COMPARATIVE ANALYSIS OF COMPRESSIVE STRENGTH IN MANUAL-MIX VS. READY-MIX CONCRETE

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department Of Civil Engineering

Sonargaon University (SU)

147/I, Green Road, Panthapath, Dhaka-1215, Bangladesh

Section:- 22B

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DECLARATION

It is hereby declared that this thesis or any part it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

To

“The people who are affected by the terrible flood in 2024 at Feni, Noakhali, Laxmipur, Cumilla. Who have lost their lives, wealth and all their property. We wish for the speedy rehabilitation of the flood affected people and the salvation of the departed souls of those who died”

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ABSTRACT

Ready-mixed concrete is manufactured according to the job requirement and delivered to the site of work in form of ready to use, where Manual mix concrete is prepared at the site of construction manually. In this study experimental work was done to determine the compressive strength test of both ready-mixed concrete and manual mix concrete at a mixture ratio of 1:1.5:3 and to compare between them. For manual mix concrete Portland composite cement (supercrete), coarse aggregate, local sand from bhuapur and Sylhet sand from fazilpur was collected. Ready-mixed concrete was collected from vendor (NDE). Both types of concrete were prepared in a mix ratio of 1:1.5.3 in 6 cylinders of each type (200 x100 mm size) with curing time of 28 days. The compressive strength test was done by using Universal Testing Machine (UTM). The average compressive strength of ready-mixed concrete is found as 4490.63 psi, where the manual mix concrete is found as 4338.50 psi. The compressive strength of ready-mixed concrete is found as 3.4% higher than that of manual mix concrete.

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CHAPTER 1

INTRODUCTION

1.1 General

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens (cures) over time. It is the second most used substance in the world after water and is the most widely used building material. Its usage worldwide is twice that of steel, wood, plastics, and aluminum combined. Globally, the ready-mix concrete industry, the largest segment of the concrete market, is projected to exceed $600 billion in revenue by 20252.

Ready-mix concrete (RMC) is concrete that is manufactured in a concrete batching plant which is manufactured according to each specific job requirement, then delivered to the job site "ready to use". It also refers to concrete that is specifically manufactured for customers' construction projects and supplied to the customer on site as a single product. It is actually a mixture of Portland or other cements, water and aggregates such as sand, gravel or crushed stone. All aggregates should be of a washed type material with limited amounts of fines or dirt and clay. An admixture is often added to improve workability of the concrete and/or increase the setting time of concrete (using retarders) to factor in the time required for the transit mixer to reach the site

There are two types of Ready-mix concrete (RMC). The first one is the barrel truck or in-transit mixers which is a device that homogeneously. combines cement, aggregate such as sand or gravel, and water to form concrete. This concrete mixer uses a revolving drum to mix the components. For smaller volume works porlqtable concrete mixers are often used so that the concrete can be made at the construction site to give the workers enough time to use the concrete before it hardens. The in-transit barrel truck delivers concrete in a plastic state to the site. The second one is the volumetric concrete mixer. A volumetric concrete mixer (also known as volumetric mobile mixer) is a concrete mixer mounted on a truck or trailer that contains separate compartments for sand, stone, cement and water. This delivers the ready mix in a dry state and then mixes the concrete on site

On the other hand, Batch Plant concrete is volumetric concrete that is prepared at the construction site. In this process concrete components are mixed in specific ratios to obtain the desired strength. This method requires using formulas to determine the amount of materials and steps to obtain the desired consistency

In Ready-mix concrete different types of admixtures are used. In this study admixture from BASF (Baden Aniline and Soda Factory) was used.

1.2 History of ready-mixed Concrete:

In 1903 the concept of ready-mix concrete was first introduced by an architect Jurgen Heinrich Magens from Germany. Despite this discovery, attempts to supply the building trade did not take off until the year of 1920 due to the poor quality of motor trucks. The first ready mix company was set up in the UK in 1930. During the year of 1940s, the availability of heavier trucks and better engines allowed mixing drum capacities to increase, which in turn allowed ready-mixed concrete producers to meet the high demand for concrete that developed as a result of World War II. By the time of 1960 a successful network of concrete firms had established themselves in the construction industry. RMC was first introduced in Indian subcontinent in 1950 and the first RMC plant was established in 1993 in Pune, India.

1.3 Objective:

1. To identify the compressive and tensile strength of ready-mix concrete and manual mix concrete at a mix ratio of 1:1.5:3.

