

SUMMARY COMMENTS AND STATUS OF HORIZONTAL DS 21-22 PHYSICAL PROPERTIES

RECOMMENDATIONS FROM THE STEERING COMMITTEE

The Steering Committee was of the opinion that this was a solid piece of work. However, due to a lack of budget for funding Phase II, **it was agreed to stop the work at the stage of desk study.**

Mr Wichmann, Work package Leader, estimated in about €100-150,000 the funds needs for reaching a TS (Technical Specification) stage and further €50-100,000 for validation work and reaching EN (European Standard) stage. Should further funds become available and taking into account other priorities, the Steering Committee could review its decision at a later stage.

SUMMARY OF COMMENTS

HORIZONTAL DESK STUDY 21 - 22 PHYSICAL PROPERTIES. *FLOWABILITY, SOLIDITY, THIXOTROPIC BEHAVIOUR AND PILING BEHAVIOUR*

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The desk studies on “Physical Properties” have been performed following a route starting from searching existing standards and non-standardised methods and arriving to define draft methods to be investigated and optimized. The initial list (see common Annex 1 of the desk studies) consists of more than 250 standards and non-standards methods. On the basis of a selected list for further consideration the methods for the determination of flowability, solidity, thixotropic behaviour and piling behaviour of sludge, treated bio-waste and soil have been divided into several groups, according to the instruments used for measuring:

- Flowability (consideration: 129; in discussion: 90): Capillary viscometers, penetrometer, rotational viscometers and flow apparatus;
- Solidity (consideration: 68; in discussion: 32): Shearing apparatus, Vane testing apparatus and Penetrometers;
- Thixotropic behaviour (consideration: 15; in discussion: 9): It should be investigated a combination of methods for determination of the solidity like penetration, etc. and an energy-input in terms of "flow" apparatus to simulate the shear stress;
- Piling behaviour (consideration: 13; in discussion: 8): Slump test apparatus, Compacting apparatus, Cubic Piling Box (CPB) and "Turned Box".

For each group was evaluated the laboratory or field test feasibility. On these bases the applicability of the described methods to the materials for the Horizontal project was documented. The recommended methods for further investigation are listed in the following tables (Table 1 for flowability and Table 2 for solidity, thixotropic and piling behaviour):

Method (Apparatus)	Flowability
Cylinder viscometer (shear controlled coaxial)	<i>Viscosity (Lab)</i>
Flow cone	<i>Viscosity (Field)</i>
Penetrometer (Magnesium cone)	<i>Yield stress (Field)</i>
Kasumeter (Extrusion tube viscometer)	<i>Yield stress (Field)</i>

Table 1: Summary of recommended methods for flowability

One further laboratory method using a stress controlled viscometer and two further field methods will be added for paste-like materials (modified slump test and inclined plane, *see comments J. C. Baudez*).

Method (Apparatus)	Solidity	Thixotropic behaviour of solid materials	Piling behaviour
Penetrometer	<i>Shear strength (Lab / field)</i>	<i>Shear strength (Lab*/field^{+/**})</i>	
Vicat apparatus	<i>Shear strength (Lab)</i>		
Laboratory vane shear apparatus	<i>Vane shear strength (Lab)</i>		
Pocket penetrometer (Neuschäfer)	<i>Bearing capacity¹ (Field)</i>		
Pocket cylinder penetrometer	<i>Unconfined compression strength² (Field)</i>		
Vibrating table		<i>Shear strength (Lab*/ field⁺)</i>	
Hammer (manual)		<i>Shear strength (Field^{**})</i>	
Cubic piling box (CPB)			<i>Piling angle (Lab/field)</i>

Oedometer			Compactibility (Lab)
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*Combinations for thixotropic behaviour: **+*, ++, **++*

¹ *Conversion into shear strength is possible*

² *Conversion into undrained shear strength is possible.*

Table 2: Summary of recommended methods for solidity, thixotropic and piling behaviour

For the research needs the basics of methods are explicated and the applicability of methods to Horizontal materials is clarified. The questions to be answered (precision, repeatability, reliability, etc.), the route how to answer them and, finally, the steps to be taken are defined since they are important for following procedures within the Horizontal project.

Further elements, which were considered in the desk studies, are:

- On flowability field the properties needed for Horizontal materials are yield stress and viscosity, while in the field of solidity, thixotropic and piling behaviour the properties shear strength resp. vane shear strength, bearing capacity, unconfined compression strength as well as piling angle and compactibility are of importance. These properties can be assessed with draft standard investigations.
- Different methods are proposed because it is necessary:
 - to study fluid, paste-like and solid materials;
 - to cover the different range of rheological properties;
- Draft Standards are prepared: The proposed methods have to be tested and optimised in future experimental activities to adapt design and part dimensions to Horizontal material.

In the framework of phase II of the HORIZONTAL Project these experimental activities will employ not less than two years to optimize the methods. In addition further work is required for the validation.

In details the phase II will consist of the following items (as regards to the original timetable):

- Experimental work on flowability, solidity, thixotropic behaviour and piling behaviour (Confidence level evaluation (CLE); Interlaboratory trials: round robin tests (RRT), see also protocol “Validation of physical parameter methods” (rev Oct. 2003; CEN/TC308/WG1/TG3 – N29)
- Draft standards for consultation of relevant CEN and ISO TC’s;
- Inter-comparison of draft procedures;
- Draft Standards for flowability;
- Draft Standards for solidity, thixotropic behaviour and piling behaviour.