# Notes to

# Malaysia National Annex to Eurocode 7: Geotechnical Design – Part 1: General rules

*(The texts in this Section are not part of the Standard.)*

This Standard is an adaptation of UK National Annex to BS EN 1997-1: Geotechnical Design – Part 1: General rules.

Methods used to establish the values of the partial factors, model factors and correlation factors are deterministic methods and are briefly described below:

1. The aim of the exercise is to ensure that design to EC7 is essentially identical to that attained by conventional design methods in terms of overall safety factor. Values of overall safety factors (required in conventional design methods) are taken from local practice, guided by:
   - JKR Specs, or
   - Recommendations by public regulatory bodies, or
   - International accepted recommendations.

   For a design situation, the relevant partial factor values given in the UK National Annex are adopted. Then, a design is produced using EC7 and the factor values. The design so produced is checked using conventional design methods to see its global factor of safety (FS) satisfies the stipulated minimum value for the respective design cases as follows:

   - Spread foundations – FS against sliding ≥ 1.5, FS against bearing ≥ 2.0
   - Pile foundations – For single pile subject to axial compression,
     Driven pile - FS (shaft) ≥ 1.5, FS (base) ≥ 3.0 & FS (total) ≥ 2.0.
     Bored pile - FS (shaft) ≥ 1.5, FS (base) ≥ 3.0 & FS (total) ≥ 2.5.
   - Retaining structures – FS against sliding ≥ 1.5, FS against bearing ≥ 2.0
   - Overall stability and slopes – FS ≥ 1.35

   If the design meets the above criteria, the factor values set are adopted. If not, the process is repeated by varying the factor values till the two designs match in accordance with the above criteria.

   As mentioned before, the above code calibration approach is used to ensure that design to EC7 will produce essentially identical design to that attained by conventional design methods.

This National Standard is an adaptation of UK NA to EN 1997-1 with some changes which are briefly described below:

1. Annex A of this Standard is made normative.
2. Adopt the original values of $\gamma_F$ given in EN 1997-1.
3. In Table A.NA.4, two sets of partial factors for soil parameters ($\gamma_M$) are described; one for slopes and embankments and the other for other structures except slopes and embankments. Variation of these factors is permitted in particular circumstances when justified by thorough consideration and documented experience, and after being agreed, where appropriate, with the relevant authorities.
4. Jack-in piles are grouped under driven piles, and Table A.NA.6 applies to jack-in piles also. The above decision was made after receiving feedbacks from engineers involved with design, construction and testing of jack-in piles. It is viewed that it is prudent to recommend same values of partial resistance $\gamma_R$ in Table A.NA.6 for jack-in piles in general. However, as stated in A.3.3.2 of Annex A of this National Standard, variation of these factors is permitted in particular circumstances when justified by thorough consideration and documented experience, and after being agreed, where appropriate, with the relevant authorities.
5. Adopt the values of the correlation factors given in EN 1997-1. These values are lower than the corresponding values given in the UK NA. Values of the partial resistance factors for pile foundations have to be revised higher to ensure that design to EC7 will produce essentially identical design to that attained by conventional design methods.
6. Even though no calibration was carried out for CFA, we observed that in UK NA, Table A.NA.8 values (for CFA) are the same as those in Table A.NA.7 for bored piles. In view of this, in Malaysia NA, the proposed values in Table A.NA.7 are adopted in Table A.NA.8.
7. EC7 allows for more than one way of determining the characteristic pile resistance. One of the ways (described as alternative procedure) is practised in UK, for which model factor is introduced to determine the characteristic pile resistance. UK NA recommended model factor values are adopted in the Malaysia NA.
8. Design and testing of ground anchors shall, in the interim, follow the current practice of using BS 8081 until it is withdrawn.
9. An improved version of Annex C of Eurocode 7 is available and is adopted in this Standard.
10. For Annex D, the Terzaghi method with Meyerhof $N\gamma$ value is recommended for bearing capacity computation. This is described in this Standard. A reference for computation of the bearing capacity of a footing located in or near a sloping ground is also given in this Standard.
11. Country specific data are not given in the UK NA. In this Standard, some country data specific to Malaysia are included for special attention.

**MALAYSIA NATIONAL ANNEX**

# NA TO MS EN 1997-1 : YYYY

# Malaysia National Annex to Eurocode 7: Geotechnical Design –

## Part 1: General rules

# Malaysia National Annex to
# MS EN 1997-1:YYYY, Eurocode 7: Geotechnical Design –
## Part 1: General rules

## Introduction

This National Annex has been prepared by *(Name of the SIRIM TC)*. In Malaysia, it is to be used in conjunction with MS EN 1997-1:YYYY and MS EN 1990:YYYY.

## NA.1 Scope

This National Annex gives:

a) the Malaysia decisions for the Nationally Determined Parameters (See NA.2) described in the following subclauses in the body of MS EN 1997-1:YYYY:

| | | |
|---|---|---|
| **2.1**(8)P | **2.4.7.4**(3)P | **7.6.2.4**(4)P |
| **2.4.6.1**(4)P | **2.4.7.5**(2)P | **7.6.3.2**(2)P |
| **2.4.6.2**(2)P | **2.4.8**(2) | **7.6.3.2**(5)P |
| **2.4.7.1**(2)P | **2.4.9**(1)P | **7.6.3.3**(3)P |
| **2.4.7.1**(3) | **2.5**(1) | **7.6.3.3**(4)P |
| **2.4.7.2**(2)P | **7.6.2.2**(8)P | **7.6.3.3**(6) |
| **2.4.7.3.2**(3)P | **7.6.2.2**(14)P | **8.5.2**(2)P |
| **2.4.7.3.3**(2)P | **7.6.2.3**(4)P | **8.5.2**(3) |
| **2.4.7.3.4.1**(1)P | **7.6.2.3**(5)P | **8.6**(4) |
| | **7.6.2.3**(8) | **11.5.1**(1)P |

And the following subclauses in Annex A of MS EN 1997-1:YYYY:

- **A.2**
- **A.3.1, A.3.2, A.3.3.1, A.3.3.2, A.3.3.3, A.3.3.4, A.3.3.5, A.3.3.6**
- **A.4**
- **A.5;**



b) the procedure to be used where alternative procedures are given in MS EN 1997-1:YYYY (see **NA**.2 first paragraph);

c) the Malaysia decisions on the status of MS EN 1997-1:YYYY informative annexes (see **NA**.3); and

d) references to non-contradictory complementary information (see **NA**.4)

e) country specific data

## NA.2 Nationally Determined Parameters

National choice is permitted in the use of a Design Approach for the STR and GEO limit states (see MS EN 1997-1:YYYY**, 2.4.7.3.4.1**(1)P. As indicated in Table NA.1, only Design Approach 1 is to be used in Malaysia.

