LUMPS AND BALLS IN HIGH-SLUMP CONCRETE: REASONS AND REMEDY

PROBLEM STATEMENT

In high-slump truck-mixed concrete, mostly used in drilled shafts (deep foundation system for heavy loads), lumps and balls, typically the size of a lemon to a baseball, are not uncommon. Such lumps and balls jeopardize structural integrity of concrete by forming weakened zones and by increasing the potential for soil intrusion. Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction (2000) section 346-7.4.1 requires that concrete should be free from lumps and balls of cementations material. Hence, when lumps are found, concrete batches are to be rejected. The consequences are disruption of work, costly rework, and loss of valuable time. A study needs to be performed to determine the root causes of the remedies for the formation of lumps and balls in high-slump truck-mixed concrete.

OBJECTIVES

The primary objectives of this research were to determine the reasons for the formation of lumps and balls in high-slump truck-mixed concrete and to find ways to avoid them. The uniformity of truck-mixed concrete depends on a number of factors such as the mixing sequence, mixing time, charging and mixing speed, discharge rate (speed at which the materials are charged into the mixing truck through chute), size of truck-load (total volume of concrete), number of initial revolutions (number of revolutions of truck mixer after addition of materials but before slump adjustment), and headwater percentage (water added to the mixer before the addition of materials, expressed as percentage of total batch water). The first three factors have been extensively studied by a number of researchers and standardized by different organizations, including the Florida Department of Transportation (FDOT Specifications, 2000). Hence, the remaining four factors were selected as variables for this research.

FINDINGS AND CONCLUSIONS

The project report outlines the major causes of lumps and balls formation, ways to avoid them, and a set of guidelines to follow when lumps and balls are found. A set of proposed specifications for high-slump truck mixed concrete is also included for consideration by the FDOT to expand or amend the existing specifications.

Based on the findings of this study, the following conclusions can be drawn:

1. Headwater percentage and initial revolutions have a combined effect on the number of lumps and balls produced. A low headwater percentage followed by higher number of initial revolutions can eliminate concrete lumps. The optimum combination was found to be 30%

headwater percentage with 100 initial revolutions at a speed of 12 rpm. It can be concluded that a headwater percentage between 30-40% and a number of initial revolutions between 90-100 can produce lumps free concrete.

2. The optimum speed at which the materials exit the loader through the chute into the mixing truck (discharge rate) was found to be 200±10 lbs/sec.

3. Although the size of a concrete load does have an effect on the number of lumps and balls formed, load sizes smaller than 9 cubic yards are not commercially feasible. Since the number of lumps and balls formed with load sizes of 7 and 9 cubic yards were found to be almost the same, it is recommended that a load size of 9 cubic yards be used whenever concrete in large amounts is required.

4. The sieve analysis indicated that most of the concrete lumps and balls were similar in gradation and made up of small coarse aggregates, coarse sand, and cement.

BENEFITS

The production of lump-free concrete is in the best interest of all parties involved in the project, i.e., the concrete producer, the contractor, and the FDOT. It is expected that this study will result in lower contract prices for the construction of drilled shafts. If the concrete producers are assured of producing concrete free of lumps and balls and, as a result, the contractors are assured that their time will not be lost, then they will be encouraged to bid lower to reflect the cost savings. This will also encourage early completion of the contracts.

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