iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** V **Month of publication:** May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5305

Development of High Early Strength Concrete for Accelerated Bridge Construction Closure Pour Connections

Amar Chandra Yadav[1], Shashank Gupta[2], Vikram Singh[3]
[1]*Postgraduate student, Structural Engineering, Department of Civil Engineering, Dr K N Modi University Newai, Rajasthan.*
[2,3]*Assistant Professor, Department of Civil Engineering, Dr K N Modi University Newai, Rajasthan.*

Abstract: Accelerated bridge construction (ABC) has become a popular alternative to using traditional construction techniques in new bridge construction and existing bridge deck replacement because of the reduction of time spent in field activities. A key feature of bridges built using ABC techniques is the extensive use of prefabricated components. Prefabricated components are joined in the field using small volume closure pours involving high performance materials (steel and concrete) to ensure adequate transfer of forces between components. To date, the materials developed for closure pours have been based on proprietary components, so a need has arisen for development of mixes that use generic components. The goal of this research was to create a method to develop concrete mixtures that are designed using generic constituents and that satisfy performance requirements of accelerated bridge construction closure pours in New England, primarily high early strength and long-term durability.
Keyword: Alternative, Techniques, Prefabricated, Adequate, Generic.

I. INTRODUCTION

Accelerated bridge construction (ABC) is a construction technique that has become popular with existing bridge deck replacement and even with some new bridge construction projects because of the reduction in on-site activities. By reducing the on-site activities, ABC techniques reduce the overall construction time, which results in economic savings. ABC techniques also create safer roadway conditions and reduce traffic delays when compared to traditional construction techniques. One common technology used with ABC is prefabricated bridge elements and systems. When this technology is utilized for ABC, structural components of the bridge are built offsite or adjacent to the alignment.

II. OBJECTIVE OF THIS STUDY

The main objective of this research project was to develop and validate concrete mixtures that develop high-early strength without detrimentally affecting their long-term performance. The concrete mixtures designed for this research project were developed for use in ABC in New England; therefore, attention was paid to conditions specific to the environment in the region when developing the mixtures, such as freeze-thaw cycles, the use of deicing materials and concrete placement under a varied range of temperatures

III. LITERATURE REVIEW

Byard and Ries 2011 Due to this deficiency in the interfacial transition zone of concrete, a weak point forms in the concrete and provides a preferable pathway for the ingress of potentially harmful chloride ions.

Fowler 2006; Young et al. 1998 There are several types of aggregate gradations. In general, continuously graded aggregate and gradations with high packing densities are favorable to develop high strength concrete.

Koehler 2014 Gap gradations often result in a concrete with a more fluid consistency, which means less high-range water reducing (HRWR) admixture is required for a desired workability. Gap gradation can also be beneficial to concrete strength because it can help reach high packing density.

Mindess and Young 1981 There has also been some criticism of this method; stating that the parabolic gradations simply do not work and there needs to be a certain proportion of fine aggregate for workability purposes.

Xie et al. 2012 maximum aggregate size has a strong impact on the strength of concrete. The main reason for this is attributed to the change in bond strength between coarse aggregates and cement paste with different aggregate sizes.

IV. DEVELOPMENT OF CONCRETE MIXTURE DESIGN

A. Methodology

To develop the concrete mixture designs intended for the application specified in a series of iterative trial batch concrete mixtures were conducted. The trial batch concrete mixtures had a goal of achieving adequate strength and constructability, while taking measures to generate a concrete mixture with durable properties. The iterative process of mixing and testing trial batch concrete mixtures led to the development of two selected concrete mixture designs. Two of the concrete mixtures, which satisfied the target strength and constructability properties were selected for further testing. Once selected, a set of additional short-term tests were conducted. For this research project, short term tests refer to tests that take less than 30 days to complete. Finally, a concrete mixture design specification was developed for ABC closure pour concrete mixtures, where guidelines are provided to develop concrete mixtures for this specific application.

B. Materials

The first step in designing trial batch concrete mixtures is to determine the materials to be used. This section will describe which aggregates, cementitious materials and chemical admixtures were used for the trial batch concrete mixtures in this research project.