Annex A of MS EN 1997-1:YYYY lists the partial and correlation factors for ultimate limit states; the values of these factors are nationally determined parameters. Table NA.1 of this National Annex lists the clauses in MS EN 1997-1:YYYY where national choice may be exercised in respect of factor values for design in Malaysia. Where choice applies, Table NA.1 indicates where values are given, or states a value to be used, or describes the procedure for specifying the factor. The values given the Tables of Annex A of this National Annex replace the recommended values in Annex A of MS EN 1997-1:YYYY.

Where reference is made in MS EN 1997-1:YYYY to the use of Annex A as a guide to the required levels of safety, this reference should be taken to mean Annex A of this National Annex.

MS EN 1997-1:YYYY contains several references to "model factors" without making recommendations for the values to be used. Table NA.1 of this National Annex also lists these references. In some cases, values of the model factors are given in A.6 of Annex A of this National Annex. Where no values are given, the values should be agreed, where appropriate, with the client and the relevant authorities. Subclauses **2.4.1(**8) and **2.4.1**(9) in MS EN 1997-1:YYYY give guidance on how the values of such model factors should be selected. Model factors for pile design are given in **A.3.3.2** of Annex A of this National Annex.

Table NA.1 Provisions of this National Annex related to Clauses in MS EN 1997-1:YYYY where "national choice" is to be exercised.

| Subclause | Feature | Provisions of this National Annex |
|---|---|---|
| **2.1**(8)P | Minimum requirements for light and simple structures and small earthworks. | Minimum requirements are not given in this National Annex and should be agreed where appropriate with the client and relevant authorities. |
| **2.4.6.1**(4)P | The value of partial factor $\gamma_F$ for persistent and transient situations. | Use the values given in **A.2.1** (EQU); **A.3.1** (STR/GEO); **A.4.1** (UPL) and **A.5** (HYD) in Annex A of this National Annex. |
| **2.4.6.1**(5) | Directly assessed design values for actions | Where design values of actions are assessed directly the values of the partial factors for actions given in Annex A of this National Annex should be used as a guide to the required level of safety. |
| **2.4.6.2**(2)P | The values of partial factor $\gamma_M$ for persistent and transient situations. | Use the values given in **A.2.2** (EQU); **A.3.2** (STR/GEO) and **A.4.2** (UPL) in Annex A of this National Annex. |
| **2.4.6.2**(3) | Directly assessed design values for geotechnical parameters. | Where design values of soil parameters are assessed directly, the values of the partial factors for soil parameters given in Annex A of this National Annex should be used as a guide to the required level of safety. |

Table NA.1 Provisions of this National Annex related to Clauses in MS EN 1997-1:YYYY where "national choice" is to be exercised. *(continued)*

| Subclause | Feature | Provisions of this National Annex |
|---|---|---|
| **2.4.7.1**(2)P | The values of partial factors to be used in persistent and transient situations. | Use the values given in the appropriate tables in Annex A of this National Annex. |
| **2.4.7.1**(3) | The value of partial factors to be used in accidental situations. | Take as equal to 1.0. |
| **2.4.7.1**(3) | The values of partial factors for resistance. | Use the values given in the appropriate tables in Annex A of this National Annex. |
| **2.4.7.1**(4) | The values of partial factors to be used in cases of abnormal risk or unusual or exceptionally difficult ground or loading conditions. | Values are not provided in this National Annex and should be agreed with the client and relevant authorities, where appropriate, for the specific situation. |
| **2.4.7.1**(5) | Reduced values of partial factors to be used for special situations for temporary structures or transient design situations, where the likely consequences justify it. | Values are not provided in this National Annex and might need to be agreed with the client and relevant authorities, for the specific situation. |
| **2.4.7.1**(6) | Values for model factors for resistance and the effects of actions. | See **A.6.1** to **A.6.6** of Annex A of this National Annex. |
| **2.4.7.2**(2)P | The values of partial factors to be used in persistent and transient situations for the EQU limit state. | Use the values given in **A.2** in Annex A of this National Annex. |
| **2.4.7.3.2**(3)P | The values of partial factors to be used in equations (2.6a) and (2.6b) of MS EN 1997-1:YYYY for determining the design effects for STR and GEO limit stares. | Use the values given in **A.3** in Annex A of this National Annex. |
| **2.4.7.3.3**(2)P | The values of partial factors to be used in equations (2.7a), (2.7b) and (2.7c) of MS EN 1997-1:YYYY for determining the design resistance in the STR and GEO limit stares. | Use the values given in **A.3.3.1, A.3.3.2, A.3.3.3, A.3.3.4, A.3.3.5** and **A.3.3.6** in Annex A of this National Annex. |
| **2.4.7.3.4.1**(1)P | The particular Design Approach to be used for the STR and GEO limit states. | Use Design Approach 1 only. |
| **2.4.7.4**(3)P | The values of partial factors for persistent and transient situations for the UPL limit state. | Use the values given in **A.4** in Annex A of this National Annex. |
| **2.4.7.5**(2)P | The values of partial factors for persistent and transient situations for the HYD limit state. | Use the values given in **A.5** in Annex A of this National Annex. |
| **2.4.8**(2) | The values of partial factors for serviceability limit state. | Take as equal to 1.0. |
| **2.4.9**(1)P | The amount of permitted foundation movement. | Values are not provided in this National Annex. Advice is given on foundation movements for buildings in Annex H of MS EN 1997-1:YYYY. |
| **2.5**(1) | Conventional and generally conservative rules. | The use of prescriptive measures for design should be agreed, where appropriate, with the client and the relevant authorities. (see **2.1**(8) above) |
| **7.6.2.2**(8)P | The values of correlation factors $\xi_1$ and $\xi_2$ | Use the values given in **A.3.3.3** of Annex A of this National Annex. |

