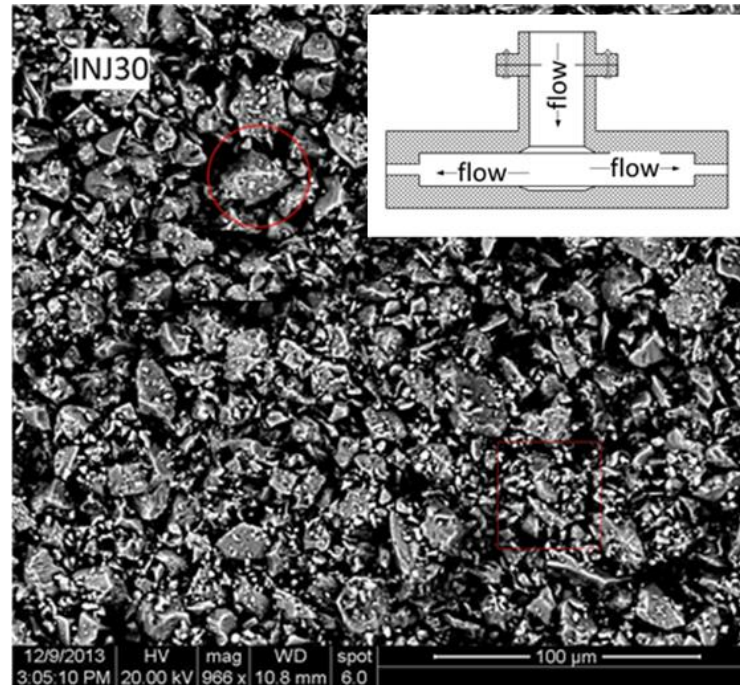


# PENETRABILITY OF CEMENT-BASED GROUTS DEPENDENT ON THE PSD-CURVE AND CEMENT CHEMISTRY

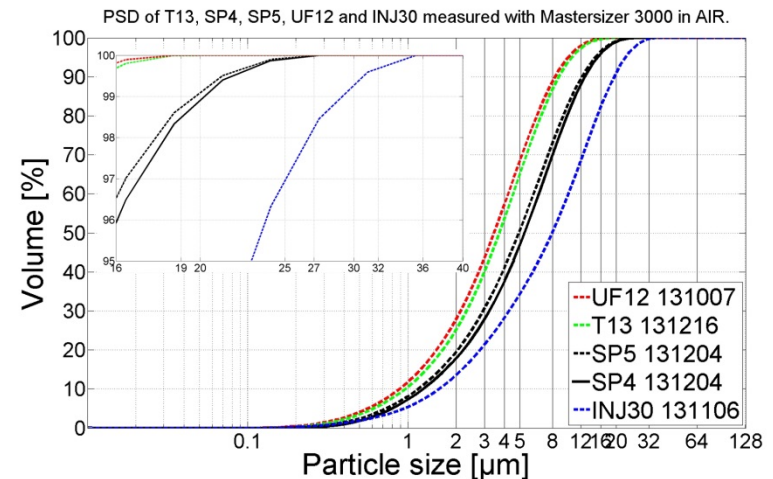
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Conny Björk, *Nauplion AB, Sweden.*



# Milling of cement as a method used to improve the penetrability of a grout

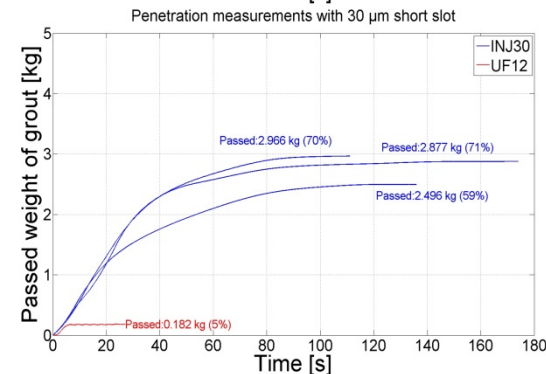
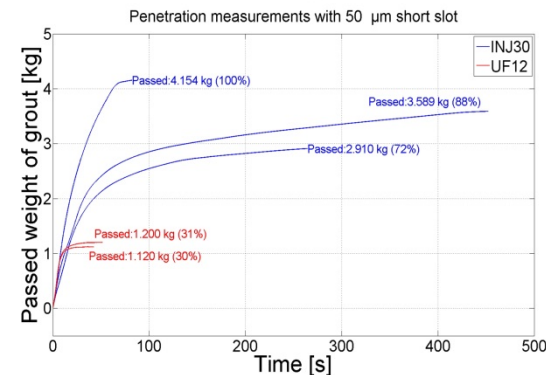
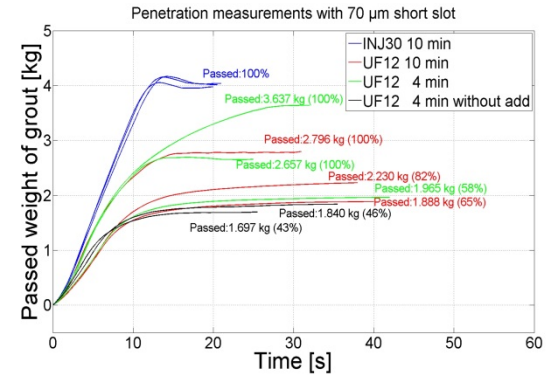
- Milling of cement is a method used to improve penetrability of a grout.
- Earlier research has shown that cement can be milled to a certain maximum grain size to improve penetrability.
- Further milling has a negative impact on penetrability, probably due to a larger proportion of fine particles which tend to flocculate.
- Figure to the right show PSD curves off cements with different  $d_{95}$  which are tested in this study.



*PSD curves of T13, SP4, SP5, UF12, and INJ30*

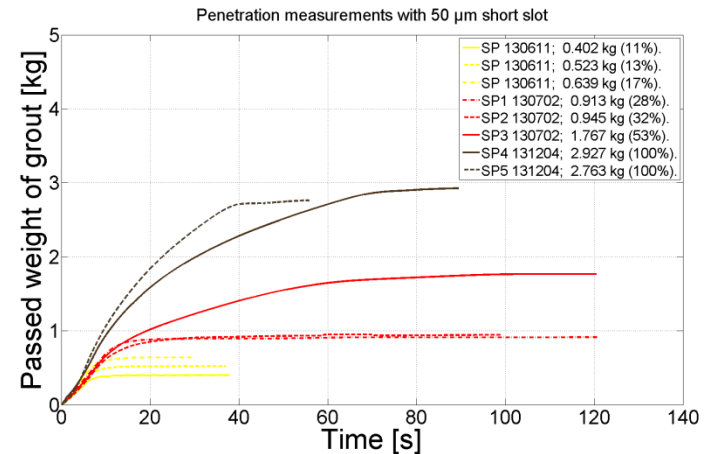
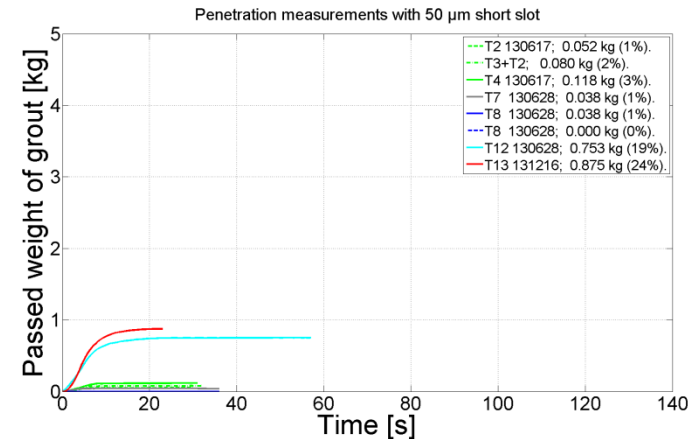
# Penetration measurements with INJ30 and UF12

- Figure to the right shows results from penetration measurements of INJ30 and UF12 based grouts measured with 70, 50 and 30  $\mu\text{m}$  slot.
- INJ30 showed a better penetrability although a larger  $d_{95}$  but a lower amount of fine particles.
- Chemical analysis of INJ30 and UF12 showed that UF12 had a somewhat lower content of gypsum than INJ30. The part of gypsum in UF12 has probably converted to hemihydrates during grinding due to the high grinding temperature. More soluble hemihydrates in contact with water may cause secondary gypsum formation. This might also contribute to lower penetrability of UF12.



# Penetration measurements with T- and SP-cements

- T-cements are produced from a mixture of UF12 and INJ30. Despite the reduction of fine particles they do not show a better penetrability. It indicates that cement chemistry is also important.
- SP-cements are produced from other Portland cement but not from INJ30 and UF12.
- SP4 and SP5-cements showed a better penetrability than UF12 with reduced amount of fine particles. SP-cement are produced from different Portland cement and it is not clear if reduced amount of fine particles or changed chemical content improved the penetrability.



# Conclusion

- This study confirms previous research findings (Eklund and Stille, 2008; Draganović and Stille, 2011; Pantazopoulos et al. , 2012) that grouts based on ordinary Portland cement with a  $d_{95}$  of 30  $\mu\text{m}$  have better penetrability than grouts based on more finely ground cement with a  $d_{95}$  of 12  $\mu\text{m}$ .
- Chemical analysis of INJ30 and UF12 and penetration tests with T- and SP-cements indicate that not just the amount of fine particles in cements is important for penetration but also the chemical content of cement such as content of gypsum and its form in cement as dihydrate or hemihydrate might be important.
- Measurements of SP-cements showed that the penetrability of grouts based on fine-milled cement can be further improved. Since the detailed chemical content of tested SP-cements is not known, it is not clear what the main reason for the improved penetrability is.