1) Aggregates
2) Cementitious Materials
3) Chemical Admixtures

C. Proportioning

Various methods were used to determine proportioning of the trial batch concrete mixtures. The first method used was to replicate select state-of-practice concrete mixtures, as described in Section 2.2.1. The compressive strength and constructability results from these trial batches were not satisfactory; therefore, two other methods were considered. One method was to follow the Guide for Selecting Proportions for High-Strength Concrete Using Portland Cement and Other Cementitious Materials written by ACI Committee 211 (ACI 211.4R) and the other was to use maximum compaction of aggregates, which has also shown to achieve high-strength of concrete, as discussed in Section 2.1.2.3 of the literature review. Both of these methods produced reasonably satisfactory results, in terms of compressive strength and workability.

D. Mixing Procedure

All concrete batches were mixed at the University of Massachusetts, Amherst Gunness Structural Engineering Lab. Mixing of concrete was performed in accordance with ASTM Standard C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory. A STOW Model CM6 concrete mixer, with a capacity of 6 cubic feet (165 liters) was used to mix all machine mixed concrete batches. The first concrete batches, which are not reported in the previous chapter, were approximately 0.27 cubic feet in volume. This volume was too small to be mixed in the concrete mixer, and, therefore, were mixed by hand in a 25.75” x 17.75” x 3.5” round edged aluminum pan. Adequate mixing was not able to be obtained using this method, due to the high cement content. The concrete became very clumpy and dry to the point that the concrete could not be cast in molds for testing; therefore, this hand mixing method was discontinued and larger volumes were mixed. Since the machine mixing procedure proved favorable, it was used for all subsequent trial batches, and all trial batches reported from this research project are only those mixed using the concrete mixer.

E. Compressive Strength

To test compressive strength of the concrete mixtures, ASTM Standard C39: *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens* was followed. Three cylindrical specimens were cast to determine compressive strength at each selected testing time (i.e. 3 – 12-hour strength specimens, 3 – 24-hour strength specimens, etc.). Standard cylindrical plastic molds, as shown in Figure 6.1-with a diameter of 4 inches and a height of 8 inches were used. To fill the molds, concrete was poured in 2 layers, and each layer was rodded with a tamping rod 25 times to consolidate the concrete. The cylinders remained in the plastic mold until the time of testing. Every concrete mixture was tested for compressive strength at 12 hours and 24 hours. Additional tests at 18 hours, 7 days and 28 days were performed for various concrete mixtures as discussed in Chapter 5 in order to understand later strength gains that occurred in the concrete mixtures. The compressive strength of each cylindrical specimen was tested using a FX500 Forney Compression Testing Machine. The cylinders were tested to failure to find the ultimate compressive strength values. The load was applied at a loading rate of 35 ± 7 psi/sec during the latter half of the anticipated loading phase. During the first half of the anticipated loading phase, a higher rate of loading was used.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Fig.6.1 Cylindrical molds

REFERENCES

[1] Akkaya, Y., Ouyang, C., and Shah, S. P. (2007). "Effect of supplementary cementitious materials on shrinkage and crack development in concrete." Cement and Concrete Composites, 29, 117–123.

[2] Al-manaseer, A. A., Aquino, E. B., and Kumbargi, H. (2000). "Properties of Concrete Containing Ultimax Rapid-Setting Hydraulic Cement." ACI Materials Journal, (96), 529–535.

[3] Balaguru, P. N., and Bhatt, D. (2001). "Rapid Hardening Concrete." Rutgers, The State University Center for Advanced Infrastucture and Technology, NJDOT, U.S. DOT FHA.

[4] Beerman, B. (2016). "U.S. DOT Federal Highway Administration." Accelerating Innovation: Prefabricated Bridge Elements and Systems.

[5] Brooks, J. J., Johari, M. A. M., and Mazloom, M. (2000). "Effect of admixtures on the setting times of high-strength concrete." Cement & Concrete Composites, 22, 293–301.

[6] Brown, J. H. (1980). Effect of Two Different Pulverized Fuel Ashes Upon the Wokability and Strength of Concrete. Wexham Springs, UK.