Table NA.1 Provisions of this National Annex related to Clauses in MS EN 1997-1:YYYY where “national choice” is to be exercised. *(continued)*

| Subclause | Feature | Provisions of this National Annex |
|---|---|---|
| **7.6.2.2**(14)P | The values of factors $\gamma_b$, $\gamma_s$ and $\gamma_t$ | Use the values given in **A.3.3.2** of Annex A of this National Annex, depending on the type of pile. |
| **7.6.2.3**(4)P | The values of factors $\gamma_b$ and $\gamma_s$ | Use the values given in **A.3.3.2** of Annex A of this National Annex, depending on the type of pile. |
| **7.6.2.3**(5)P | The values of correlation factors $\xi_3$ and $\xi_4$ | Use the values given in **A.3.3.3** of Annex A of this National Annex. |
| **7.6.2.3**(8) | The value of a corrective model factor for $\gamma_b$ and $\gamma_s$ | Use the values given in **A.3.3.2** of Annex A of this National Annex. |
| **7.6.2.4**(4)P | The values of factors $\gamma_t$, $\xi_5$ and $\xi_6$. | For $\gamma_t$, use the values given in **A.3.3.2** of Annex A of this National Annex, depending on the type of pile.<br>For $\xi_5$ and $\xi_6$, use the values given in **A.3.3.3** of Annex A of this National Annex. |
| **7.6.3.2**(2)P | The value of factor $\gamma_{s,t}$ | For $\gamma_{s,t}$, use the values given in **A.3.3.2** of Annex A of this National Annex, depending on the type of pile. |
| **7.6.3.2**(5)P | The values of correlation factors $\xi_1$ and $\xi_2$ | Use the values given in **A.3.3.3** of Annex A of this National Annex.. |
| **7.6.3.3**(3)P | The value of factor $\gamma_{s,t}$ | For $\gamma_{s,t}$, use the values given in **A.3.3.2** of Annex A of this National Annex, depending on the type of pile. |
| **7.6.3.3**(4)P | The values of correlation factors $\xi_3$ and $\xi_4$ | Use the values given in **A.3.3.3** of Annex A of this National Annex. |
| **7.6.3.3**(6) | The value of a corrective model factor for $\gamma_{s,t}$. | Use the values given in **A.3.3.2** of Annex A of this National Annex. |
| **8.5.2**(2)P | The value of factor $\gamma_a$. | See NA.4, paragraph 2. **Section 8** of MS EN 1997-1:YYYY on ground anchorages is being revised. Therefore design of ground anchorages shall in the interim follow BS 8081:1989. Hence **8.5.2**(2)P, **8.5.2**(3) and **8.6**(4) are not applicable. |
| **8.5.2**(3) | The value of correlation factor $\xi_a$ for anchorages that are not individually checked by acceptance tests. | |
| **8.6**(4) | The value of the model factor to be applied to an anchorage force at SLS. | |
| **11.5.1**(1)P | The values of partial factors for stability analysis of slopes for persistent and transient design situations. | Use the values given in **A.3.1, A.3.2** and **A.3.6** in Annex A of this National Annex. |

## NA.3 Decisions on the status of informative annexes

### NA.3.1 Annex B

MS EN 1997-1:YYYY Annex B may be used.

MS EN 1997-1:YYYY, **B.1**(3), **B.1**(4) and **B.1**(5) and **B.2**(6) and **B.2**(7) relate to Design Approach 2 and 3 and are therefore not applicable to designs in Malaysia.

*NOTE Design resistances are expressed in three forms in MS EN 1997-1:YYYY, 2.4.7.3.3, namely Equations (2.7a), (2.7b) and (2.7c). Equations (2.7a) and (2.7b) are simplifications of Equation (2.7c) for the specific cases where $\gamma_M$ =1 and $\gamma_R$ =1 respectively. The reference to Equation (2.7) in **B.3**(1) is strictly relevant to Equation (2.7c).*

### NA.3.2 Annex C

Annex C of EN 1997-1 has been improved by EC7 Maintenance Group. The improved Annex C is described in Annex C of this National Annex.

The values of $K_a$ and $K_p$ given in Figures C.1.1 to C.1.4 and Figures C.2.1 to C.2.4 relate to vertical retained faces. Where the retained face is inclined, Equations C.6 and C.9 should be used. The note under Equation C.9 says the expression is on the safe side; this can be taken to mean that it over-estimates the active pressure and under-estimate the passive pressure. When the active pressure is favourable and passive pressure is unfavourable the results are therefore not on the safe side.

The values of $K_a$ and $K_p$ given in Figures C.1.1 to C.1.4 and Figures C.2.1 to C.2.4 are based different theories from those on which Equations C.6 and C.9 are based. The two methods will therefore yield different results when $\delta$ is not equal to zero. The equations are more soundly based in theory but there is long experience of use of the graphs (i.e. Figures C.1.1 to C.1.4 and Figures C.2.1 to C.2.4). They differ mainly for high values of $\phi$ and $\delta/\phi$ for which it might be difficult to establish the reliability of the experience.

### NA.3.3 Annex D

Annex D may be used with the following modifications:

- The factor $N_\gamma$ in Equation (D.2) should be determined by the following equation which supersedes the formula for $N_\gamma$ given in the Annex D:

  $N_\gamma = (N_q - 1) \tan (1.4\, \phi')$

- The sample method given in MS EN 1997-1:YYYY, Annex D omits depth and ground inclination factors which are commonly found in bearing resistance formulations. The omission of the depth factor errs on the side of safety, but the omission of the ground inclination factor does not. To determine the ground inclination factor, one of the methods which may be considered is described in Design Manual DM-7.02 NAVFAC – Foundations and Earth Structures (see page 7.2-135).

### NA.3.4 Annex H

MS EN 1997-1:YYYY Annex H may be used.

*NOTE The limiting values of structural deformation and foundation movement relate primarily to buildings. Limiting value of structural deformation and foundation movement for other civil engineering works should be determined for the project and agreed, where appropriate, with the client and relevant authorities.*

### NA.3.5 Other Annexes

MS EN 1997-1:YYYY Annex E, Annex F, Annex G and Annex J may be used.

## NA.4 References to non-contradictory complementary information

The following is a list of references that contain non-contradictory complementary information for use with MS EN 1997-1:YYYY.

BS 1377;
BS 5930;
BS 6031;
BS 8008;
BS 8081;
PD 6694-1 [1)];
CIRIA C580;
UK Design Manual for Roads and Bridges;
IEM Publication entitled "Foundation Problems in Limestone Areas of Peninsular Malaysia" dated September 1986;
BS EN ISO 14688-1:2002 Geotechnical investigation and testing – Identification and classification of soil – Part 1: Identification and description;
BS EN ISO 14688-2:2004 Geotechnical investigation and testing – Identification and classification of soil – Part 2: Principles for a classification.
Quaternary Geology Report 9 – Quaternary Geology of the Kuching Area, Sarawak. Minerals and Geoscience Department Malaysia, 1997.
Quaternary Geology Report 10 – Quaternary Geology of the Sibu Town Area, Sarawak. Minerals and Geoscience Department Malaysia, 1998.

