Discussion: Empirical correlations for the compression index of Irish soft soils

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McCabe *et al.* (2014) have presented some very useful correlations between index properties and compression indices (C_c) from a wide range of sites across Ireland. Most of the specimens appear to have been obtained from lacustrine or estuarine deposits in Ireland. The paper contains a single data point for marl which does not fit well with the correlations proposed by the authors. Some additional data for marl and other Irish soils are presented below.

Marl (or calcareous silt) is encountered on many road schemes across the limestone regions in Ireland and can result in significant settlements when loaded. Marl was typically formed by calcium-rich water seeping upwards from the underlying limestone through lake muds into a lake basin (Long and Rodgers, 1995). Marl frequently contains a large number of shells that were deposited at the base of the lake. Index tests commonly show that the natural water content is greater than the liquid limit due to the breakdown of the soil structure during the liquid limit test.

Natural water contents and corresponding compression indices from a number of sites in Ireland are presented in Table 4 and plotted in Figure 8. The samples were taken with a 100 or 101 mm diameter piston sampler with 30° cutting edges. In addition to the marl sites, a site from the Foyle Valley in Northern Ireland is included. Quigley *et al.* (2014) describe how there is some evidence to suggest that these silts are structured, which is uncommon in Ireland. Some additional data on silts with high water contents underlying the marl from Hunt (1991), McGill (1990) and Naughton (1996) are included for completeness. Figure 8 shows that the scatter in C_c values at higher water contents is more pronounced and care should be exercised in using empirical relationships. There is reasonable agreement between the relationship between natural water content and C_c proposed by the authors for the high water content organic silt reported

by Hunt (1991). However, the relationship typically overpredicts C_c for marl. A revised correlation between the natural water content (w_n) and the compression index for marl, which may be more applicable, is shown on Figure 8. The geological origin of the additional data differs from the origins of the majority of the data examined by the authors. The relationship between natural water content and compression index proposed by the authors would appear to be valid for natural water contents up to about 110%, but may lead to conservative estimates at higher water contents, which are typical of marl at many sites in Ireland. As suggested by the authors in the original paper, consolidation tests on Class 1 samples should be carried out to validate any assumption on compressibility, especially at high natural water contents.

Authors' reply

The authors welcome the additional data on the relationship between w_n and C_c for marl and other types of Irish soils and the proposed revised correlation for marl. The additional data include results from a structured silt from the Foyle Valley, which is described in the paper by Quigley *et al.* (2014). The marl and the structured silt both have liquidity indices significantly greater than unity, which is indicative of a sensitive soil. It is noted by Quigley *et al.* (2014) that C_c on the Foyle Valley data was best related to the w_n rather than w_L , which is consistent with the findings of McCabe *et al.* (2014). The correlation given in the paper by McCabe *et al.* (2014) was limited to $w_n < 150\%$ as there was much more scatter and decreasing reliability in the extrapolation of the original correlation at high moisture contents. The r^2 value is not given for the correlation equation on the contributor's Figure 8; however, it is estimated to be about 0.65, which is considerably less than the value of 0.86 for the data series selected by McCabe *et al.* (2014). Some of the scatter may be related to the organic content; however, this requires further research.

Reference	Site location	Soil type	Natural water content: %	C_c
Fahy (1990)	Bloomhill, Co Offaly	Marl	183.0	1.771
			175.0	2.527
Hunt (1991)	Terryland, Galway	Marl	288.5	3.086
			254.0	3.190
			294.7	2.700
			232.9	2.287
			182.9	2.355
			251.7	3.947
			234.3	2.214
			186.0	1.764
			220.0	2.276
			207.5	2.056
			191.5	1.891
			202.2	2.094
			166.3	1.486
Hunt (1991)	Terryland, Galway	Silt	166.3	1.419
			264.9	3.244
			216.6	2.337
			220.4	2.807
			181.3	2.167
			215.3	3.012
			216.5	2.603
			215.3	4.023
			164.9	2.262
Naughton (1996)	Ballinfoyle, Galway	Marl	150.4	1.442
			137.0	1.506
			143.9	1.284
			150.4	1.578
			145.2	1.300
			142.2	1.349
McGill (1990)	Wilton, Co Cork	Marl	191.0	2.550
McGill (1990)	Wilton, Co Cork	Silt	98.0	1.092
			47.0	0.434
			81.1	2.545
			41.0	0.755
			68.6	0.304
			78.7	0.546
			57.9	0.789
			46.8	0.757
Quigley <i>et al.</i> (2014)	Foyle Valley	Silt	99.5	1.070
			109.0	1.062
			114.8	1.244
			110.0	1.413
			106.9	1.146
			106.2	1.408
			108.1	1.146
Unpublished	Athlone	Marl	131.0	1.220
			150.0	1.420
Unpublished	Terryland, Galway	Marl	173.0	3.021
Unpublished	Tuam	Marl	173.0	1.460

Table 4. Natural water content and compression index data

Figure 8. Relationship between natural water content and compression index

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