EC7 pile design - TC250/SC7

Evolution Group 7

UK Proposal for Items to be Included in the EG7 Agenda

Item		Description	Background	Outcome
1	General Discussions			
	1.1	Can EC7 section 7 be improved?	EC Mandate M/466 EN 19th May 2010 has the stated aims: a) New Eurocodes (not part of the EG7 scope) b) Further development of existing Eurocodes by: Reducing the number of nationally determined parameters Simplifying the rules	
	1.2	Can EC7 section 7 be simplified?	Currently EC7 is considered to be extremely complex and costly to implement mainly because of different Design Approaches, an excessive number of partial factors and complicated methods of combining these factors. This has resulted in the need for a series of National Annexes.	Rules simplified UK NA removed
	1.3	Can EC7 section 7 be harmonised	Main differences are caused by four different Design Approaches: DA1, DA2, DA2* and DA3 Can we ever square the circle and agree a single design methodology that all European countries can adopt without compromise to existing methods? It is understood that EG8 are considering removal of Design Approaches. How can EG7 contribute to this outcome?	Single method adopted (GEO and STR?) Current UK partial factors amalgamated into main body of EC7

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2	General Comments			
	2.1	Remove clutter	Part of the criticism of EC7 is that it mixes Principles, Application Rules and Guidance. If a clause is neither a Principle or an Application Rule, it is suggested that the clause is relocated either to an appendix, or better, is removed to an alternative document outside of EC7. This would simplify and clarify the important aspects of EC7.	Unnecessary clauses moved from the main text either to appendices or other documents
	2.2	Remove unnecessary rules and restrictions	The prime objective of EC7 is to provide rules that define what the Designer or Client must do, but should not make unnecessary restrictions on how the design is achieved and should not prevent innovation or the adoption of new and better methods for design.	Unnecessary clauses moved from the main text either to appendices or other documents
	2.3	Provide detailed guidance	However, there is still need for guidance on a number of topics. These include: Displacement of pile Pile load testing Negative shaft friction Ground heave Horizontal loads from the ground Axial loads on piled retaining walls Structural design. These could be included as informative appendices (or preferably as an alternative document outside of the EC7).	More guidance provided either in the appendices or other documents
	2.4	Are the current informative appendices necessary at all?	These could be included in an alternative document outside of the EC7.	Unnecessary appendices moved to other documents
	2.5	Provide detailed guidance	It has been suggested that rather than include detailed guidance in the informative appendices, these could be included in the relevant National Annexes.	

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3	General (section 7.1)			
	3.1	Simplify	No need to refer to execution codes here. References should be moved to section 1, or removed entirely and covered by a basic statement.	
	3.2	Exclusions	Why exclude piles intended to reduce settlement such as in some raft foundations?	
4	Limit States (section 7.2)			
	4.1	Simplify	The list of limit states is probably incomplete and is unnecessary. A statement saying all relevant limit states should be considered is all that is required.	
5	Actions (section 7.3)			
	5.1	Simplify	General section not necessary.	
	5.2	Revise section on actions due to ground displacement	Negative shaft friction (downdrag) and heave are primarily service behaviour issues and unlikely to be relevant to GEO ultimate limit states. Transverse loading from moving soil needs to be considered in both GEO and STR limit states. [Whether GEO or STR governs design depends to some extent on the method of calculation and whether soil stiffness (and pile stiffness) is also factored. See below]. Much of this text should be moved to a calculation section (axial compression, tension or horizontal) with more detail regarding methodology and factors. More advice on how partial factors should be applied is necessary.	Moved to calculation section Additional rules included
6	Design Methods (section 7.4)			
	6.1	Simplify	Much of this text is unnecessary. Focus on what the designer should do and not give what is almost certainly going to be an incomplete list of items. Remove clutter.	
	6.2	Combinations	More clarity is required on how to apply combinations of design method such as calculation and static load testing. [The current UK National Annex has attempted to combine calculation and testing by varying model and resistance factors dependent on the amount and quality of the load testing].	

Item		Description	Background	Outcome
7	Pile Load Tests (section 7.5)			
	7.1	Improvement of section 7.5 dealing with static load tests	Is all this text really necessary. Simplify down to what the designer requires and should specify. Much of this should now be included in execution codes.	
	7.2	Clarity	There are a considerable number of issues within this section that need clarification: 7.5.1 (3) Very cautious design values (but these are governed by partial factors) 7.5.2 Static load testing should be renamed maintained load testing 7.5.2.1 Pile does not need to be loaded to failure (extrapolation allowable) 7.5.2.3 SLS or ULS design load	
8	Axial Loading (section 7.6)			
	8.1	Add a section dealing with the calculation method in 7.6.2	EC7 clearly includes calculation methods as a legitimate option for design (see section 2.1, 2.4 and 7.4.1). However in section 7.6.2, (Compressive Ground Resistance), calculation methods are included almost as an afterthought within the section dealing with design based on ground test results. This needs to be changed with calculation given an equal footing to static load tests, dynamic impact tests and ground test results methods.	The UK calculation method included as a primary option in the main EC7 text
	8.2	Model factors	Values and method for applying model factors needs to be discussed.	
	8.3	ULS versus SLS	ULS limit states may occur in the structure before the ULS resistance of a pile is fully mobilised. Should pile settlements therefore be considered for ULS states? At present, 7.6.4 only covers SLS.	Additional rules included
	8.4	Better structure other parts of 7.6.2	There has been some doubt expressed that the method of design based on static load tests can ever be applied in practical situations. Load testing is very important but the results are usually used together with a calculation. More clarity is required on combination design involving different methods. Rules need to be reviewed regarding consideration of variations in the ground and installation conditions [see7.6.2.2 (10) and (11)].	Additional rules included