Design aspects of some of these, or parts of them, might be in conflict with the design principles in the MS EN 1997-1:YYYY. Until such time as "residual" documents are prepared to remove such conflicts and in the event that use of these documents presents a conflict, the Eurocode takes precedence other than design of ground anchorages. Section 8 of MS EN 1997-1:YYYY on ground anchorages is being revised and EN 1537 (execution standard of ground anchors) is under major revision in the design and testing sections of the execution standard. Until the revisions are complete and the revised documents published, design and testing of ground anchorages shall follow relevant parts of BS 8081, and execution of ground anchorages shall follow the execution sections of EN 1537.

EN 1997-1 Geotechnical Design does not cover the design and execution of reinforced soil structures. The design and execution of reinforced fill structures and soil nailing should be carried out in accordance with BS 8006, BS EN 14475 and prEN 14490 [1)]. The partial factors set out in BS 8006 should not be replaced by similar factors from EN 1997-1 or this National Annex.



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[1)] In preparation.

## NA.4 Country specific data (informative)

### NA 4.1 Foundations in limestone areas

Ground conditions in limestone areas are considered as exceptionally difficult. Relevant local publications should be referred on this subject. One of the publications is IEM Publication dated September 1986 entitled "Foundation Problems in Limestone Areas of Peninsular Malaysia".

Foundation design in limestone areas shall be classified as Geotechnical Category 3 in accordance with Clause 2.1(8)P. The requirements described in MS EN 1997-1:YYYY are minimum. The extent and content of geotechnical investigations may need to be expanded, design control and construction control shall be stringent.

The amount of investigations required will be at least the same as indicated for Geotechnical Category 2 projects described in MS EN 1997-2:YYY. Additional investigations and more specialised tests may be necessary; for example, because of karstic features of limestone formations and possible presence of pinnacles and cavities, the recommendations on spacing and depth of investigations in Annex B.3 of MS EN 1997-2:YYYY need to be modified.

Design supervision level (DSL) shall be DLS3 described in Table B4 of MS EN1990:YYYY.

Inspection level shall be IL3 described in Table B5 of MS EN 1990:YYYY. Additional requirements are described in Section 4 of MS EN 1997-1:YYYY.



### NA 4.2 Geotechnical works in peat

Peat is identified by its dark colour, characteristic mouldy odour and presence of plant remains.

Peat is classified as fibrous peat, pseudo-fibrous peat or amorphous peat according to the degree of decomposition. The degree of decomposition can be established by squeezing a wet sample. Refer Table 5 of BS EN ISO 14688-1:2002. The table is reproduced below for ease of reference.

| Term | Decomposition | Remains | Squeeze |
|---|---|---|---|
| Fibrous | Not | Clearly recognizable | Only water.<br>No solids. |
| Pseudo-fibrous | Moderate | Recognizable | Turbid water.<br><50% solids. |
| Amorphous | Full | Not recognizable | Paste.<br>>50% solids. |

Description of the genesis and characteristics of peat in Malaysia can be found in some local publications, like Quaternary Geology Reports 9 and 10 published by Minerals and Geoscience Department Malaysia in 1997 and 1998 respectively. It should be noted that peat in Malaysia is a tropical peat and some of its properties are different from those of the peat found in the temperate countries, for example the rate of land subsidence in a developed peat area. Therefore drainage management may need to be included as part of the design.

Engineering properties of fibrous peat are significantly different from those of most inorganic soils; for example the almost indefinite prolonged post construction settlement with time. Refer G. Mesri and M. Ajilouni (2007). Therefore design of structures in peat would include considerations of factors which are not necessary or crucial for a similar design in inorganic soils.

## NA 4.3 Partially saturated fill

Collapse compression of a partially saturated fill could result in large post-construction settlement or ground movement. The problem is associated with the movement of groundwater or the ingress of surface water. It is a major hazard for buildings on fill. As collapse compression can occur unpredictably many years after embankment construction and be localized, this form of settlement is also hazardous to road pavement. The potential for collapse compression is linked to the compacted state of the fill with air voids being a key parameter.

In Malaysia, such problems have been encountered; for example in large post construction settlement of deep fill subjected to ingress of water. Therefore, in designing embankment or structures on deep fill, effects of post construction ground movement due to long term wetting of the fill should be considered. One of references on this subject is BRE Report No. 424 entitled “Building on fill: Geotechnical Aspects” by J A Charles and K S Watts published in 2001.

## Bibliography


### Standards publications

BS 1377 (all parts), *Methods of test for soils for civil engineering purposes*

BS 5930, *Code of practice for site investigations*

BS 6031, *Code of practice for earthworks*

BS 8002, *Code of practice for earth retaining structures*

BS 8004, *Code of practice for foundations*

BS 8006:1995, *Code of practice for Strengthened/reinforced soils and other fills*

BS 8008, *Safety precautions and procedures for the construction and descent of machine-bored shafts for piling and other purposes*

BS 8081, *Code of practice for ground anchorages*

MS EN 1990:YYYY, *Eurocode: Basis of structural design*

MS EN 1997-1:YYYY, *Eurocode 7: Geotechnical design - Part 1: General rules*

BS EN 14475, *Execution of special geotechnical work - Reinforced fill*

PD 6694-1, *Recommendations for the design of structures subject to traffic loading to BS EN 1997-1* [2)]

prEN 14490, *Execution of special geotechnical works – Soil nailing* [2)]

BS EN ISO 14688-1:2002, *Geotechnical investigation and testing – Identification and classification of soil – Part 1: Identification and description;*

BS EN ISO 14688-2:2004, *Geotechnical investigation and testing – Identification and classification of soil – Part 2: Principles for a classification.*

2) In preparation.

### Other publications

[1] Gaba A. R. et al. C580 – *Embedded retaining walls – Guidance for economic design.* London: CIRIA, 2003.[3)]

[2] *UK Design Manual for Roads and Bridges*. London: The Stationery Office.

[3] *Foundation Problems in Limestone Areas of Peninsular Malaysia.* Kuala Lumpur: The Institution of Engineers, Malaysia, September 1986.

