Effects of spacing, depth and soil type on *in situ* shear strength measurements

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1- Background:

Shear strength is soil resistance to any deformation caused by an applied force (Ali et al. 2010). A useful means of measuring shear strength is the shear vane which is a portable tools which can be used for in situ shear strength measurements (Sposaro et al. 2008; Zimbone et al. 1996). Although it is inexpensive, quick and easy way of in situ measuring shear strength, data about the minimum distances and depths apart between the points of measurement are scarce, and will be investigated here – as this information is required to improve shear measurement methodology.

2- Methodology:

A shear vane was used in three sites with different soils (sandy, sandy loam and clay loam) in Four gate and Large Marsh field located at Harper Adams University college for *in situ* shear strength measurements (fig. 1) at two different depths (3.5 and 10.5 cm). Soil moisture content was measured and the average of 31.59% and 35.59% were recorded for sandy loam and clay loam soil respectively.

A shear vane tester (1.75 X 3.5 cm) was used for measuring soil shear strength as shown in (fig. 2) at two different depths in each point, the measurement started with pushing down the vane to a depth of 3.5 cm in the soil then rotated clockwise, torque was applied and the maximum value recorded. The vane was then pushed to the soil into the second depth of 10.5 cm and the same process repeated.

The vane shear was moved to the second distance 4 cm apart then 6, 8 and 10 cm (fig.3) and the measurements process repeated data were recorded.

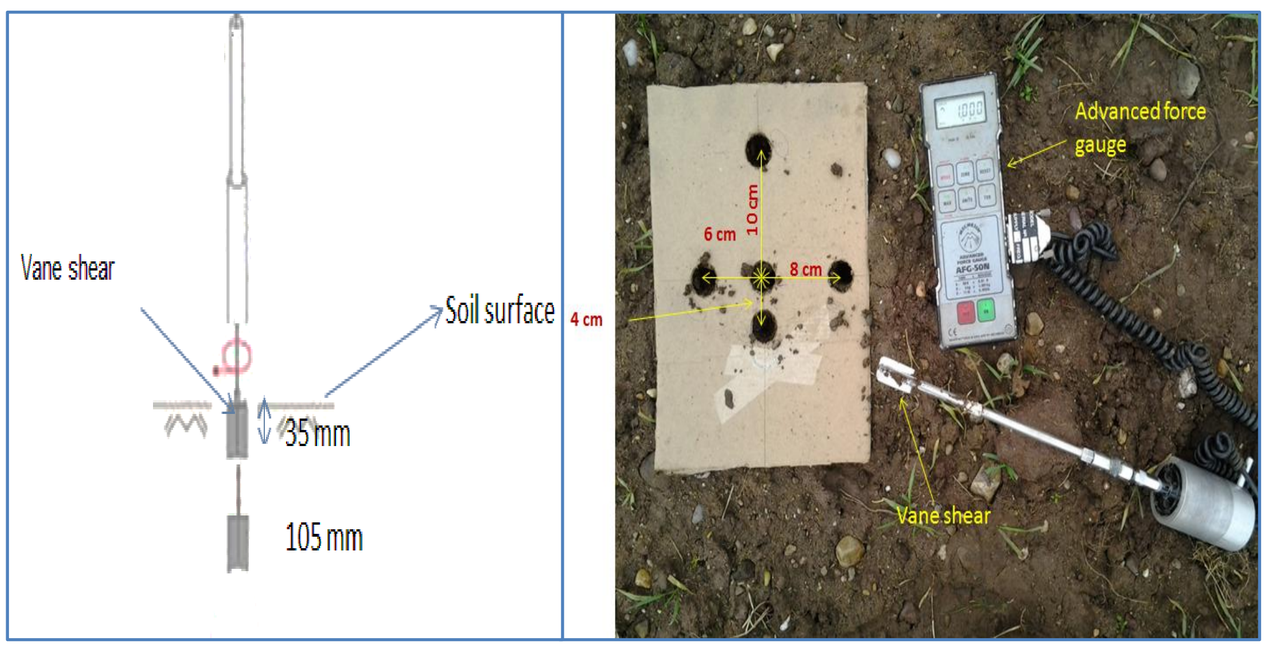
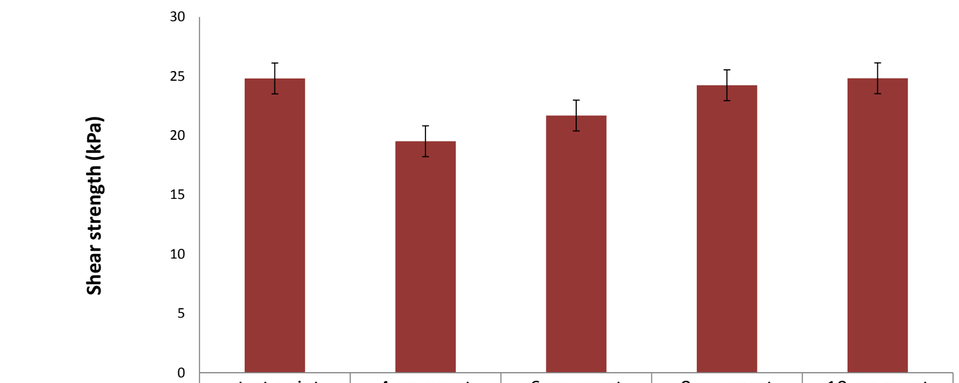