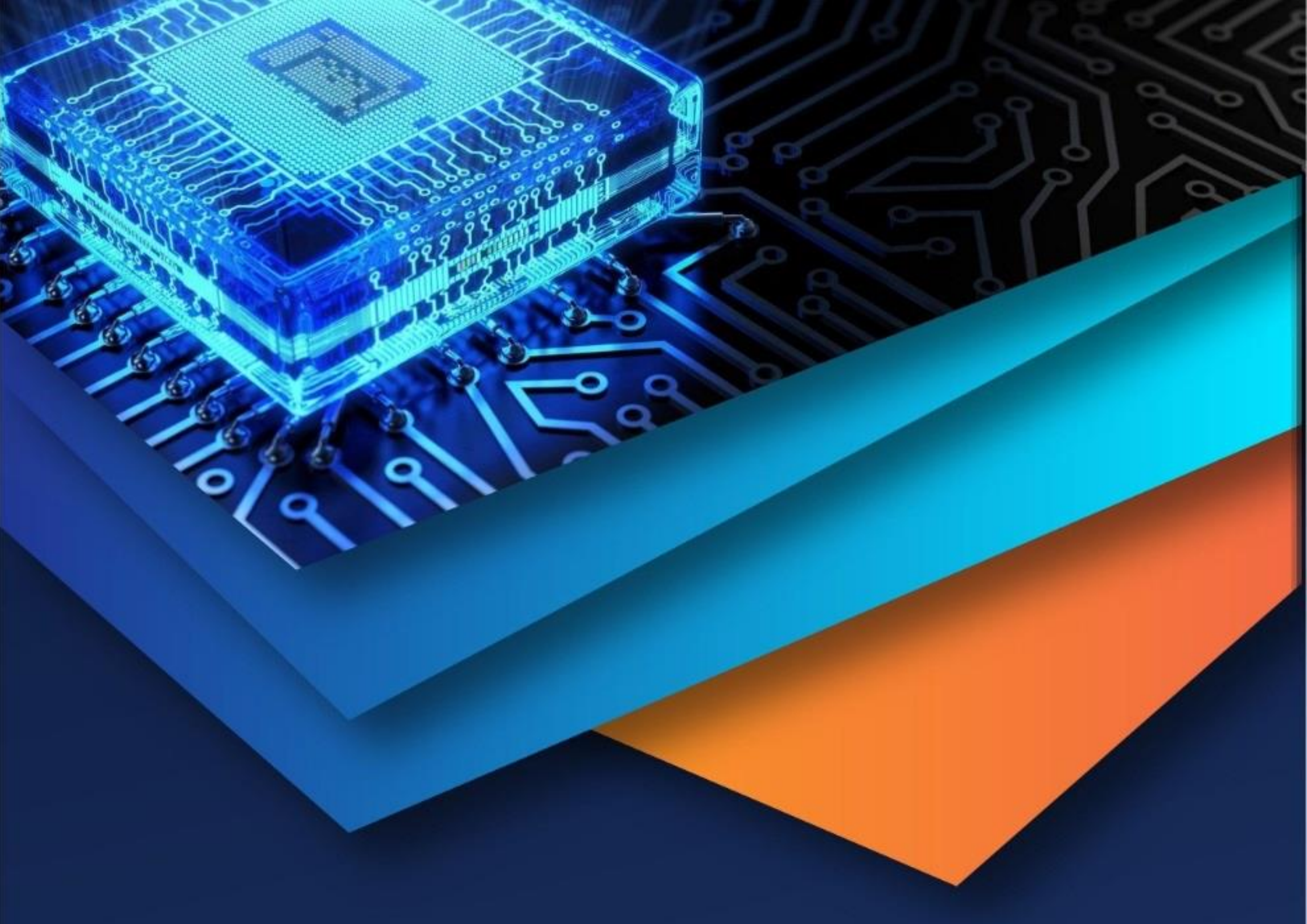
[7] Byard, B. E., and Ries, J. (2011). "Optimizing the Sustainability of Concrete Through Internal Curing.pdf." American Concrete Institute Speical Publication.

[8] Folliard, K. J., and Berke, N. S. (1997). "Properties of High Performance Concrete Containing Shrinkage-Reducing Admixture." Cement and Concrete Research, 27, No 9, 1357–1364.

[9] Freyne, S. F., Russell, B. W., Bush, T. D., and Hale, W. M. (2004). "Comparing Different Cements in High-Performance Concrete." ACI Materials Journal, (November-December), 435–441.

[10] Han, V., Ros, S., and Shima, H. (2013). "Effects of sand content, superplasticizer dosage, and mixing time on compressive strength of mortar." ACI Materials Journal, 110(1), 23–31.

[11] Hover, K., and Stokes, T. (1995). "Making 'Cents' out of the Water-Cement Ratio." Concrete International, May, 52–54.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY