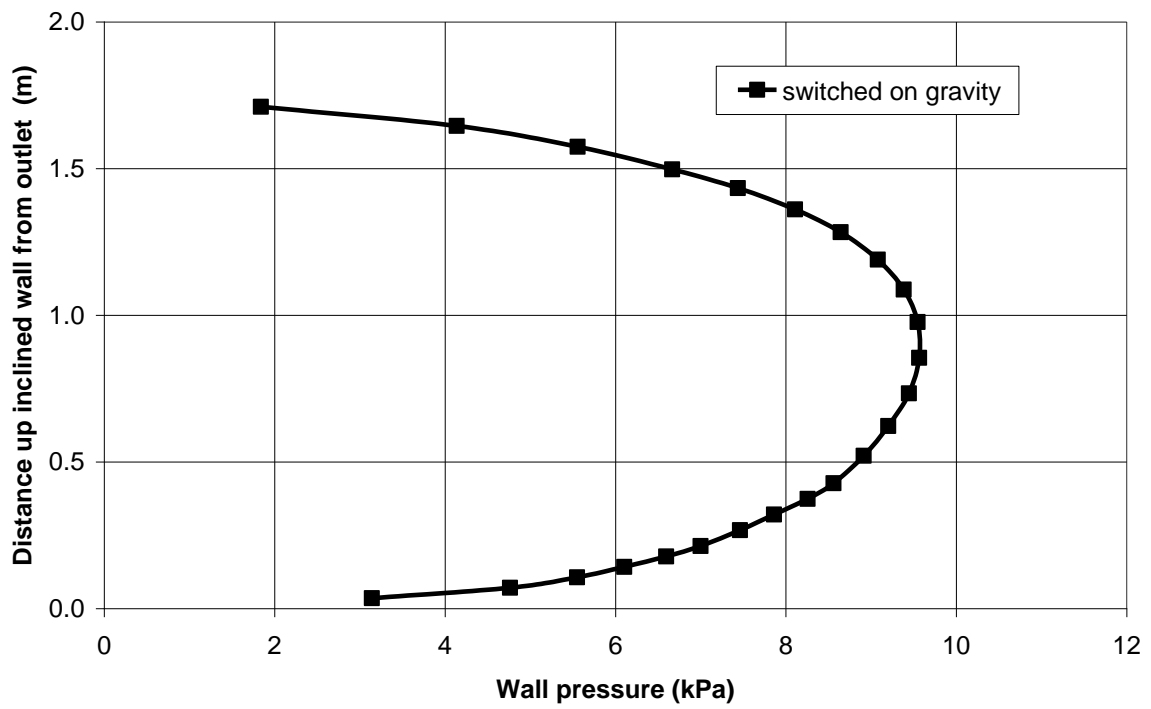


Fig. 1 Layered segments used in the finite element representation