Figure 2. Shear strength measurements at two different depths at the same point

Figure 3. *In situ* shear strength measurement in different distances apart

3- Results:

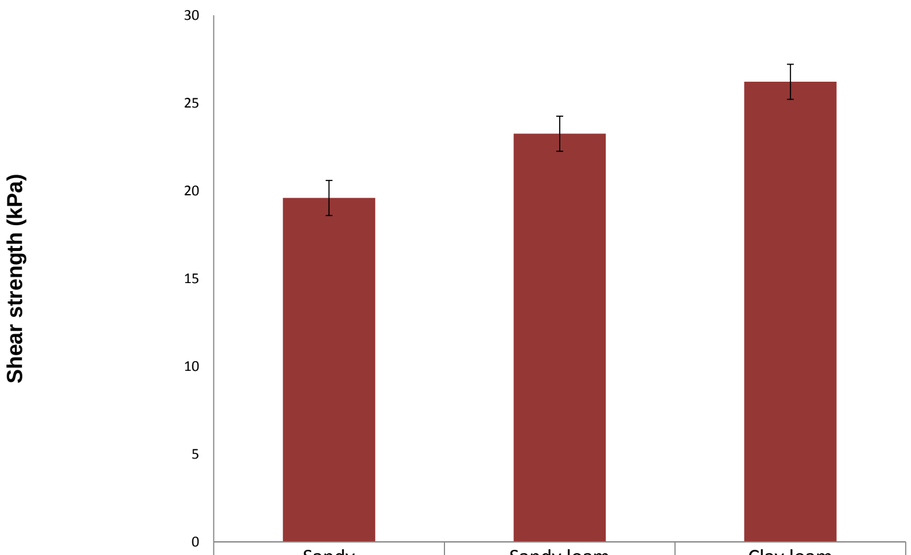
1. The values of shear strength at 4, 6 cm apart were significantly less than those measured at the start point by 21.3% and 12.6% respectively (fig. 4).



	start point	4 cm apart	6 cm apart	8 cm apart	10 cm apart
Shear strngth (kPa)	24.81	19.52	21.68	24.24	24.83

Figure 4. The effect of distance apart on *in situ* shear strength measurements (S.E.D = 0.551) C.V (%) = 24, d.f. = 595, p= <0.001

2. Shear strength in sandy soil was significantly ($p<0.001$) less than sandy loam by 25.2% and clay loam soil by 15.7% (fig. 5).