2. To Compressive strength test of concrete by Universal Testing Machine (UTM).

3. Compressive Strength Test of Concrete:

The concrete cylinder is cast for standard size and allowed to cure for 28 days. Three specimens of the same dimension are cast for testing. Tacked out the specimen from the curing tank. Wiped out the excess water from the surface of the specimen. Placed the specimen vertical on the platform of Universal Testing Machine (UTM) for testing compressive strength. Uniform load application and distribution is facilitated by having pad caps at the ends of the cylinders. Before start to apply the load, ensured that the loading platforms have touched the top of the cylinder. Applied the load continuously and uniformly without shock at the rate of 315 KN/min. And continue the loaded until the specimen failed. Were Recorded the maximum load. The test is repeated for the remaining specimens. the compressive strength between ready-mix concrete and manual mix concrete at the same mix ratio.

4. To identifying higher strength concrete among ready-mix concrete and manual mix concrete of same mix ratio.

CHAPTER 2

Literature Review

A study by Soroka, 1 (1976) was conducted on variations of compressive strength of 57 types of ready-mix concrete of 11 plants. The study showed that strength variation in ready-mixed concrete is not lower than that of manual mix concrete and formal compliance with a set of nominal requirements cannot alone secure an expected level of control and the corresponding assumed variation in concrete strength. This study also showed that strength variation is much more dependent on the actual level of supervision rather than on the methods of production proper and the availability of equipment".

ALVES, A (2017) studied on the dispersion of compressive strength of different ready-mix and manual mix concrete mixtures correspond to 20, 25, 30, 35 and 40 MPa. This study showed that variation in the workers team presents a significant influence on the homogeneity of the compressive strength of concrete 10

TAMAI, T (2003) studied on seasonal variations of compressive strength of ready-mix concrete on 7 days and 28 days curing strength. The three years long study showed that the standard cured compressive strengths at 28 days were 1.25 times of Nominal strength in summer and 1.5 times in winter 12.

CHAPTER 3

Methodology

3.1 Materials of manual mix Concrete and Ready-mixed Concrete:

3.1.1 Materials of manual mix Concrete:

For the concrete mixtures, Portland composite Cement (Supercrete) we as used, Coarse Aggregates (3/4" down:1/2") and two types sand (Local Sand 50% & Sylhet Sand 50%) local sand FM: 1.8 & syhlet sand FM : 2.5 . Also were used clean water.



Fig 3.1: Cement.



Fig 3.2: Coarse Aggregates.



Fig. 3.3: Local sand



Fig 3.4: Sylhet sand

3.1.2 Materials of Ready-mixed Concrete:

Ready mix concrete of this test was made of following ingredients

Portland composite Cement

Coarse Aggregate (3/4" down:1/2")

Fine Aggregate

Water and

Admixture (BASF) (2.5-3.5) kg/ As per need.

Which is collect from vendor (NDE). It is a mixture of Portland or other cements, water and aggregates: sand, gravel, or crushed stone. All aggregates should be of a washed type material with limited amounts of fines or dirt and clay.



Fig 3.5: Cylinder Mold (100 X 200) mm.



Fig 3.6: Tamping Rod (16mm Dia)



Fig 3.7: Scoop

3.2 Casting:

3.2.1 Casting of manual mix Concrete:

Proper mixing of concrete ingredients is of almost importance in order to produce good quality of fresh concrete. During the process of mixing the surface of all the aggregate particles is coated with cement paste Well mixed concrete is required for the desired workability and performance of concrete in both the fresh as well as the hardened state. If the concrete is not well mixed, then it tends to segregation and bleeding. Casting Ratio 1:1.5:3. We have followed the below Steps for Casting:

- First of all, we wet the inner surfaces of the drum of the mixer Machine.
- Coarse aggregates are placed in the mixer machine first followed by sand and then cement.
- Mixed the materials in the dry state in the mixing machine. Normally it's took 1.5 to 3 minutes.
- After proper mixing of dry materials, were added the correct quantity of water while the machine is in motion.
- After adding the water, we mixed concrete for a minimum of 1.5 minutes in the drum.
- We unloaded from the mixer machine.
- We used metal 100x200mm cylinder moulds for concrete test specimens in the field.
- We Filled moulds in 2 equal layers and vibrated each layer until the concrete becomes smooth and there is no further egress of entrapped air bubbles.



Fig 3.8: Mixing of materials in this study.



Fig 3.9: Casting concrete in cylinder.

3.2.2 Casting of Ready-mixed Concrete:

Ready-mix concrete (RMC) is concrete that is manufactured in a batch plant, according to each specific job requirement, then delivered to the job site "ready to use".

For cylinder casting Ist time we take a Reusable steel, then we clean it, next we fill it one third by concrete. Then 16mm Dia rod taming 25 times in this cylinder.