[4] *ICE specification for piling and embedded retaining walls, Second Edition*.

[5] *Design Manual DM-7.02 NAVFAC – Foundations and Earth Structures.* Naval Facilities Engineering Commnad, USA, 1986.

[6] *Quaternary Geology Report 9 – Quaternary Geology of the Kuching Area, Sarawak.* Minerals and Geoscience Department Malaysia, 1997.

[7] *Quaternary Geology Report 10 – Quaternary Geology of the Sibu Town Area, Sarawak.* Minerals and Geoscience Department Malaysia, 1998.

[8] G. Mesri and M. Ajilouni (2007) - *Engineering properties of fibrous peats.* Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 133, NO.7, pp.850-866.

[9] JA Charles and KS Watt - *Building on fill: Geotechnical Aspects (2nd Edition).* BRE Report: BR 424, 2001.


3) CIRIA Classic House 174–180 Old Street London EC1V 9BP, U.K.

# Annex A (normative) Design Approach and values of partial, correlation and model factors for ultimate limit states to be used in conjunction with MS EN 1997-1:YYYY

## A.1 Nationally Determined Parameters

**A.1.1** This Annex gives:

a) partial factors for geotechnical actions ($\gamma_F$) or the effects of geotechnical actions ($\gamma_E$) for ultimate limit states in the persistent and transient design situations;

b) partial factors for soil properties ($\gamma_M$) for ultimate limit states in the persistent and transient design situations;

c) partial factors for resistances ($\gamma_R$) for ultimate limit states in the persistent and transient design situations;

d) correlation factors ($\xi$) for pile foundations and anchorages in all design situations; and

e) advice on the use of model factors.

**A.1.2** As stated in **NA 2**, paragraph 1, only Design Approach 1 is used in Malaysia for the STR and GEO limit states. This Annex therefore only provides partial factors appropriate for Design Approach 1. In applying Design Approach 1, the design resistance for both Combination 1 and Combination 2 can be found using Equation (2.7c) in MS EN 1997-1:YYYY. Equations (2.7a) and (2.7b) are simplified versions of Equation (2.7c) which can be used in situations where $\gamma_R$=1 and $\gamma_M$=1 respectively. For sliding, Equations (6.3a) and/or (6.4a) in MS EN 1997-1:YYYY can be used for both Combination 1 and Combination 2. Equations (6.3a) and (6.4a) are simplified versions of the full expressions for sliding resistance for situations where $\gamma_{R;h}$ = 1. The partial factors specified for permanent actions in this Annex have been established to be consistent with the principle that a single partial factor can be applied to permanent actions arising from a single source for the STR and GEO limit states (see Note to **2.4.2**(9)P of MS EN 1997-1:YYYY).

## A.2 Partial factors for the equilibrium limit state (EQU) verification

### A.2.1 Partial factors on actions ($\gamma_F$)

For the verification of the equilibrium limit state (EQU), the values of the partial factors on actions are given in Table A.NA.1.

In cases where overturning instability of a structure could occur without the resistance of the ground being exceeded the partial factors specified in the National Annex to MS EN 1990:YYYY can give an overall factor of safety on overturning lower than that from which confidence has been gained through past Malaysian practice. In such cases it is recommended that consideration be given to the use of higher partial factors.

The partial factors specified in Table A.NA.1 might not be appropriate for self-weight of water, ground-water pressure and other actions dependent on the level of water, see **2.4.7.3.2**(2). The design value of such actions may be directly assessed in accordance with **2.4.6.1**(2)P and **2.4.6.1**(6)P of MS EN 1997-1:YYYY. Alternatively, a safety margin may be applied to the characteristic water level, see **2.4.6.1**(8) of MS EN 1997-1:YYYY.

The design value of earth pressures should be based on the design value of the actions giving rise to the earth pressure. For bridge design, in some cases, additional model factors might be required when evaluating horizontal earth pressures (see **A.6.3** of this National Annex).

Actions listed in MS EN 1997-1:YYYY, **2.4.2** for which no values are set in MS EN 1991 may be specified for a particular project. The values of these actions and their partial factors and combination factors should be agreed with the client and relevant authorities.

**Table A.NA.1 Partial factors on Actions ($\gamma_F$) for the equilibrium (EQU) limit state**

| **Action** | **Symbol** | **Value** |
|---|---|---|
| Permanent | | |
| Unfavourable[a] | $\gamma_{G;dst}$ | 1.1 |
| Favourable[b] | $\gamma_{G;stb}$ | 0.9 |
| Variable | | |
| Unfavourable[a] | $\gamma_{Q;dst}$ | 1.5 |
| Favourable[b] | $\gamma_{Q;stb}$ | 0.0 |

[a] Destabilising
[b] Stabilising

### A.2.2 Partial factors for soil parameters ($\gamma_M$)

For the verification of the equilibrium limit state (EQU) the values of the partial factors on soil parameters should be taken from Table A.NA.2.

**Table A.NA.2 Partial factors for soil parameters ($\gamma_M$) for the EQU limit state**

| Soil Parameter | Symbol | Value |
|---|---|---|
| Angle of shearing resistance [A)] | $\gamma_{\phi'}$ | 1.1 |
| Effective cohesion | $\gamma_{c'}$ | 1.1 |
| Undrained shear strength | $\gamma_{Cu}$ | 1.2 |
| Unconfined strength | $\gamma_{qu}$ | 1.2 |

[A)] Applied to tan $\phi'$ and tan $\phi'_{cv}$, although it might be more appropriate to determine the design value of $\phi'_{cv}$ directly.

*NOTE The value of the partial factor should be taken as the reciprocal of the specified value if such a reciprocal value produces a more onerous effect than the specified value (but see also the Note to* ***2.4.2****(9)P of MS EN 1997-1:YYYY)*



## A.3 Partial factors for structural (STR) and geotechnical (GEO) limit states verification

### A.3.1 Partial factors on actions ($\gamma_F$) or the effects of actions ($\gamma_E$)

**Table A.NA.3 Partial factors on actions ($\gamma_F$) or the effects of actions ($\gamma_E$) for the structural (STR) and geotechnical (GEO) limit states**

| Action | | Symbol | Set | |
|---|---|---|---|---|
| | | | A1 | A2 |
| Permanent | Unfavourable | $\gamma_G$ | 1.35 | 1.0 |
| | Favourable | | 1.0 | 1.0 |
| Variable | Unfavourable | $\gamma_Q$ | 1.5 | 1.3 |
| | Favourable | | 0 | 0 |

For the verification of the structural (STR) and geotechnical (GEO) limit states, the values of the partial factors on actions ($\gamma_F$) or the effects of actions ($\gamma_E$) should be taken from Table A.NA.3.