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	8.5	Better structure other parts of 7.6.2	It is probably better that wave equation methods together with pile driving formulae be incorporated into the dynamic impact test section.	Less important sections amalgamated or moved to an alternatives section
	8.6	Better structure other parts of 7.6.2	The section on re-driving should perhaps also be included within the driving formulae section [unless this means re-strike tests associated with dynamic impacts]. More clarity is required.	
	8.7	Add a section dealing with negative shaft friction	Negative shaft friction (downdrag) is primarily a service behaviour issue and is not relevant to GEO ultimate limit states [although needs to be considered for STR ultimate limit states]. Move content from 7.3.2 to calculation section. Better rules are necessary for methodology and factors should be consistent with positive friction.	Negative shaft friction better covered
	8.8	Add a section dealing with the calculation method in 7.6.3	Ground tension resistance (section 7.6.3) also needs to include calculation methods as a legitimate option for design with equal standing to the other approaches. In some circumstances, calculation may be the only possible method.	The UK calculation method included as a primary option in the main EC7 text
	8.9	Add a section dealing with calculation methods for pile displacement in 7.6.4	The section on vertical displacement of piles (section 7.6.4) needs review regarding calculation methods. Should pile settlements also be considered for ULS states?	Additional calculation methods included
	8.10	Add a section dealing with test methods for pile displacement in 7.6.4	The section on vertical displacement of piles (section 7.6.4) needs review regarding movement determined by test, particularly where conditions at the time of the test may differ substantially from the permanent condition. This could include the effect of negative shaft friction, temporary hold up and changes in ground properties due to excavation or filling.	Additional rules included to cover pile testing in non normal situations
	8.11	SLS settlements	Notes given in clauses 7.6.4.1 and 7.6.4.2 imply that ULS design is usually sufficient to ensure compliance with the SLS in the structure. This requirement means that partial factors for pile resistance must be carefully selected to ensure this is achieved. This needs to be discussed in more detail.	

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9	Transversely Loaded Piles (section 7.7)			
	9.1	General improvement of text dealing with horizontally loaded piles	The section on transversely loaded piles also needs to include better details on how the calculation method should be applied for design, particularly when using soil-structure interaction methods. More guidance is required on using material factors, resistance factors or factors on effects.	Horizontally loading better covered
	9.2	General guidance on soil stiffness	Guidance on whether soil stiffness should be factored when using FE or beam analysis software. [It has been argued that if material strength has been factored, then soil resultant strains will be higher and therefore lower soil stiffness is relevant. But if soil stiffness is also factored, why not pile stiffness as well]?	
	9.3	Add a section dealing with transverse loading from moving soil	In some circumstances, calculation may be the only possible method, particularly when considering transverse loading from moving soil. Move content from 7.3.2 to calculation section. Better rules are necessary for methodology and factors.	
10	Structural Design of Piles (section 7.8)			
	10.1	Improvement of section 7.8 dealing with structural design	Better cross reference to EC2, EC3 and execution codes with some detail regarding some of the likely difficulties and inconsistencies. Particular issues relate to shear reinforcement design for transversely loaded piles (and bored pile, secant pile and diaphragm walls), and clauses introduced in EC2 covering structural design of bored piles.	
11	Supervision of Construction (section 7.9)			
	11.1	Revision and simplification	Although it is important that the designer knows about the construction, most of this section should be removed and incorporated in the relevant execution codes. [The drafting committees for the execution code are making efforts to avoid including unnecessary design guidance. In a similar manner, EC7 should avoid including unnecessary construction and workmanship guidance].	

Item		Description	Background	Outcome
12	Removal of UK National Annex			
	12.1	Design approach	UK uses Design Approach 1 which requires two combinations to be considered, (essentially GEO and STR) plus a service or nominal loads case for pile behaviour calculations.	UK method included in main EC7 text
	12.2	Partial resistance factors	Calculation based on two sets of factors (GEO applies partial resistance factors greater than 1.0 and STR applies resistance factors equal to 1.0) with partial factors on actions as given in EC7. UK values have been modified from the EC7 values with the intention of providing similar design to original BS 8004 factor of safety. [However there has been UK criticism that calculation design has become more onerous, particularly for driven piles and that factors need to be reviewed].	Modified UK factors included in main body of EC7
	12.3	Partial resistance factors	Resistance factors also include an allowance for verification of pile displacement either by test or calculation. If a load settlement verification factor can be adopted, the basic resistance factor set can be simplified to one set per pile type. This would be more consistent with EC7 values.	Revise resistance factors
	12.4	Model factors	UK currently uses a model factor as a means of introducing variation in partial resistance factors to take account of the type and quantity of pile load testing. If a pile load test factor can be adopted (see below), then values for model factors could be made more consistent with EC7 intention and the use in other countries.	Revise model factors
	12.5	Load test and settlement verification factors	UK currently uses a model factor as a means of introducing variation in partial resistance factors to take account of the type and quantity of pile load testing, and variations in resistance factors to account for verification of pile settlement. However it would be feasible to adopt additional partial factor sets to cover load testing and verification of settlement.	Add new load test factor sets covering type and quality of pile testing and verification of settlement