

Quality Assurance of Neat Cement Grout

Progress Report

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Problem Definition

- This research project looks to investigate the quality assurance procedure for neat cement grout used with micropiles.
- Furthermore, to minimize the inconsistencies that exist within the current quality assurance method of grout cube sampling.
- Therefore, the consistency and accuracy of current Australian grout-related standards regarding the performance of grout require an investigation.

Project Aims

The aims supporting this investigation are as follows:

- To confirm the reliability of the 'mud' balance test for quality assurance purposes
- To confirm that a 0.45 W/C ratio (S.G of 1.89) is the most economically, yet structurally integral mixture
- Test and compare the affects of different 'on site' variables on the cube sample/curing process

Project Objectives

The Objectives required to justify these aims are as follows:

- Justification of the relationship between the specific gravity of grouts and the respective compressive strengths according to AS 1012.9
- Check whether the differing specific gravities comply with Transport and Main Roads specifications according to ASTM C490-10a and the ASTM C939-10
- Comparison of the practicality between the mud balance test and grout cube sampling (site variable analysis)

Project Scope

- In Australia, the Queensland Department of Transport and Main Roads have recognized cube sampling as an adequate testing procedure.
- However have not yet fully recognized mud balance testing.
- Further testing to examine the relationship between water bleed and compressive strength of neat cement to the water-cement ratio to determine if these properties can be reliably forecast through the use of real time checks on site using specific gravity.

Literature Review

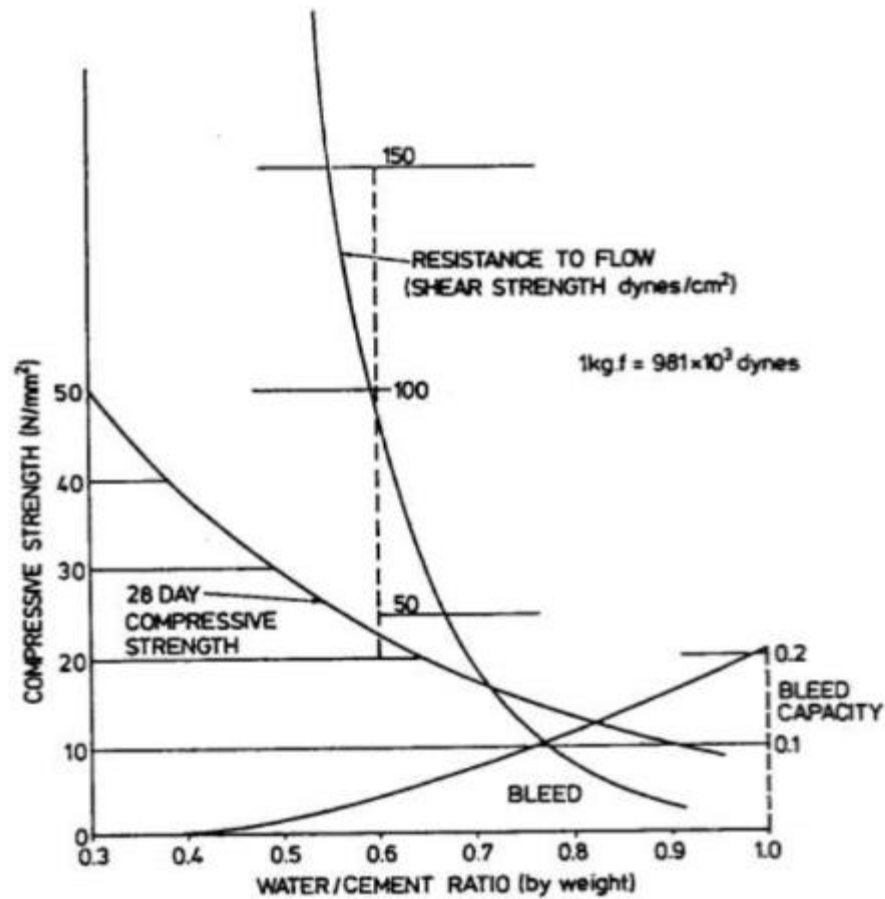


Figure 1. Grout Mixture Properties

(Little John and Bruce, 1977, published in Micropile Design and Contrustion, 2005.)

