

Response to discussion: Silt and its misrepresentation on the conventional plasticity charts

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This is a response to Shirlaw *et al.* (2026) Discussion: Silt and its misrepresentation on the conventional plasticity charts. *Proceedings of the Institution of Civil Engineers – Geotechnical Engineering*, <https://doi.org/10.1680/jgeen.25.00199>.

I thank Messrs Shirlaw, Boone and Westland and am very much appreciative for their discussion on the serious consequences of underestimating the behaviour of silts and silty sands and their interaction with groundwater in tunnelling operations. They have provided further examples of the difficulties of dealing with groundwater control in these soils and the effects of pore water pressure responses, resulting in some unexpected behaviours from an initial excavation when dilation within the soil from stress relief in the tunnel face can produce dry and stable conditions, and even excessively stiffened soil depending on the overall stress conditions, followed by deterioration into ‘flowing ground’ as defined by Terzaghi or as ‘water-soil gushing’ by the discussers.

They report the failures occurring in soils described as silts, sandy silts and silty sands, soils that have been investigated mostly in the context of liquefaction susceptibility (Thevanayagam, 1998; Thevanayagam and Mohan, 2000; Thevanayagam *et al.*, 2002), and they have found that particle size distributions and ‘fines contents’ are insufficient to define behaviour. They agree that liquid and plastic limit tests are impracticable and unrealistic in these circumstances and should be treated with some caution, particularly when establishing erodibility of these soils, which is naturally a major consideration. The author suggests the best approach to defining non-plastic behaviour is that a soil thread, of any diameter and at any water content, cannot be formed manually. Erodibility tests, such as pinhole, have their place in the assessment of silt and clayey silt behaviour. As suggested by the discussers, research into their results compared with manual/visual tests, grain size distributions in the finer size regions and possibly other larger-scale erosion set-ups would be welcomed. The author agrees with the discussers that soil description, logging and testing are fundamental to geotechnical engineering design and construction.

It is well known that any economising on these aspects at the early stages will often lead to major economic consequences later. Unfortunately, engineers have been saying this for decades.

The discussers report that geotechnical investigations sometimes do not differentiate between silt and clay, as if they have comparable material behaviours. This confirms the author’s opinion that while clay and sand are easily identified and well researched, silt-like behaviour is unique and not fully understood: silt should not be treated as intermediate between clay and sand.

The current national standards compound these difficulties by affirming that the only criterion available for the identification and classification of silts is that their liquid and plastic limit points must lie below a single line on the plasticity chart. This line is shown in the paper (Barnes, 2025) to be incorrect and misleading and not fit for the purpose of identification and classification of silts.

Casagrande (1947) referred to typical inorganic silts and silty clays (M group) located below the A line. The A line was positioned semi-parallel and mid-way between a group of glacial clays and a group of kaolin-type clays with virtually the same gradient of 0.73, as shown on Figure 1. These soils have no relevance to a clay/silt boundary. In the current American Society for Testing and Materials (ASTM) Standard, ASTM D2487-17 (ASTM, 2017), the precision of the line is grossly overstated: a point lying on the A line is clay and a fraction below it is silt. Given the poor reproducibility of the liquid and plastic limits, this is an inflexible and unworkable rule to follow. In an earlier publication, Casagrande (1939) presented a plasticity index versus liquid limit chart with data on organic soils from five additional locations that were not presented in the 1947 paper, as shown on Figure 2. For an inorganic/organic boundary the A line should have been placed higher. Casagrande later acknowledged that organic clays exist above the A line (Howard, 1984).

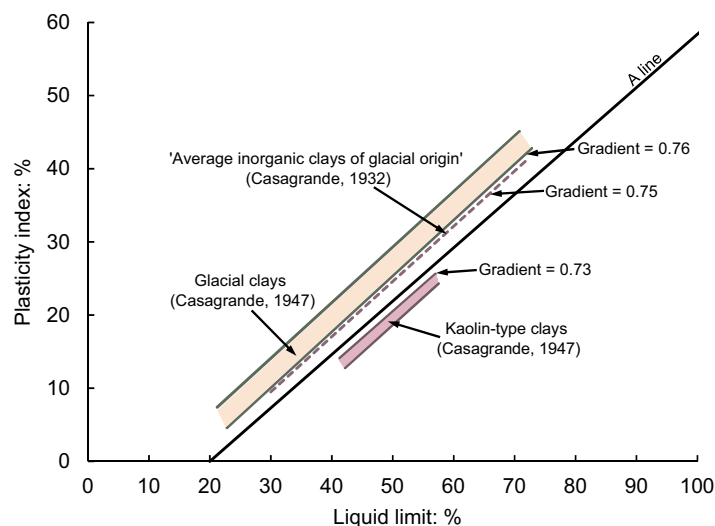


Figure 1. Clay/silt boundary on the plasticity chart (data from Casagrande (1947))

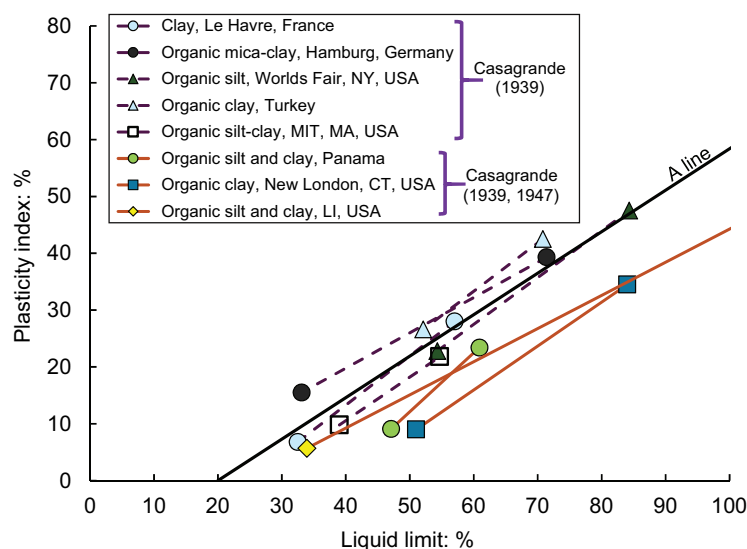


Figure 2. Organic soils on the plasticity chart (data from Casagrande (1939, 1947))

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