The partial factors values specified in Table A.NA.3 might not be appropriate for self-weight of water, ground-water pressure and other actions dependent on the level of water, see **2.4.7.3.2**(2). The design value of such actions may be directly assessed in accordance with **2.4.6.1**(2)P and **2.4.6.1**(6)P of MS EN 1997-1:YYYY. Alternatively, a safety margin may be applied to the characteristic water level, see **2.4.6.1**(8) of MS EN 1997-1:YYYY.

The design value of earth pressures should be based on the design value of the actions giving rise to the earth pressure. For bridge design, in some cases, additional model factors might be required when evaluating horizontal earth pressures, see **A.6.3** of this National Annex.

Actions listed in MS EN 1997-1:YYYY **2.4.2** for which no values are set in MS EN 1991:YYYY may be specified for a particular project. The values of these actions and their partial factors and combination factors might need to be agreed with the client and relevant authorities.

### A.3.2 Partial factors for soil parameters ($\gamma_M$)

For the verification of the structural (STR) and geotechnical (GEO) limit states, the values of the partial factors on soil parameters should be taken from Table A.NA.4.

**Table A.NA.4 Partial factors for soil parameters ($\gamma_M$) for STR and GEO limit states**

| Soil Parameter | Symbol | Set | | |
|---|---|---|---|---|
| | | **M1** | **M2** (Other than Slopes and Embankments) | **M2** (Slopes and Embankments) |
| Angle of shearing resistance A) | $\gamma_{\phi'}$ | 1.0 | 1.25 | 1.35 B) |
| Effective cohesion | $\gamma_{c'}$ | 1.0 | 1.25 | 1.35 B) |
| Undrained shear strength | $\gamma_{cu}$ | 1.0 | 1.4 | 1.5 B) |
| Unconfined strength | $\gamma_{qu}$ | 1.0 | 1.4 | 1.5 B) |

A) Applied to tan $\phi'$ and tan $\phi'_{cv}$ although it might be more appropriate to determine the design value of $\phi'_{cv}$ directly.

*NOTE The value of the partial factor should be taken as the reciprocal of the specified value if such a reciprocal value produces a more onerous effect than the specified value (but see also the note to* ***2.4.2****(9)P in MS EN 1997-1:YYYY.*

B) Less severe $\gamma_M$ value may be used for temporary structures or transient design situations (for example, end of construction stability for embankment) where the likely consequences justify it. Variation of these factors is permitted in particular circumstances when justified by thorough consideration and documented experience, and after being agreed, where appropriate, with the relevant authorities.

### A.3.3 Partial resistance factors ($\gamma_R$)

#### A.3.3.1 Partial resistance factors for spread foundations

For the verifications of the structural (STR) and geotechnical (GEO) limit states the values of the partial factors $\gamma_{R;v}$ on bearing resistance and $\gamma_{R;h}$ on sliding resistance should be as given in Table A.NA.5.

**Table A.NA.5 Partial resistance factors ($\gamma_R$) for spread foundations for the STR and GEO limit states**

| **Resistance** | **Symbol** | **Set R1** |
|---|---|---|
| Bearing | $\gamma_{R;v}$ | 1.0 |
| Sliding | $\gamma_{R;h}$ | 1.0 |

#### A.3.3.2 Partial resistance factors for pile foundations

The values of factors provided here are considered to be generally applicable for pile foundations. However, variation of these factors is permitted in particular circumstances when justified by thorough consideration and documented experience, and after being agreed, where appropriate, with the relevant authorities.

For verifications of the structural (STR) and geotechnical (GEO) limit states of pile foundations, the values of the partial factors on resistance ($\gamma_R$) should be those given in Table A.NA.6, Table A.NA.7 and Table A.NA.8. These values are used to convert characteristic resistances to design values for ultimate limit state calculations. They apply irrespective of the process by which the characteristic resistances are derived.

Jack-in piles are classified as driven piles. Table A.NA.6 applies to jack-in piles.

Characteristic resistances may be derived from static load tests using MS EN 1997-1:YYYY **7.6.2.2** (**7.6.3.2** for tensile loading), or from ground test results using MS EN 1997-1:YYYY Equations 7.8 or 7.9 (7.17 or 7.18 for tensile loading). When the approach of Equations 7.9 or 7.18 is used to derive the characteristic resistances, a model factor should be applied to the shaft and base resistance calculated using characteristic values of soil properties by a method complying with MS EN 1997-1:YYYY **2.4.1**(6). The value of the model factor should be 1.4, except that it may be reduced to 1.2 if the resistance is verified by a maintained load test taken to the calculated , unfactored ultimate resistance.

The trial pile static load test should meet the requirements spelt out in **7.5.1** and **7.5.2** of MS EN 1997-1:YYYY. The required number of trial piles shall comply with **7.5.2.2** of MS EN 1997-1:YYYY. "ICE specification for piling and embedded retaining walls" 2nd Edition,

Table C15.1 can be used in determining the appropriate level of pile testing.

**Table A.NA.6 Partial resistance factors ($\gamma_R$) for driven piles for the STR and GEO limit states**

| Resistance | Symbol | Set | | |
|---|---|---|---|---|
| | | R1 | **R4** without explicit verification of SLS [A)] | **R4** with explicit verification of SLS [A)] |
| Base | $\gamma_b$ | 1.0 | 1.87 | 1.65 |
| Shaft (compression) | $\gamma_s$ | 1.0 | 1.65 | 1.43 |
| Total/combined (compression) | $\gamma_t$ | 1.0 | 1.87 | 1.65 |
| Shaft in tension | $\gamma_{s;t}$ | 1.0 | 2.20 | 1.87 |

[A)] The lower $\gamma_R$ values in R4 may be adopted

(a) if serviceability is verified by static load tests (preliminary and/or working) carried out on more than 1% of the constructed piles to loads not less than 1.5 times the representative load for which they are designed, or

(b) if settlement is explicitly predicted by a means not less reliable than in (a), or

(c) if settlement at the serviceability limit state is of no concern.

**Table A.NA.7 Partial resistance factors ($\gamma_R$) for bored piles for the STR and GEO limit states**

| Resistance | Symbol | Set | | |
|---|---|---|---|---|
| | | R1 | **R4** without explicit verification of SLS [A)] | **R4** with explicit verification of SLS [A)] |
| Base | $\gamma_b$ | 1.0 | 2.20 | 1.87 |
| Shaft (compression) | $\gamma_s$ | 1.0 | 1.76 | 1.54 |
| Total/combined (compression) | $\gamma_t$ | 1.0 | 2.20 | 1.87 |
| Shaft in tension | $\gamma_{s;t}$ | 1.0 | 2.20 | 1.87 |

[A)] The lower $\gamma_R$ values in R4 may be adopted

(a) if serviceability is verified by static load tests (preliminary and/or working) carried out on more than 1% of the constructed piles to loads not less than 1.5 times the representative load for which they are designed, or

(b) if settlement is explicitly predicted by a means not less reliable than in (a), or

(c) if settlement at the serviceability limit state is of no concern.

**Table A.NA.8 Partial resistance factors ($\gamma_R$) for continuous flight auger CFA piles for the STR and GEO limit states**

| Resistance | Symbol | Set | | |
|---|---|---|---|---|
| | | **R1** | **R4** without explicit verification of SLS A) | **R4** with explicit verification of SLS A) |
| Base | $\gamma_b$ | 1.0 | 2.20 | 1.87 |
| Shaft (compression) | $\gamma_s$ | 1.0 | 1.76 | 1.54 |
| Total/combined (compression) | $\gamma_t$ | 1.0 | 2.20 | 1.87 |
| Shaft in tension | $\gamma_{s;t}$ | 1.0 | 2.20 | 1.87 |

A) The lower $\gamma_R$ values in R4 may be adopted

(a) if serviceability is verified by static load tests (preliminary and/or working) carried out on more than 1% of the constructed piles to loads not less than 1.5 times the representative load for which they are designed, or

(b) if settlement is explicitly predicted by a means not less reliable than in (a), or

(c) if settlement at the serviceability limit state is of no concern.



### A.3.3.3 Correlation factors for pile foundations

For the verifications of Structural (STR) and Geotechnical (GEO) limit states, the following correlation factors $\xi$ should be applied to derive the characteristic resistance of axially loaded piles:

$\xi_1$ on the mean values of the measured resistances in static load tests;

$\xi_2$ on the minimum value of the measured resistances in static load tests;

$\xi_3$ on the mean values of the calculated resistances from ground test results;

$\xi_4$ on the minimum value of the calculated resistances from ground test results;

$\xi_5$ on the mean values of the measured resistances in dynamic load tests;

$\xi_6$ on the minimum value of the measured resistances in dynamic load tests.

Table A.Na.9, Table A.NA.10 and Table A.NA.11 give the correlation factor values.

**Table A.NA.9 Correlation factors ($\xi$) to derive characteristic values of the resistance of axially loaded piles from static pile load tests (n - number of tested piles)**

| $\xi$ for n = | 1 | 2 | 3 | 4 | = > 5 |
|---|---|---|---|---|---|
| $\xi_1$ | 1.40 | 1.30 | 1.20 | 1.10 | 1.00 |
| $\xi_2$ | 1.40 | 1.20 | 1.05 | 1.00 | 1.00 |

*NOTE For structures having sufficient stiffness and strength to transfer loads from "weak" to "strong" piles, values of $\xi_1$ and $\xi_2$ may be divided by 1.1, provided that $\xi_1$ is never less than 1.0, see MS EN 1997-1* ***7.6.2.2****(9).*

**Table A.NA.10 Correlation factors ($\xi$) to derive characteristic values of the resistance of axially loaded piles from ground test results (n - number of profiles of tests)**

| $\xi$ for n = | 1 | 2 | 3 | 4 | 5 | 7 | 10 |
|---|---|---|---|---|---|---|---|
| $\xi_3$ | 1.40 | 1.35 | 1.33 | 1.31 | 1.29 | 1.27 | 1.25 |
| $\xi_4$ | 1.40 | 1.27 | 1.23 | 1.20 | 1.15 | 1.12 | 1.08 |

*NOTE For structures having sufficient stiffness and strength to transfer loads from "weak" to "strong" piles, values of $\xi_3$ and $\xi_4$ may be divided by 1.1, provided that $\xi_3$ is never less than 1.0, see MS EN 1997-1* ***7.6.2.2****(9).*



**Table A.NA.11 Correlation factors ($\xi$) to derive characteristic values of the resistance of axially loaded piles from dynamic impact tests (where n is the number of tested piles)**

| $\xi$ for n = | ≥2 | ≥5 | ≥10 | ≥15 | ≥20 |
|---|---|---|---|---|---|
| $\xi_5$ | 1.60 | 1.50 | 1.45 | 1.42 | 1.40 |
| $\xi_6$ | 1.50 | 1.35 | 1.30 | 1.25 | 1.25 |

*NOTE 1 The $\xi$-values may be multiplied with a model factor of 0.85 when using dynamic impact tests with signal matching.*

*NOTE 2 The $\xi$-values should be multiplied with a model factor of 1.10 when using a pile driving formula with measurement of the quasi-elastic pile head displacement during the impact.*

*NOTE 3 The $\xi$-values should be multiplied with a model factor of 1.20 when using a pile driving formula without measurement of the quasi-elastic pile head displacement during the impact.*

*NOTE 4 If different piles exist in the foundation, groups of similar piles should be considered separately when selecting the number n of test piles.*

### A.3.3.4 Partial resistance factors ($\gamma_E$) for pre-stressed anchorages

Section 8 of MS EN 1997-1:YYYY on ground anchorages is being revised and EN 1537 (the executive standard of ground anchors) is under some major revision on design and testing sections of this execution standard. Until the revisions are complete and the revised documents published, design and testing of ground anchorages shall follow relevant parts of BS 8081, and execution of ground anchorages shall follow the execution sections of EN 1537. Therefore the partial resistance factors $\gamma_E$ will not be applicable and no values are set.

**Table A.NA.12 Partial resistance factors ($\gamma_R$) for pre-stressed anchorages for STR and GEO limit states**

| Resistance | Symbol | Set | |
|---|---|---|---|
| | | R1 | R4 |
| Temporary | $\gamma_{a;t}$ | * A) | * A) |
| Permanent | $\gamma_{a;p}$ | * A) | * A) |
| * A) Not applicable in Malaysia. | | | |

### A.3.3.5 Partial resistance factors ($\gamma_R$) for retaining structures

For retaining structures and verifications of the structural (STR) and geotechnical (GEO) limit states, the partial factors to be applied on resistance ($\gamma_R$) should be as given in Table A.NA.13.

