Needs and directions for future research of creep of geomaterials: Discussion, led by
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From notes by Cor Zwanenburg, Deltares

The discussion followed the introduction given by David Muir Wood.

Ronald Brinkgreve (Plaxis): What is needed most in practice? Over the last 25 years material models became more and more advanced requiring more parameters. One of the consequences of this development is lack of good data. How to proceed?

- Improve the availability of data?
- Changing (simplifying) models?
- More use of field data?

General reaction: the development of the database with field and laboratory experience, part of CREEP project, might lead to better use of field data.

Jelke Dijkstra (Chalmers) points out that sometimes you can learn more from unsuccessful tests giving unexpected results. This raises questions on the quality of the tests that are needed for calibration.

Ronald Brinkgreve: What is the future of advanced modelling given the fact that data for parameter assessment are limited?

Chris Dykstra (Boskalis): The industry will use advanced models when the benefit is clear. If models improve prediction and / or can be used efficiently they will be used. However, new models should be applicable for all situations and should not be focusesd on one specific item of soil behaviour. There seems a difference in view on model improvement between academia and industry. In academia the focus is on specific parts of soil behaviour. When a new model is developed that takes care of this specific part in soil behaviour, the academic job is done. Industry needs models that are sufficiently good in all aspects of soil behaviour. Required data for parameter assessment and experience will become available. In this process education and knowledge dissemination are the key to success. Information and data from test sites should be publicly available. In this way the industry can test new models and get confidence in their applicability.

The initiative to set up a database for field and laboratory data is an attempt to foresee the need of data for calibration of new models.

Davis Nash (Univ. Bristol) points out that education is very important, practitioners should get the opportunity to analyse field and laboratory data themselves. This is one of the few ways to get confidence in new models. In daily life, practitioners rarely get the change to do this.

Jaap Bijnagte (Deltares): have patience, if models really are an improvement they will be used. Court cases can provide a driving force for applying advanced models.

David Muir Wood summarises: This discussion has concentrated around education and dissemination of knowledge. Academia should have an eye for this. Sometimes guidelines and codes form a barrier for application of new models. It is a good habit to have thought about the calculation result before

starting the calculation. This reduces the risk of a non-sense result and improves the potential for learning when applying new models.

David Muir Wood: What should be the research items to focus on for the coming years?

Evert den Haan (Deltares): The preloading technique is widely used in the Netherlands, to forestall creep during service life of landfills and embankments. So the behaviour after unloading is important for our engineering practice, much more so than virgin compression, where a few decimeters more or less settlement is not always so important. Present day models do not cope well with unloading. In fact, many advanced models become essentially elastic after significant unloading. Therefore this an area where there is a clear need for improved models..

Meindert Van (Deltares): There is little known about the influence of cyclic loading on creep. In the coming years this aspect will grow in relevance. Cyclic loading includes not only change in mechanical load, but also daily or seasonal fluctuations in temperature. We should go from a 1D approach to a 3D approach. In a 1D approach shear strain is not accounted for, while it plays a role in a 3D approach.

Minna Karstunen (Chalmers) indicates that two 4-year projects on this item have just started at Chalmers University.

Jelke Dijkstra: Long term effects around structures are more complicated than behaviour of embankments. That is why the creep database is focused on embankments on soft soil. From there we can proceed to more complicated soil – structure interaction.

Sjoert Spierenburg (BAM) asks if there is a need for benchmark applications of different models.

David Muir Wood adds: besides different models, the comparison of analyses performed by different users with the same models should be included.

Gustav Grimstad (NTNU Trondheim): The group of users should certainly include among others the developer of the model and someone who has had no previous involvement in development or use of the model.

The discussion continued on the need for a prediction competition. It is agreed upon that a prediction competition is interesting but not necessarily helpful.

Sjoert Spierenburg adds later some practical issues regarding creep:

> The influence of surcharge on creep after surcharging is a design issue. Surcharging is used to limit post-construction settlements. Post-construction settlements are limited by contractual specifications
>
> We learned that 1-D analyses with unloading become in fact 3-D problems. This should be clarified: show us, teach us. Clarify the difference of applying a standard, classical 1D settlement model or an advanced creep model.
>
> We learned that stress dependent C_α is the result of development of structure. Clarify, show us, teach us.
>
> Further development might focus on analysing benchmark problems with different, available models showing the differences.

Final publication of the Creep Project should not only be a volume with a collection of Papers. The project should also focus on a textbook on creep showing, teaching, clarifying, educating the aspects of creep in engineering.

There was an interesting paper on the influence of creep on the ultimate capacity of existing footings.
A practical situation is the extension in cross section of existing (road or rail) embankments. At the moment a rail project is under construction (OVSaal) which includes the extension (in cross section) of an existing high embankment. The extension is being surcharged while next to the surcharged area (in cross section) the rail traffic continues on the existing track. Additional settlements of existing track are extremely limited. The subsoil includes thick layers of soft clay and peat. The existing track was constructed approximately 30 years ago but still shows creep settlements
Displacement calculations of the effect of surcharge on the existing track have been made with Plaxis (SoftSoil).
How can the new models contribute to such a problem?

[David Muir Wood asks - are there data available to show how these extended embankments are performing by comparison with true predictions made using PLAXIS or other routes to analysis? It would certainly be desirable to include data from such a project in a creep database.]