Then we fill it two third by concrete as previous. Also rod tamping 25 time again finally last gap was filled by concrete as previous.

3.3 Curing Time:

Curing is the process or operation which controls the loss of moisture from concrete after it has been placed in position, or in the manufacture of concrete products, thereby providing time for the hydration of the cement to occur. The concrete cylinder is cast for standard size and allowed to be cured for 28 days. For final curing, cylinders placed in their curing storage than 30 minutes after removing from the molds.

3.4 Compressive Strength Test of Concrete:

The concrete cylinder is cast for standard size and allowed to cure for 28 days. Three specimens of the same dimension are cast for testing. Tacked out the specimen from the curing tank. Wiped out the excess water from the surface of the specimen. Placed the specimen vertically on the platform of Universal Testing Machine (UTM) for testing compressive strength. Uniform load application and distribution is facilitated by having pad caps at the ends of the cylinders. Before start to apply the load, ensured that the loading platforms have touched the top of the cylinder. Applied the load continuously and uniformly without shock at the rate of 315 kN/min. And continue the loaded until the specimen failed. Were Recorded the maximum load. The test is repeated for the remaining specimens.



Fig:3.10: Compressive strength test of concrete by Universal Testing Machine (UTM).

3.5 Compressive Strength Test of Concrete:

The concrete cylinder is cast for standard size and allowed to cure for 28 days. Three specimens of the same dimension are cast for testing. Tacked out the specimen from the curing tank. Wiped out the excess water from the surface of the specimen. Placed the specimen vertical on the platform of Universal Testing Machine (UTM) for testing compressive strength. Uniform load application and distribution is facilitated by having pad caps at the ends of the cylinders. Before start to apply the load, ensured that the loading platforms have touched the top of the cylinder. Applied the load continuously and uniformly without shock at the rate of 315 kN/min. And continue the loaded until the specimen failed. Were Recorded the maximum load. The test is repeated for the remaining specimens.

CHAPTER 4

Results and Discussion

4.1 Ratio of manual mix concrete and Ready-mixed Concrete : (1:1.5:3)

4.1.1 Ratio of manual mix concrete:

Concrete is made from cement, sand, gravel and water. For the concrete mixtures cement, sand, gravel and water was used to be mixed in a ratio of 1:1.5:3 to achieve maximum strength. That is 1-part cement, 1.5 parts sand, 3 parts stone, and clean water as per required.

4.1.2 Ratio of Ready-mixed concrete:

Ready mix concrete was made of following ingredients for 1 m^3 of fresh concrete:

Table no. – 4.1

Materials	Unit	Quantity
Water	Kg	165
Cement	Kg	143
Fine Aggregate	Kg	424
Coarse Aggregate	Kg	1144
Admixture	%	0.6
Slump	Mm	95

4.2 Result of compressive strength test and tensile strength of manual mix concrete and Ready-mixed Concrete:

4.2.1 Result of compressive strength test and tensile strength test of manual mix concrete:

We had tested 02 set (06 EA) Concrete cylinders for Result of compressive strength and tensile strength of manual mix concrete. The results of the cylinder test are sequentially mentioned below:

Concrete of Cylinder No-1 for Compressive strength of manual mix concrete:

Cylinder Size 204x100.38 mm

here, Area = (πd^2/4)

=(πx100.38^2/4)

= 7913.785 mm^2

now, C.S = (force/ Area) = (1000x238/7913.785)

= 30.07 N/mm^2

= 4360.75 PSI

Concrete of Cylinder No-2 for Compressive strength of manual mix concrete:

Cylinder Size 203x100.02 mm

here, Area = (πd^2/4)

=(πx100.02^2/4)

= 7857.123 mm^2

now, C.S = (force/ Area) = (1000x235/7857.123)

= 29.9 N/mm^2

= 4337.9 PSI

Concrete of Cylinder No-3 for Compressive strength of manual mix concrete:

Cylinder Size 202x100.05 mm

here, Area = (πd^2/4)

=(πx100.05^2/4)

= 7861.837 mm^2

now, C.S = (force/ Area) = (1000x234/7861.837)

= 29.764 N/mm^2

= 4316.856 PSI

Concrete of Cylinder No-1 for Compressive strength of Ready mix concrete:

Cylinder Size 205x100.34 mm

here, Area = (πd^2/4)

=(πx100.34^2/4)

= 7907.5 mm^2

now, C.S = (force/ Area) = (1000x248/7907.5)

= 31.362 N/mm^2

= 4548.71 PSI

Concrete of Cylinder No-2 for Compressive strength of Ready mix concrete:

