7	28
	Mpa	Mpa
M25	2.193	2.499

Table 10. Flexural strength of concrete (50% sea sand)

Grade of concrete	Age of curing(Days)	
	7	28
	Mpa	Mpa
M25	4.304	4.562

Fig. 1, 2 and 3 shows the compressive, split tensile and flexural strength of concrete with and without sea sand.

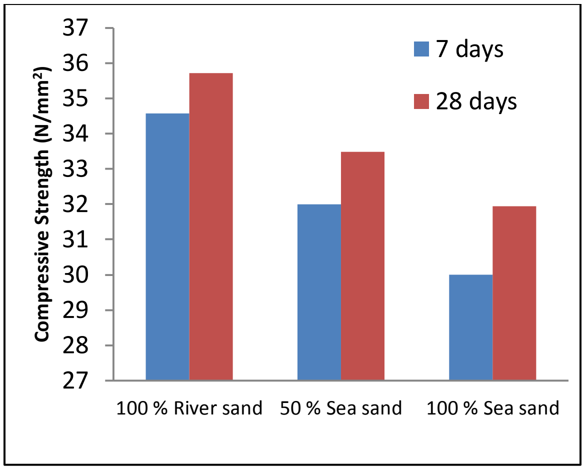

Fig. 1. Compressive strength of concrete

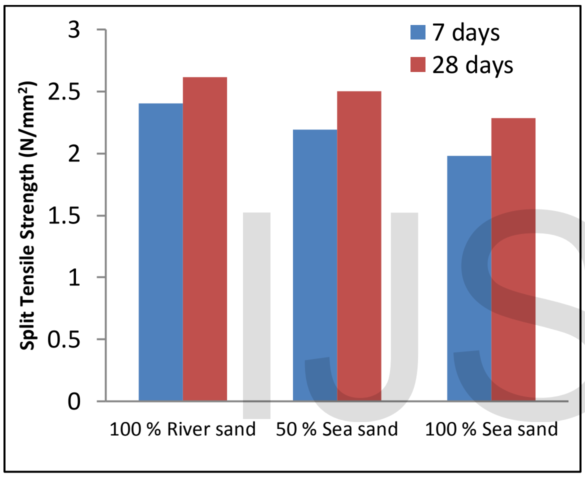

Fig. 1. Split tensile strength of concrete

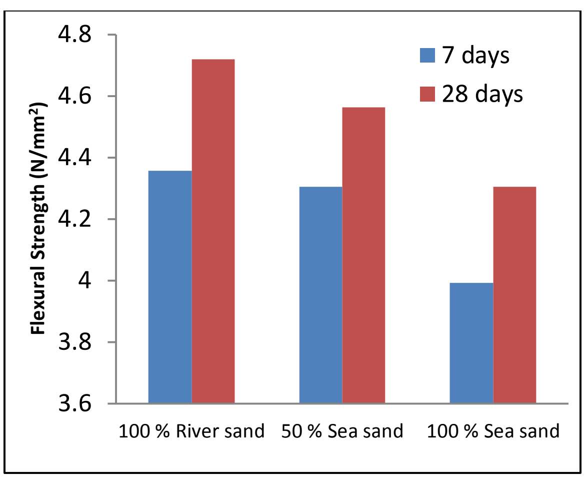

Fig. 3. Flexural strength of concrete

5. CONCLUSION

Sand has become a very important mineral for the expansion of society. Not only, is it used for glass but more so for making concrete, filling roads, reclamations and building sites. The research reported here is on offshore sand, which was considered the most viable of the alternatives for river sand, with respect to availability, ease of extraction, environmental impact and cost. This study is experiment the suitability to use beach/sea sand as a substitute for river sand as fine aggregate for concrete. Experimental results show that the washed sea sand is ideal for concrete and plastering activities. When compared with 100% river sand concrete, 50 and 100% replacement of sea sand with river sand in concrete gives lesser in compressive, split and flexural strength.

6. REFERENCE

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