

# UTILIZATION OF MATURITY METERS FOR CONCRETE QUALITY ASSURANCE

## PROBLEM STATEMENT

Florida Department of Transportation (FDOT) specification 346-9 requires contractors to prepare three “Quality Control (QC) cylinders” for each concrete LOT (50 yd<sup>3</sup>, or one day production, whichever is less). In addition, FDOT prepares three “Verification cylinders” and two “Hold cylinders” (to be used if the strength difference between the QC and Verification cylinders is more than 750 psi) from one of every four consecutive LOTS of each mix design. This current QA/QC practice results in a large number of cylinders to be cast, cured, and tested.

Moreover, FDOT specification 353-10.1 requires that the concrete pavement slabs be kept closed to the traffic until the compressive strength of 2200 psi is reached. The strength should be verified either by cylinder test results per specification 353-5 or by the maturity method as described in specification 353-10.2. The latter requires contractors to develop standard strength-maturity relationship charts for the project-specific concrete mixtures according to ASTM C1074 standard practice. The charts are to be verified by the Engineer on the first day of production of concrete or on subsequent days as desired by the Engineer. These strength-maturity relationships charts are valid for those particular concrete mix designs only. The procedure described in ASTM C1074 standard is quite general, and selection of certain parameters (such as the proper maturity index function, datum temperature, and supplemental strength prediction method) depends on the local specifications, test conditions, and the discretion of the Engineer. A specific procedure should be developed to supplement the existing ASTM C1074 standard.

## OBJECTIVES

The purpose of this research was to develop a standard protocol for the incorporation of the maturity method for concrete QA/QC. The goal is to replace part of the conventional cylinder testing procedure with the maturity technique to expedite construction and achieve cost savings.

This research project has four main objectives:

1. Compare different types of maturity equipment, in particular maturity sensors, and develop clear guidelines regarding their selection criteria.
2. Develop standard strength-maturity relationship charts for selected concrete mixtures commonly used by FDOT.
3. Investigate suitable location(s) for the installation of maturity sensors in different types of structural elements (i.e., drilled shafts, columns, and bridge decks/slabs).
4. Develop a Quality Assurance (QA) protocol for implementing the maturity method in the existing FDOT specifications.

## **FINDINGS AND CONCLUSIONS**

The findings of this study are summarized below:

1. Both Sacrificial (S) and Non-sacrificial (NS) sensors produce equally accurate results. The choice between the two types should depend on total cost and compatibility with field conditions. The NS-type sensors are economical when the number of simultaneously operated sensors is four or less. When this number exceeds four, the S-type sensors become more cost effective.
2. Sacrificial sensors are more secure than the non-sacrificial sensors. These sensors have less chance of data loss due to the power failure or breakage of wires. However, they could be displaced during the placement of concrete and, hence, cannot be installed at positions where no reinforcement is available to provide proper support.
3. The temperature gradient across the cross-section is lowest at the sides; hence, it is reasonable to install the sensors on the sides rather than in the middle portions. The sensors located in the middle of the structure have a greater chance of displacement during the placement of concrete.
4. The sensors must be installed at the bottom portion of drilled shafts and at the top portion of columns to record the conservative or lower strength values in the respective structural element. The strength development in a concrete structure is not uniform. Thus, for structures other than drilled shafts and columns, the sensors should be installed at regions where internal temperature of concrete will be lowest, or regions where the highest loads are expected.