Testing and Data Collection

- 60 grout cubes will be tested as per the relevant Australian and American Standards as per TMR.
- Testing will be conducted in 3 sections:
 - Testing a range of water-cement ratios (0.4-0.8) for their compressive strengths to produce a relationship with the specific gravity of neat-cement grout under ideal conditions.
 - Testing the properties of these grout mixes according to TMR specs to investigate the ideal water-cement ratio
 - Subjecting grout cubes to various 'site' conditions to investigate the flaws that exist within the cube sampling/curing process

Past Compressive Strength Testing

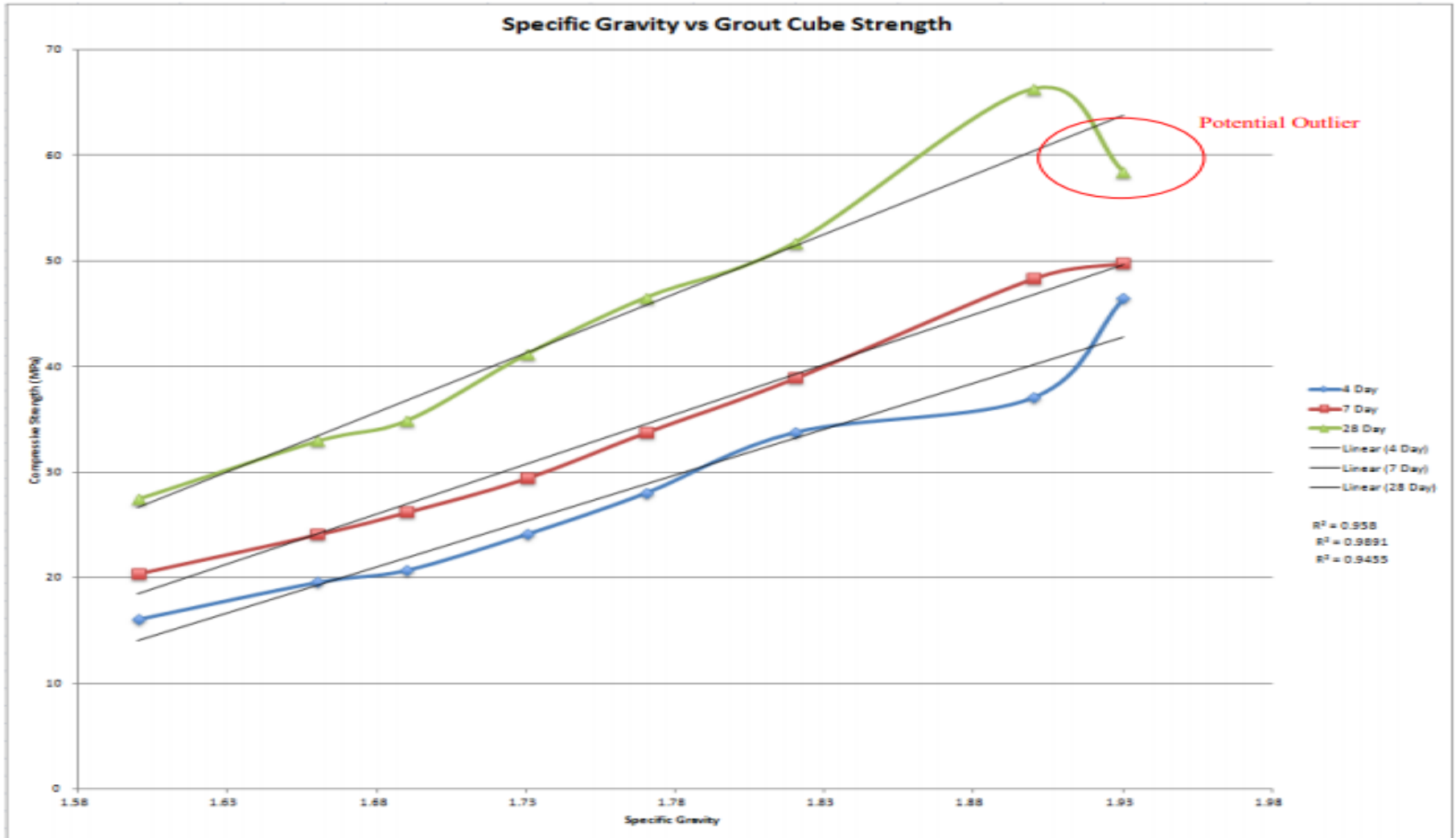


Figure 27. Grout Mix Specific Gravity vs. Grout Cube Compressive Strength

Past Project Testing

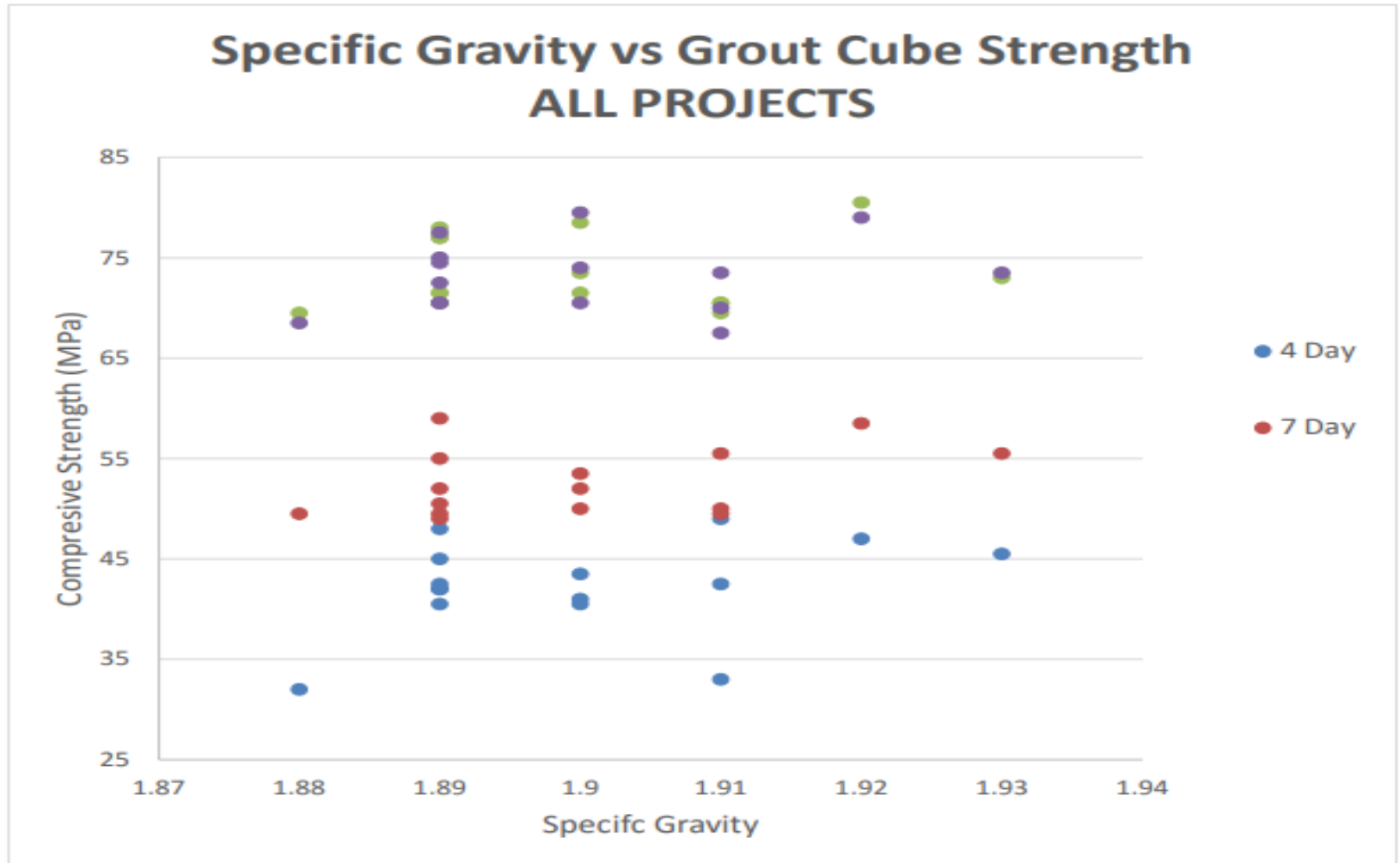


Figure 29. Grout Performance Details Provided by Piling and Civil Australia

Future Site Condition Testing

- In order to investigate the reliability of cube crushing as a method of quality control, 33 cubes will be subject to 11 different site conditions. These conditions include;
 - High temp curing
 - Dry curing
 - Low temp curing
 - Morning sun
 - Afternoon sun
 - Sun all day
 - Controlled sun (shade)
 - Early de-mould (18 hrs)
 - Normal de-mould (24 hrs)
 - Late de-mould (36 hrs)
 - And finally a Control condition

Future Bleed Testing

- Furthermore, to be carried out as the current semester continues, bleed (%) data will be taken from the samples and relationships such as the;
 - Volume of Bleed (%) Present at Differing Water-Cement Ratio relationships will be formed
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 - As well as the combined expansion for wicked and unwicked samples.
 - Bleed vs Water-cement relationship will be assessed to display the variances since the first relationship was formed in 1977.

Future Bleed Testing

Property	Test Method	Criteria
Bleeding	ASTM C9401	Final Bleeding < 0.5%.
Early Expansion	ASTM C940	< 2% at 3 hours.

Property	Test Method	Criteria
Fluidity	ASTM C9392	Immediately after mixing: Efflux time < 20 s. 45 minutes after mixing: Change in efflux time < ± 3 s
Minimum compressive Strength	Q476	32 MPa at 7 days



Post Testing & Data Collection

- From here the data will be analyzed and relationships will be assessed
- Then these results will be discussed and further evaluated within the objectives of the research project
- With conclusions hoping to be able to fulfill the aims of this investigation to confirm that a 0.45 W/C ratio (S.G of 1.89) is the most economically, yet structurally integral mixture and the effectiveness and reliability of the 'mud' balance test for quality assurance purposes for neat cement grout