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Session 1: Closing Remarks

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SESSION I CLOSING REMARKS

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This session has addressed the problem of modelling soil behavior under dynamic loading conditions, and many good papers have been presented. Some of them deal with simple and well established models with few parameters. today's scientific literature provides parameter values for many soils, but more experimental work carried out on other not so well known materials, is still necessary. The main goal of these models is their simplicity and robustness together with a very clear and precise physical meaning of their parameters, which can be even thought of as "dynamic properties". This first group of models apply mainly to small strain problems, in which it is not the soil but the structure founded on it that may fail.

On the other hand, more complex and rational models have been developed in the past decades for more general situations (Large strain, liquefaction, failure, etc). The main drawback is their sometimes large number of parameters, many of which cannot be directly measured in laboratory. It should be remarked, however, that rational models should be used if accurate predictions of the response of soil structures and foundations are required.

It should be mentioned at this point that complex constitutive models may be used out of the framework of finite element codes. We could imagine, for instance, a horizontal layer of saturated loose sand. due to the inherent anisotropy of soil, the results obtained in the cyclic triaxial machine can overestimate the liquefaction resistance.

The solution to this problem is, of course, to use the simple shear test, but simple shear or hollow cylinder machines are not as available as triaxials are. An alternative could be to fit the parameters of a constitutive model using the results obtained in the triaxial and simulate a cyclic shear test, from which a much better estimate of soil resistance could be obtained.

Much work has been devoted to this class of models, but there are still problems to be solved such as

(i) Accurate modelling of history effects, including induced and initial anisotropy, rotation of principal stress axes and degradation.

(ii) Influence of the stress increment direction.

Another important phenomenon related to constitutive modelling of soil under dynamic loading is that of localization of strain on failure surfaces. Here, classical finite element techniques fail to provide a good resolution, of the shear band, and the failure is smeared over a wide zone. From the numerical point of view, it is necessary to use a much finer mesh in that zone, and this can be achieved by using adaptive of the remeshing techniques.

If the material is strain saftening type the overall response will depend on the shear band or localized zone width, and therefore on the mesh. Very coarse meshes will predict a very small global softening while very fine ones will result in very high and unrealistic softening. this effect can only be overcome in the context of Plasticity if some "characteristic length" is included in the model.

This problem is attracting the attention of a growing number of researchers and will result in a new generation of models.

From the experimental point of view, it is necessary to detect when the specimen loses its homogeneity and to measure the orientation of the shear bands, which can be done by using stereophotogrammetric techniques. The constitutive law should be able to predict both the inception and the orientation of the shear bands observed in laboratory tests, and to circumvent the problem of mesh objectivity described above.

To conclude, it should be mentioned that the gap between advanced research and everyday's practice has grown wider during past years, and that a joint effort from both sides is needed to reduce it, leading to simpler models with more physical parameters which will be - no doubt - more used.