Cylinder Size 206x103.08 mm

here, Area = (πd^2/4)

=(πx103.08^2/4)

= 8345.26 mm^2

now, C.S = (force/ Area) = (1000x250.5/8345.26)

= 30.017 N/mm^2

= 4353.551 PSI

Concrete of Cylinder No-3 for Compressive strength of Ready mix concrete:

Cylinder Size 204x101.67 mm

here, Area = (πd^2/4)

=(πx101.67^2/4)

= 8118.51 mm^2

now, C.S = (force/ Area) = (1000x255.8/8118.51)

= 31.508 N/mm^2

= 4569.64 PSI



Fig 4.1 : Crashed concrete of cylinder no.-1 of ready mix concrete.



Fig 4.2 : Crashed concrete of cylinder no.-2 of ready mix concrete.



Fig 4.3 : Crashed Concrete of cylinder no.-1 of manual mix concrete.



Fig 4.4 : Crashed Concrete of cylinder no.-2 of manual mix concrete.

Table:4.2 Compressive strength test of Manual mix concrete:

SL	Length(mm)	Dia (mm)	Area(sq.mm)	Load (KN)	Compressive strength (Psi)	Average Compressive strength (Psi)
1	200	100.38	7913.785	239	4360.75	4338.50
2	200	100.02	7857.12	235	4337.90	
3	200	100.05	7861.837	234	4316.856	

Table:4.3 Compressive strength test of Ready-mix concrete:

SL	Length(mm)	Dia (mm)	Area(sq.mm)	Load (KN)	Compressive strength (Psi)	Average Compressive strength (Psi)
1	200	100.34	7907.5	248	4548.71	4490.63
2	200	103.08	8345.26	250.5	4353.55	
3	200	101.67	8118.51	255.8	4569.64	

4.3 Comparison between Manual mix and Ready-Mix Cylinder Crush vs Crushing Pattern:

4.3.1 Comparison between Manual mix Cylinder Crush vs Crushing Pattern:



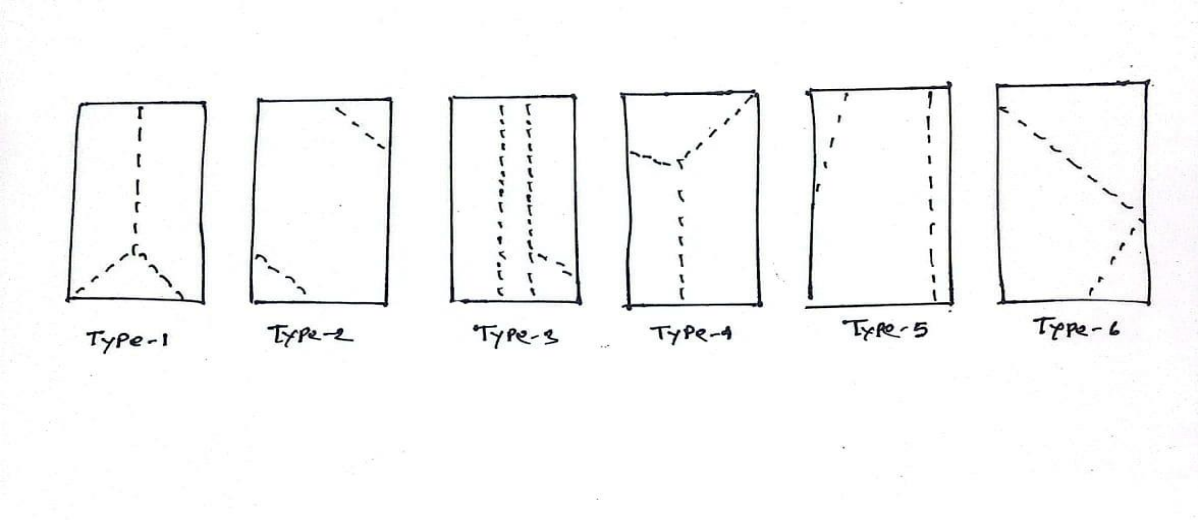


Fig. : 4.5 Crash pattern of Cylinder type-6 of manual mix concrete.



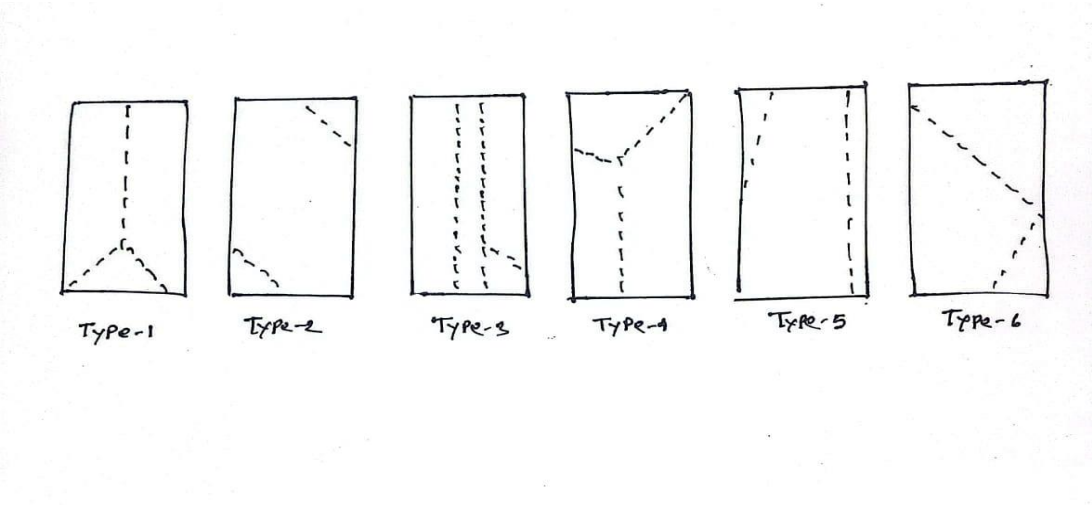


Fig. : Crash pattern of cylinder (type-3) Ready mix concrete.

4.4 DISCUSSION:

The compressive strength of ready-mix concrete is found as 4490.63 psi and the manual mix concrete is found as 4338.5 psi. So, the compressive strength of ready-mix concrete is found as 3.4% higher than that of batch mix one.

4 Reasons why Ready Mixed Concrete is better than manual Mixed Concrete:

Concrete is the most used construction material Two types of mixing process are commonly used on construction Site for concrete ready-mix concrete and Batch mix concrete.

Ready-Mix Concrete:

Since Ready mix concrete is the Computerized process it's easier to maintain the Quality. For Ready mix concrete We have used Portland composite Cement, Coarse Aggregate, Fine Aggregate, Clean Water and Additional Chemical Admixture (BASF) to improve manageability The chemical elements reduced the water quantities in the mixture and increased its strength without much effort, we were followed mixing ratio of 1:1.5:3.

Manual mix Concrete:

Manual mix Concrete is manual process on construction site. Workers must be careful and meticulous with the material's proportions to avoid any quality issues in the concrete for batch mix concrete. We have used of three components for Batch mix concrete: Coarse Aggregates (3/4" down:1/2") and two types sand (Local Sand 50% & Sylhet Sand 50%) . Also were used clean water, we were followed mixing ratio of 1:1.5-3.

Experimental program on RMC:

The compressive strength of concrete is the ability to resist a crushing controlled by the water-cement ratio. Strength testing of ready-mix concrete sample is a very important. there are two types of strength test which are performed. These are:

- Slump Test
- Compressive Strength Test

This test is performed to check the consistency of freshly made concrete. The slump test is done to make sure a concrete mix is workable.

However, the theoretical compressive strength related to a particular water- cement ratio will be attained only if the actual amount of water added is carefully regulated. This test is performed by Universal Testing Machine (UTM) after 28 days curing. We find that the compressive strength of ready-mix concrete is higher than batch mix concrete.

So, we agreed that Ready Mixed Concrete is better than manual Mixed Concrete.

Chapter-5

Conclusions and Future Works

5.1 Conclusions:

Concrete is a very important building material and it is used mostly now in all the construction work and life of any structure is totally depend upon the best material quality. In this study the compressive strength of the ready-mixed concrete and manual mix concrete has been discussed. On the basis of this study, it is found that:

- The compressive strength of ready-mixed concrete is higher than that of manual mix study
- The tensile strength of ready-mixed concrete is almost the same of that of batch mix concrete

- For large concrete work and mass concreting, or while constructing multistoried buildings, employing Ready-mixed concrete can be beneficial in terms of labor, quality, and time too.

5.2 Limitations and Recommendations for Future Works:

This is a short scale research work due to limitation of time and resources. Large scale of research is needed with changing various parameters for having more accurate results. More research works by changing the mix ratios for both of these concretes can be done for more accurate results. Following suggestions are recommended:

- Large scale research can be done by changing mixing ratios and comparing among them.
- Changing the size of coarse aggregates and also changing the water cement ratio is recommended for future study.
- Compressive strength test of both ready-mixed concrete and manual mix concrete in different temperature variations is recommended.

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