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Editorial

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Editorial

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Vibratory rollers for surface compaction of granular soils have been used since the 1930s for road and embankment construction. Since then, a series of important advancements have produced vibratory rollers that can be used for the treatment of granular and cohesive soils, as well as of asphalts. Today, vibratory rollers are widely used and accepted because they achieve the required densities very fast, resulting in speedy production. Compaction effectiveness is influenced by machine factors, but also depends greatly on the material to be compacted. A major development was the introduction of a new electronic compaction monitoring concept, aimed at achieving higher quality of compaction and documentation of the achieved compaction work.

The roller-integrated continuous compaction control (CCC) concept was initially developed by the Austrian engineer, Dr Heinz Thurner and the Swedish researcher Dr Åke Sandström, who developed a 'compactometer', which was patented in Sweden in 1978. The objective of CCC was to continuously measure the acceleration of the roller drum and calculate a compaction meter value from the acceleration signal. Since then, different types of CCC concepts have evolved into practical methods for monitoring surface compaction worldwide. An important reason for the rapid development and practical application of CCC has been the close cooperation between researchers at academic institutions and engineers in the compaction industry. An additional reason is the availability of ever-more powerful electronic data acquisition systems, combined with the application of wireless data transfer systems. As a result, CCC has resulted in enhanced compaction quality control and, at the same time, significant cost savings. The CCC concept has since been included in national specifications in Austria, Germany, Finland and Sweden.

In order to celebrate the achievements of CCC, an anniversary symposium *40 Years of Roller Integrated Continuous Compaction Control (CCC)* was held on 29 November 2018 in Vienna, Austria. The symposium was organised by TU Wien, Vienna, Austria, in cooperation with the Royal Institute of Technology (KTH), Stockholm, Sweden. Internationally renowned experts met to review and discuss present applications and new innovative concepts. The anniversary symposium offered also an opportunity for geotechnical engineers and researchers to meet and exchange experience regarding practical applications and future developments. In more than twenty contributions, authors from different parts of the world described new equipment development, data interpretation and evaluation. An important aspect was the presentation of new findings and novel compaction techniques. Contributions to and presentations at the anniversary symposium have been published as extended abstracts by the TU Wien. Details of the symposium and access to the proceedings can be obtained from the symposium website: https://www.igb.tuwien.ac.at/en/ccc/program-proceedings/.

The Editorial Board of *Geotechnical Engineering* has now published a selection of seven reviewed conference papers in this themed issue on continuous compaction control: past experience, practical applications and future developments. The contributions are based on the extended abstracts published in the symposium proceedings and are briefly summarised. Six of the contributions address the use of vibratory rollers and one paper describes surface compaction by vibratory plates.

First, Paulmichl *et al.* (2020a) present a parametric study of the compaction effect and the response of an oscillation roller. The effect of different model and operating parameters and the response parameter are examined. An interesting finding is that the roller speed has a significant effect on the soil compaction achieved.

Next, Paulmichl *et al.* (2020b) studied the stick–slip motion of the drum for four different oscillation rollers during near-surface compaction of non-cohesive soils, using a lumped parameter model of the interacting oscillation roller–subsoil system. In a comprehensive sensitivity study, the excitation frequency, the coefficient of friction at the contact between the drum and subsoil, and the properties of the suspension between drum and frame were varied in order to demonstrate their impact on the drum response and, thus, on the compaction indicator. The results of this study confirm the suitability of compaction indicator for the considered oscillation rollers for a wide range of soil stiffness.

Stark *et al.* (2020) present a new mechanically reasoned method in order to derive the permissible spatial variation of CCC data from driving comfort requirements. A depth-dependent stress distribution and interaction of base courses is analysed, where the initial stiffness of the spring elements is derived from oedometer tests. The long-term evenness of the asphalt pavement and effects of a spatially varying subsoil stiffness were investigated as function of traffic load and utilisation period.

Tirado *et al.* (2020) suggest that proof rolling or mapping of geomaterials using intelligent compaction (IC) rollers after completing the compaction can effectively assess the compaction uniformity of the compacted layers. A protocol for project acceptance of earthwork that integrates the IC roller with a deflection-based device is proposed. The protocol seems to address some of the main concerns frequently raised due to lack of momentum in implementation of the more mechanistic quality management approaches.

Wersäll *et al.* (2020) introduce a new intelligent compaction method for vibratory soil compaction rollers, which automatically and continuously adjusts the vibration frequency to obtain resonance. The coupled roller–soil system was evaluated in full-scale field tests on a 1 m high rock-fill embankment. Compacting at the resonant frequency results in maximised deformations in the soil by optimising the dynamic behaviour of the system and improving the interaction between the drum and the soil. Field tests demonstrate that the effect was most significant at the top of the embankment, where considerable compression was obtained, in contrast to the very loose material resulting from conventional compaction – thus, eliminating the need for subsequent static passes. A more homogeneously compacted embankment can be achieved, which benefits long-term behaviour, fuel consumption, environmental impact and machine wear.

Winter (2020) presented an overview of the background to earthworks compaction in the context of the potential beneficial use of CCC in the UK specification. Historic and current CCC specifications are then reviewed and examples of the use of CCC are provided. It is concluded that there is no major technical obstacle to the introduction of CCC to road and highway earthworks in the UK. Major UK transport infrastructure projects offer excellent opportunities to develop and refine example specifications and bring CCC into mainstream use.

Massarsch and Wersäll (2020) describe the development of vibratory plate compaction in different parts of the world. In Europe, the vibrator/plate system operates at a higher frequency and may be dynamically tuned by attaching a heavy mass, supported by elastomeric springs. Three case histories are presented where the compaction effect was carefully monitored by site investigations prior to and after treatment. Analysis of the results shows that the depth of influence is directly related to the size of the plate. Finally, a recently developed application of the resonance compaction concept is described and illustrated by a case fourth history.

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