a) Switched-on gravity filling

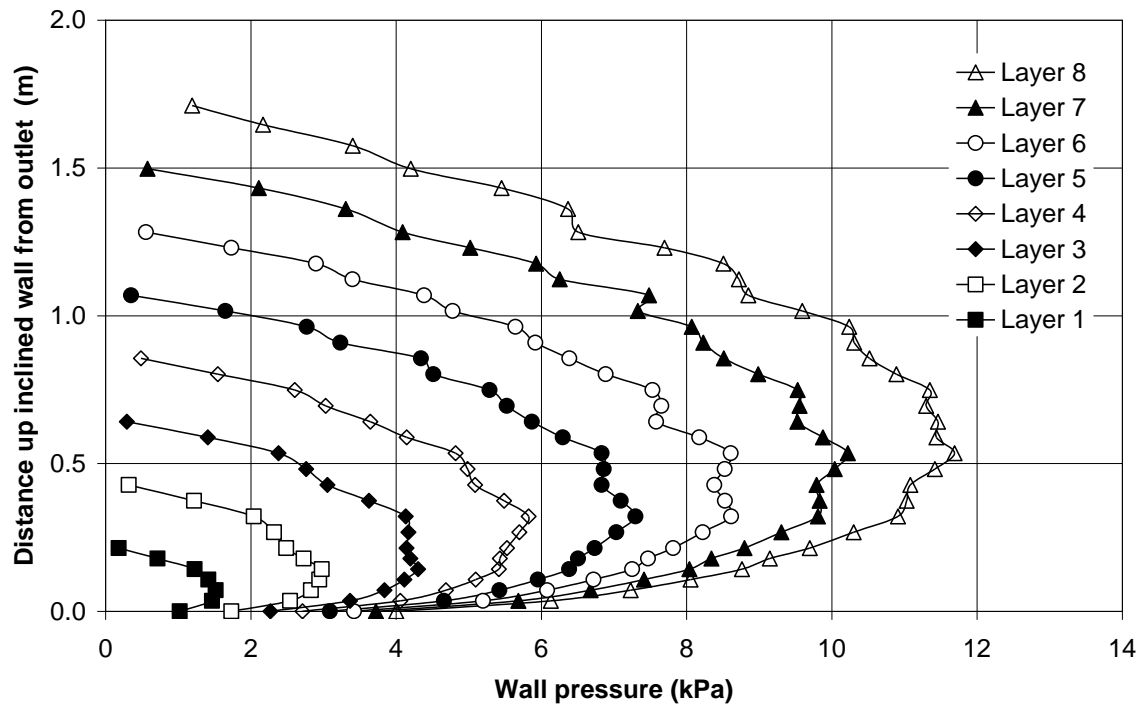
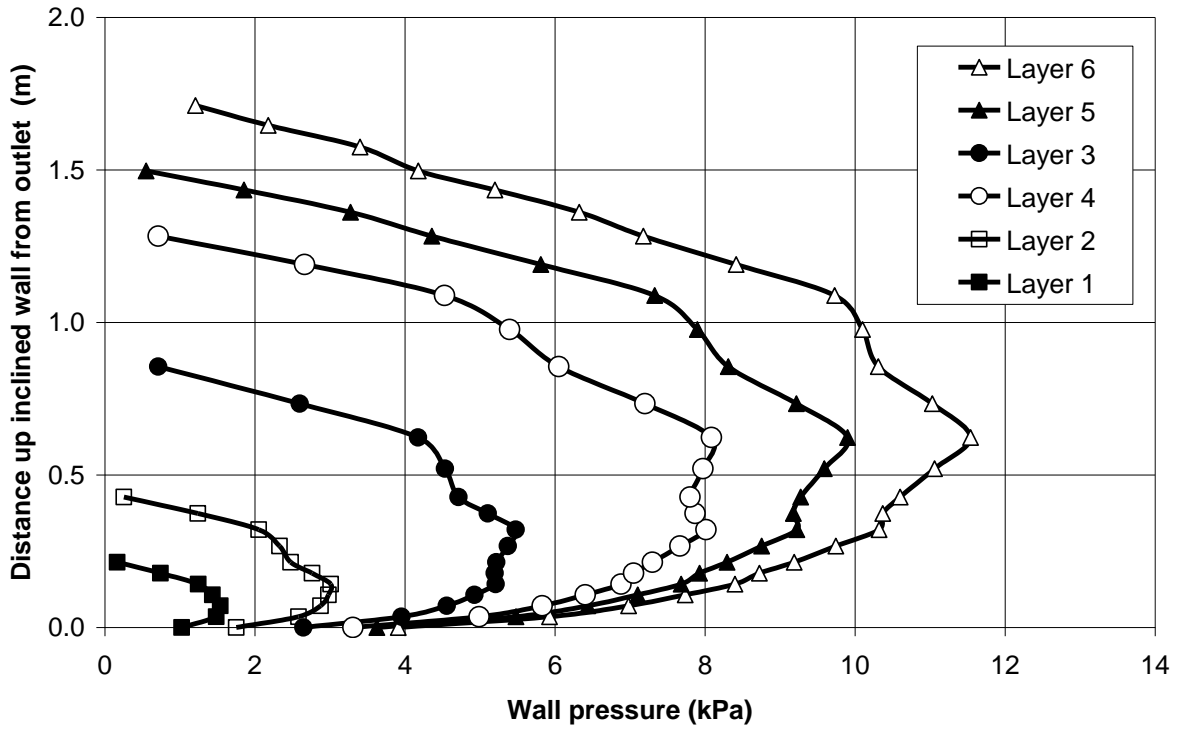


Fig. 2 Normal pressure developed on the hopper walls

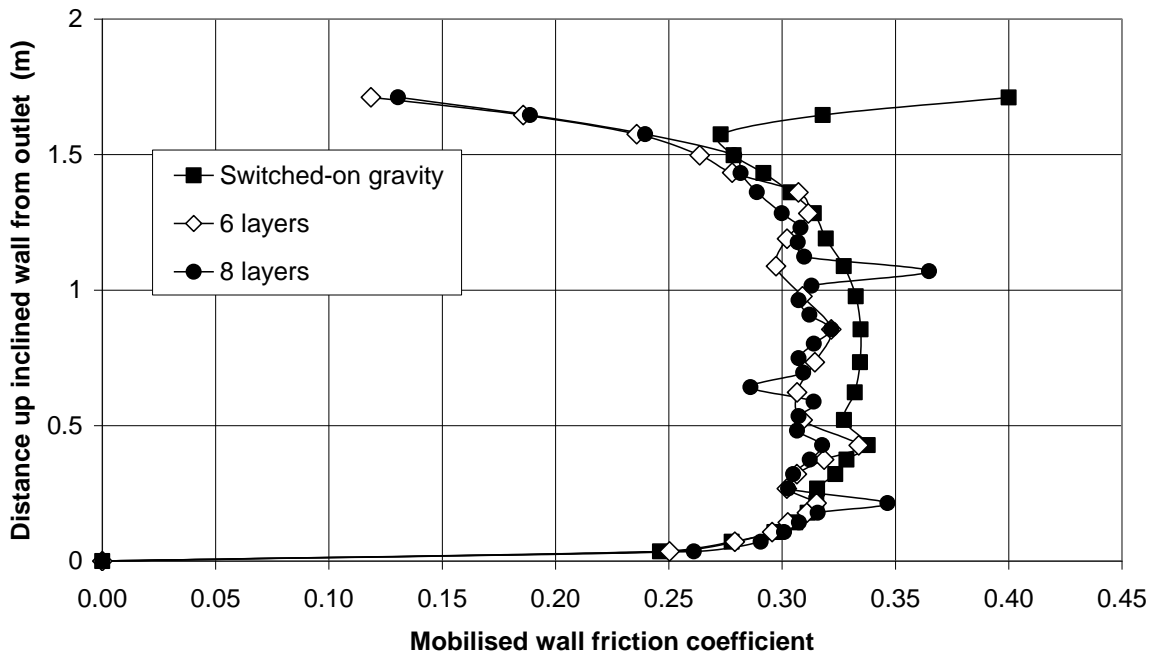
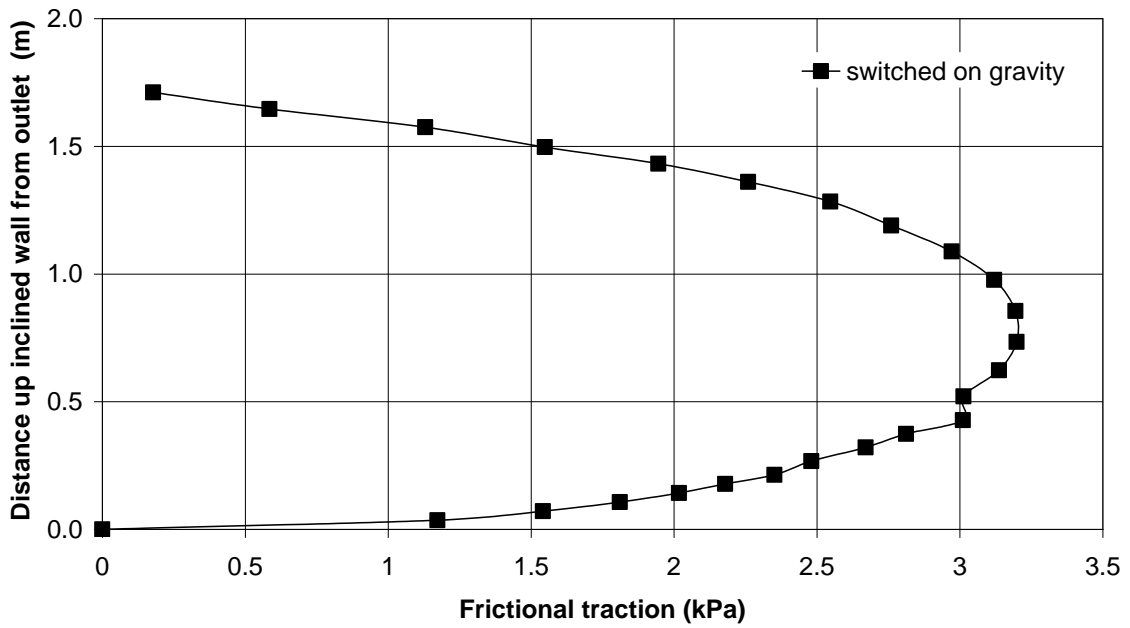
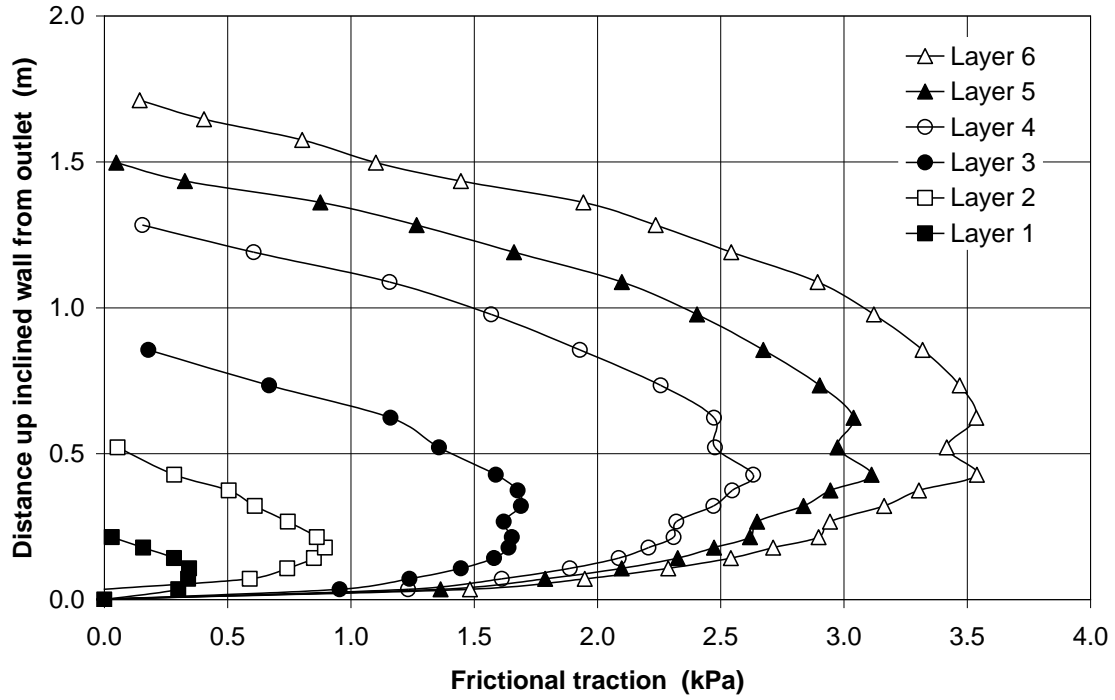


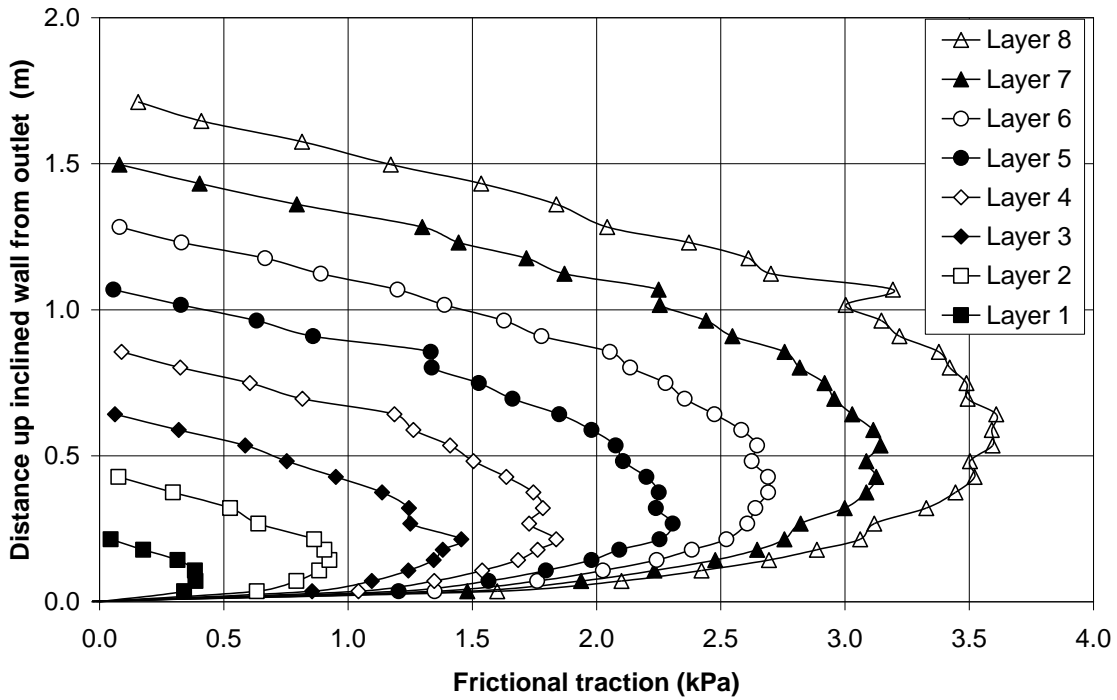
Fig. 3 The local value of mobilised friction coefficient



(a) Switched-on filling



(b) Six-step filling



(c) Eight-step filling

Fig. 4 Frictional traction distributions developed on the wall

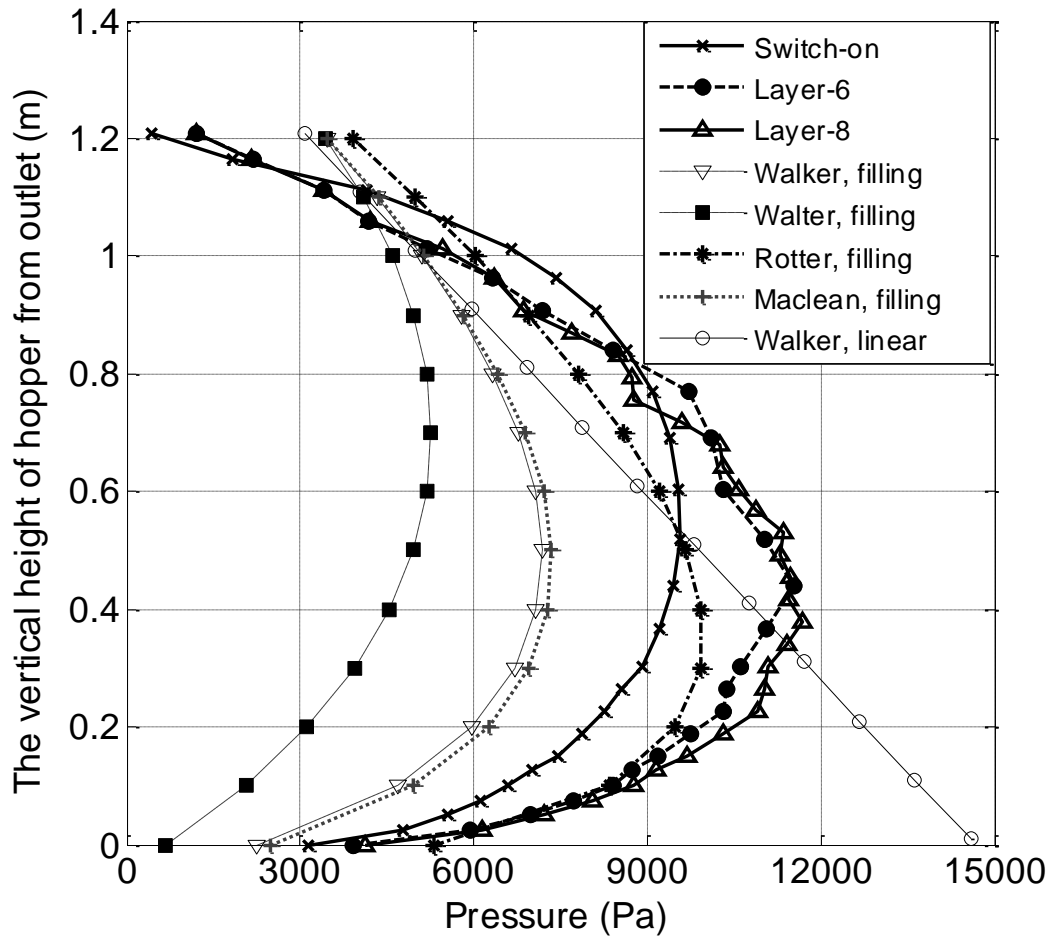


Fig. 5 Alternative predicted pressures on the shallow hopper wall

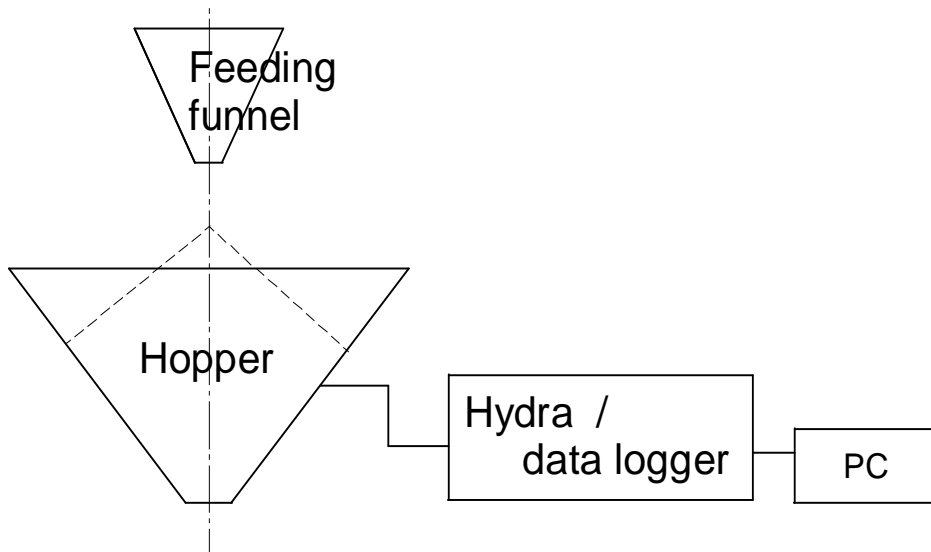


Fig. 6 Schematic view of the experimental arrangement

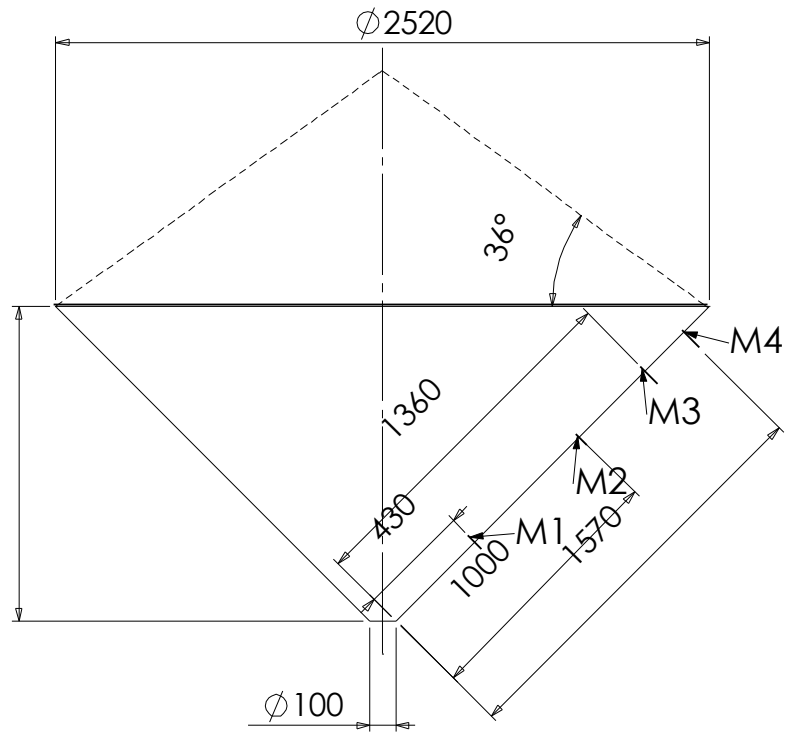
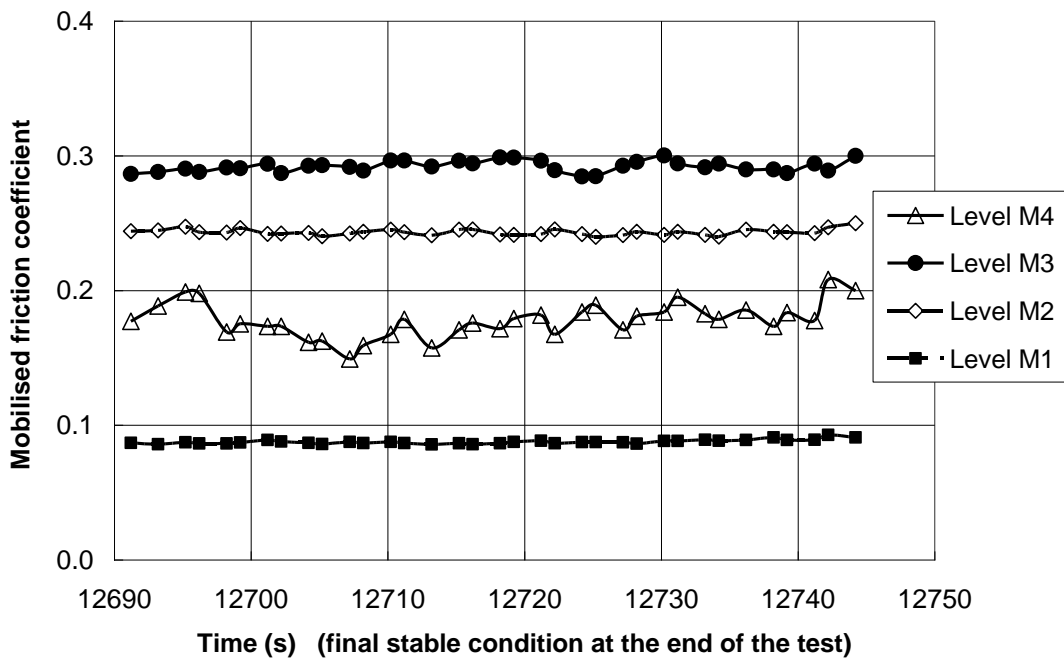
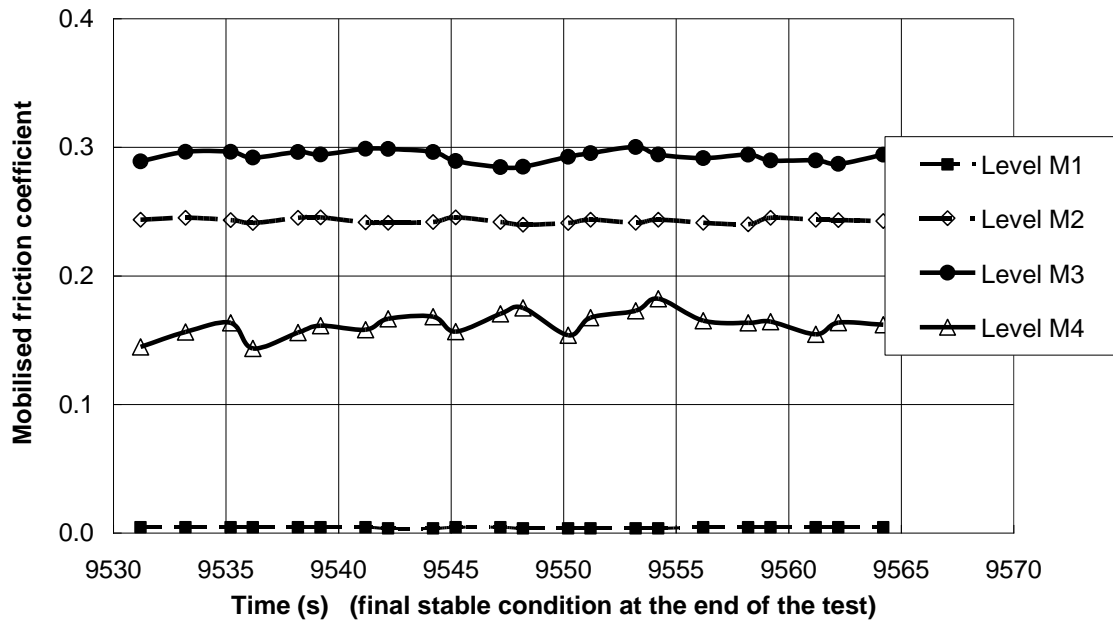


Fig. 7 Location of pressure transducers on a meridional generator of the hopper



a) Test 1



b) Test 2

Fig. 8 Mobilised wall friction coefficients at the end of filling

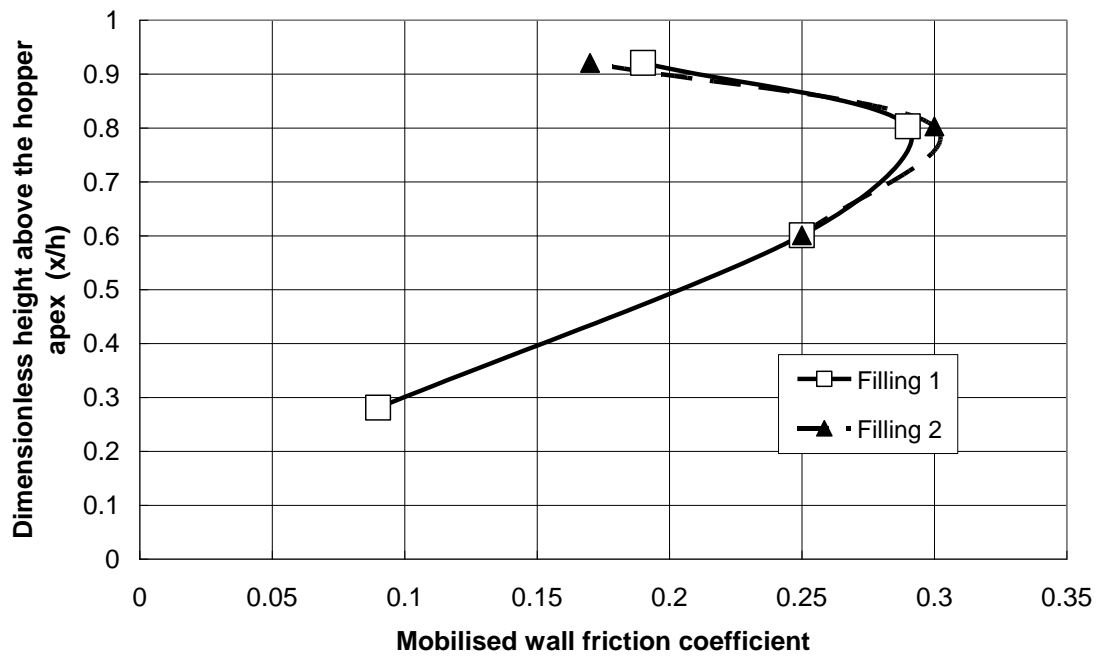


Fig. 9 Measured wall friction coefficients on the hopper wall at the end of filling

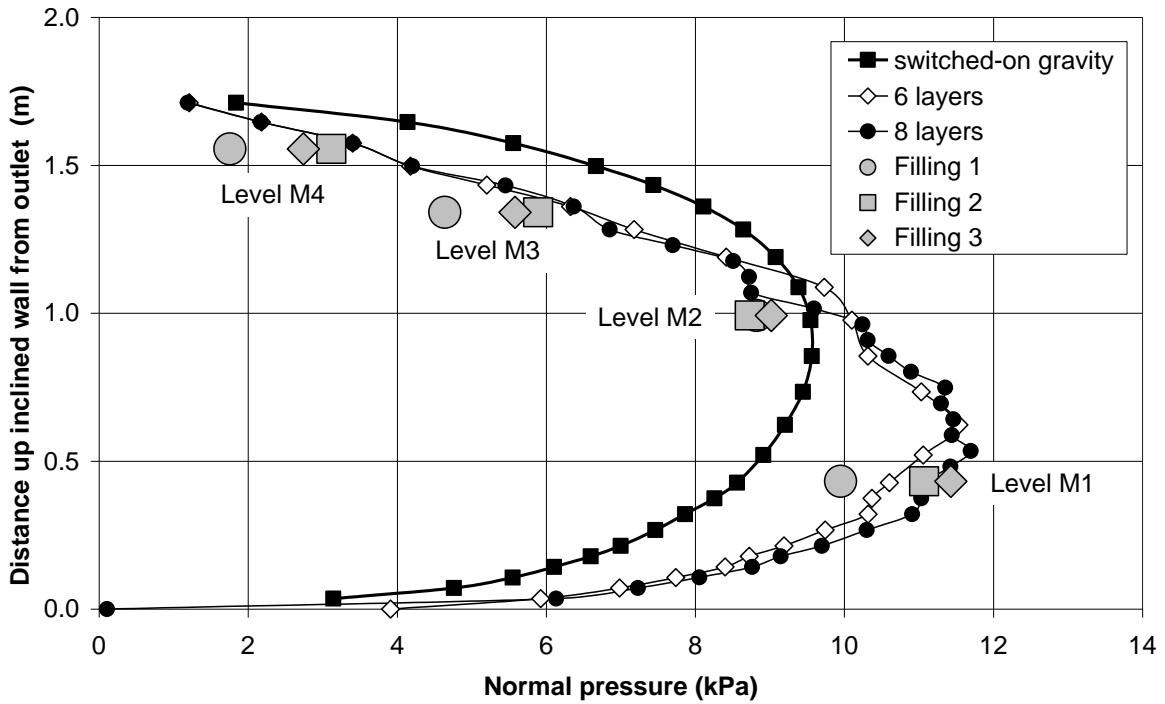


Fig. 10 Comparison of experimentally measured and numerically predicted pressure at the end of filling

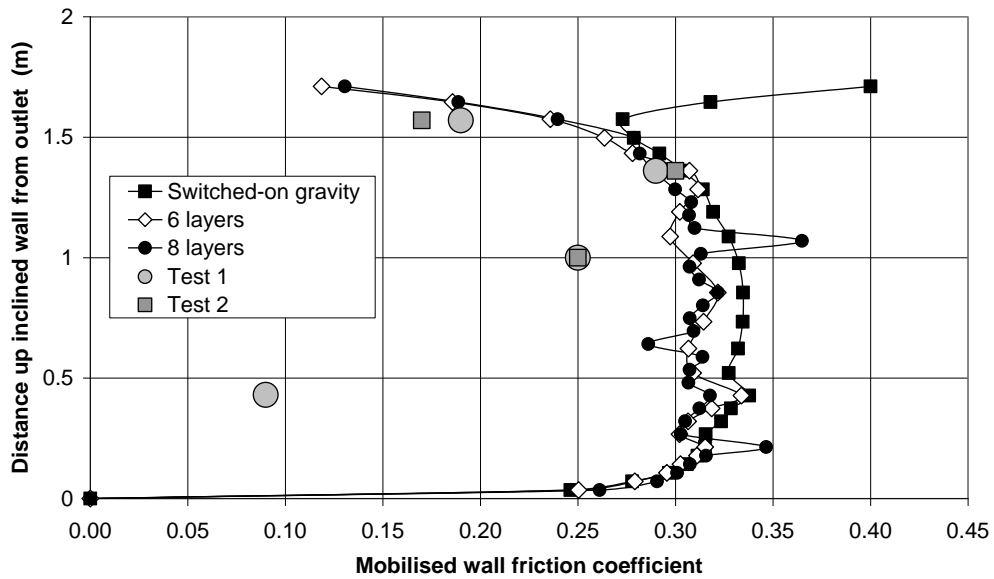


Fig. 11 Comparison of experimentally measured and numerically predicted mobilised friction at end of filling