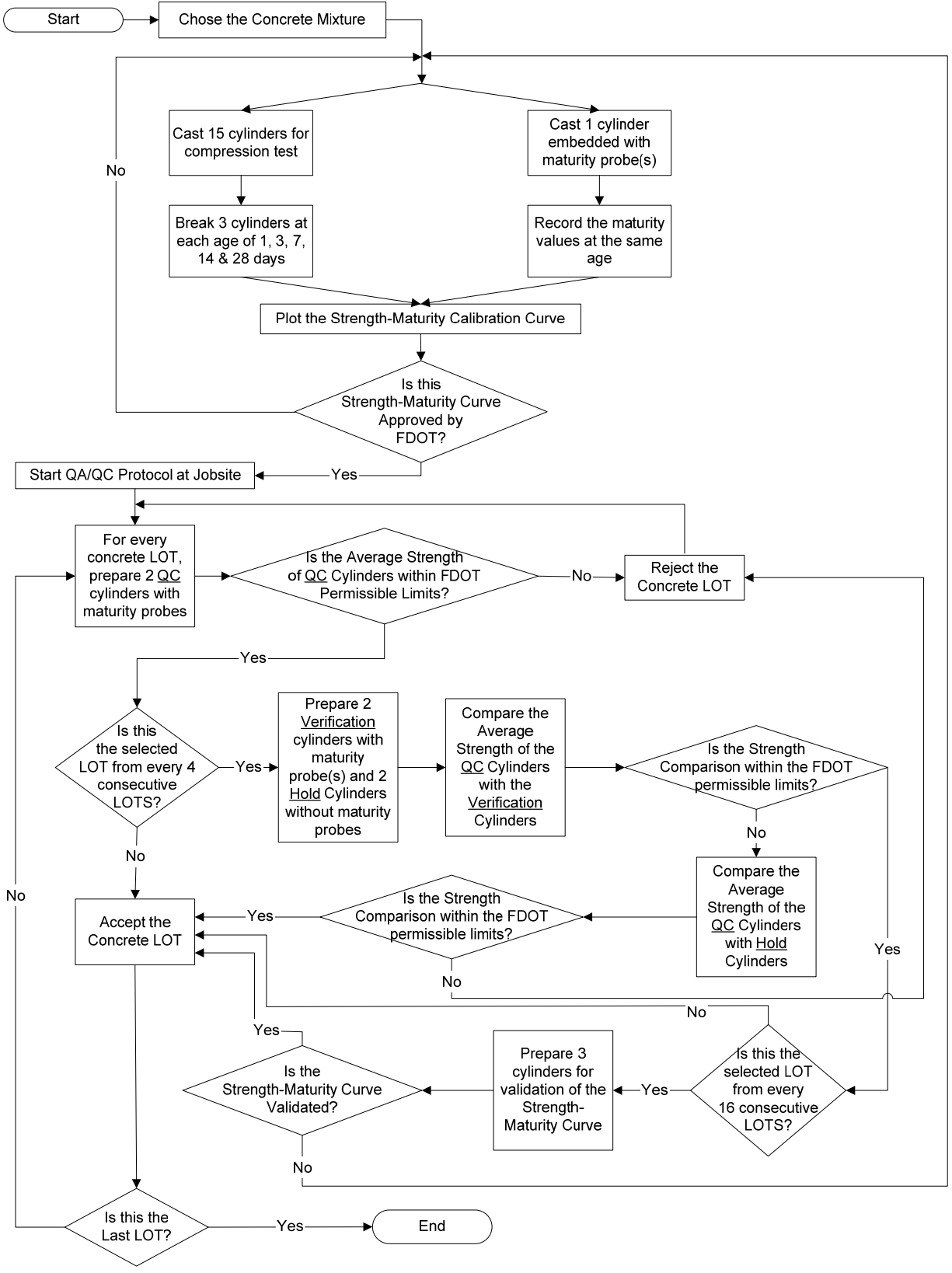
Researchers developed a new QA/QC protocol based on the maturity method and suitable for FDOT (see Figure 1).

## **BENEFITS**

The proposed QA/QC protocol will allow contractors to use the maturity method to predict the strength of concrete. The current FDOT specification (346-9.1) requires at least 17 cylinders to be tested for direct compressive strength in the laboratory for every four consecutive LOTS. By successfully implementing the proposed QA/QC protocol, this number will be reduced to 12, thereby resulting in about 30% savings in laboratory testing costs and transportation charges.

The maturity testing of the QC and the verification cylinders can be reliably performed in the field and there will be no need to transport the cylinders to the laboratory. This will further reduce the transportation costs which are incurred as a result of transporting the cylinders from the field to the laboratory. Moreover, prediction of strength can be made instantaneously at any given time. This will increase the speed of construction in fast-track projects, where the preceding activities (such as removal of formwork) are linked with the attainment of required level of strength.

This research project was conducted by Irtishad Ahmad, Ph.D., P.E., of Florida International University. For more information, contact Hesham Ali, Ph.D., P.E., Project Manager, at (954) 777-4106 or [hesham.ali@dot.state.fl.us](mailto:hesham.ali@dot.state.fl.us).



**Figure 1: The Proposed QA/QC Protocol for Concrete Construction**