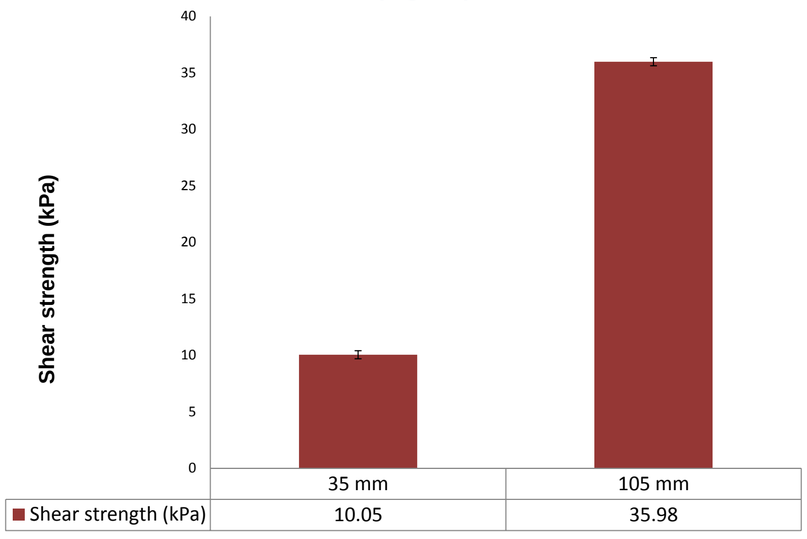


	Sandy	Sandy loam	Clay loam
Shear strength (kPa)	19.59	23.25	26.21

Figure 5. The effect of soil type on *in situ* shear strength measurements (S.E.D = 0.999), C.V (%) = 61.4, d.f. = 597, p= <0.001

Figure 1. In situ shear strength measurement in different distances apart

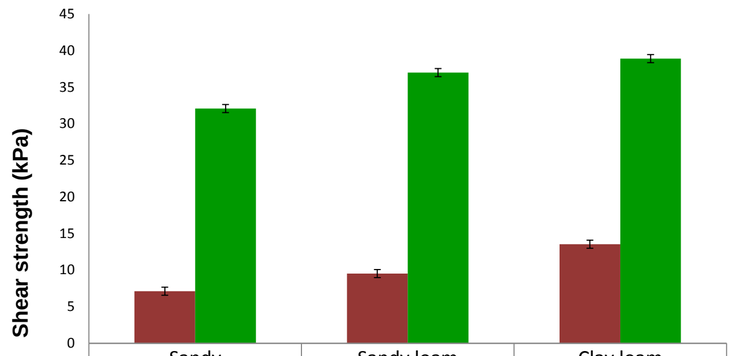
3. Shear strength was significantly increased by 70% when depth increased from 3.5 to 10.5 cm (fig. 6).



	35 mm	105 mm
Shear strength (kPa)	10.05	35.98

Figure 6. The effect of depth on *in situ* shear strength measurements (S.E.D = 0.355) C.V (%) = 26.7, d.f. = 598, p= <0.001

4. The interaction of soil type and depth significantly affected shear strength as it can bee seen in (fig. 7).



	Sandy	Sandy loam	Clay loam
35	7.11	9.51	13.54
105	32.07	36.99	38.89

Figure 7. The effect of soil type and depth on *in situ* shear strength measurements (S.E.D = 0.551) C.V (%) = 24, d.f. = 594, p= 0.049

4- Conclusions:

1. Distance apart between the points of *in situ* shear strength measurements significantly affects its values. The distance between the points at which shear strength is measured should be no less than 8 cm.
2. The depth of measurement has a significant effect on shear strength value.
3. Soil type significantly affects shear strength. Shear strength showed a greater value in clay loam soil than sandy loam and sandy soil used in this investigation.

References:

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