**Table A.NA.13 Partial resistance factors ($\gamma_R$) for retaining structures at the STR and GEO limit states**

| Resistance | Symbol | Set R1 |
|---|---|---|
| Bearing capacity | $\gamma_{R;v}$ | 1.0 |
| Sliding resistance | $\gamma_{R;h}$ | 1.0 |
| Earth resistance | $\gamma_{R;e}$ | 1.0 |

### A.3.3.6 Partial resistance factors ($\gamma_R$) for slopes and overall stability

For slopes and overall stability verifications of the structural (STR) and geotechnical (GEO) limit states, the partial factors to be applied on ground resistance ($\gamma_{R;e}$) should be as given in Table A.NA.14.

**Table A.NA.14 Partial resistance factors ($\gamma_R$) for slopes and overall stability at the STR and GEO limit states**

| **Resistance** | **Symbol** | **Set R1** |
|---|---|---|
| Bearing capacity | $\gamma_{R;e}$ | 1.0 |



## A.4 Partial Factors for the uplift limit state (UPL) verification

### A.4.1 Partial factors on actions ($\gamma_F$)

For verifications of the uplift limit state (UPL), the values for the partial factors on action ($\gamma_F$) should be as given in Table A.NA.15.

**Table A.NA.15 Partial factors on actions ($\gamma_F$) for the UPL limit state**

| **Action** | | **Symbol** | **Set** |
|---|---|---|---|
| Permanent | Unfavourable [A] | $\gamma_{G;dst}$ | 1.1 |
| | Favourable [B] | $\gamma_{G;stb}$ | 0.9 |
| Variable | Unfavourable [A] | $\gamma_{Q;dst}$ | 1.5 |
| | Favourable [B] | $\gamma_{Q;stb}$ | 0 |

[A] Destabilising
[B] Stabilising

*NOTE: The partial factor specified for permanent unfavourable actions does not account for uncertainty in the level of ground water or free water. In cases where the verification of the UPL limit state is sensitive to the level of ground water or free water, the design value of uplift due to water pressure may be directly assessed in accordance with 2.4.6.1(2)P and* ***2.4.6.1****(6)P of MS EN 1997-1:YYYY. Alternatively, a safety margin may be applied to the characteristic water level, see* ***2.4.6.1****(8) of MS EN 1997-1:YYYY.*

### A.4.2 Partial factors on soil parameters ($\gamma_M$) and resistances ($\gamma_R$)

For verification of the uplift limit state (UPL), the partial factors on soil parameters ($\gamma_M$) and resistance ($\gamma_R$) should be as given in Table A.NA.16.

**Table A.NA.16 Partial factors for soil parameters ($\gamma_M$) and resistance ($\gamma_R$) for the UPL limit state**

| **Soil Parameter** | **Symbol** | **Value** |
|---|---|---|
| Angle of shearing resistance [A)] | $\gamma_{\phi'}$ | 1.25 |
| Effective cohesion | $\gamma_{c'}$ | 1.25 |
| Undrained shear strength | $\gamma_{cu}$ | 1.4 |
| **Resistance** | **Symbol** | **Value** |
| Tensile pile resistance | $\gamma_{s;t}$ | See Note 2 |
| Anchorage | $\gamma_a$ | * [B)] |

[A)] Applied to tan $\phi'$ and tan $\phi'_{cv}$, although it might be more appropriate to determine the design value of $\phi'_{cv}$ directly.

[B)] Not applicable because design of anchorage does not follow *MS EN 1997-1:YYYY* for the time being.

*NOTE 1: The value of the partial factor for soil parameters should be taken as the reciprocal of the specified value if such a reciprocal value produces a more onerous effect than the specified value (but see also the Note to* ***2.4.2****(9)P of MS EN 1997-1:YYYY)*

*NOTE 2: Pile design should comply with clauses* ***A.3.3.2*** *and* ***A.3.3.3****.*

### A.5 Partial Factors for actions for the Hydraulic Heave limit state (HYD) verification

For verification of the Hydraulic Heave limit state (HYD), the values for the partial factors on action ($\gamma_F$) are given in Table A.NA.17.

**Table A.NA.17 Partial factors on actions ($\gamma_F$) at the Hydraulic Heave (HYD) limit state**

| **Action** | | **Symbol** | **Value** |
|---|---|---|---|
| Permanent | Unfavourable [A)] | $\gamma_{G;dst}$ | 1.35 |
| | Favourable [B)] | $\gamma_{G;stb}$ | 0.9 |
| Variable | Unfavourable [A)] | $\gamma_{Q;dst}$ | 1.5 |
| | Favourable [B)] | $\gamma_{Q;stb}$ | 0 |
| [A)] Destabilising<br>[B)] Stabilising | | | |
| *NOTE: In applying the specified partial factors in Equation (2.9a) of MS EN 1997-1:YYYY, the hydrostatic component of the destabilizing total pore water pressure ($u_{dst;d}$ ) and the stabilizing total vertical stress ($\sigma_{stb;d}$ ) can be considered to arise from a single source, see Note to* ***2.4.2****(9) P in MS EN 1997-1:YYYY.* | | | |

### A.6 Model Factors

**A.6.1** MS EN 1997-1:YYYY, **2.4.7.1**(6) states that model factors may be applied to the design value of a resistance or the effect of an action to ensure that the results of the design calculation model are either accurate or err on the safe side.

**A.6.2** For buildings designed using conventional calculation methods, it can be assumed that the necessary model factors are incorporated in the partial factors given in this Appendix except as specified in **A.6.5**.

**A.6.3** For bridges and other structures subject to highway loading, an additional model factor may be introduced for the evaluation of the earth pressure coefficient *K*, see PD 6694-1.

**A.6.4** Additionally, where the method of analysis of a building or a bridge is innovative, or where the results of a calculation are of uncertain reliability, model factors may be applied. In such cases the values should be agreed with the client and relevant authorities. In selecting the values of a model factor, the principles described in MS EN 1997-1:YYYY, **2.4.1**(8) and **2.4.1**(9) should be applied.

**A.6.5** Model factors required in pile design are provided in **A.3.3.2** and **A.3.3.3**.

# Annex C (informative)

## Sample procedures to determine earth pressures

*(The revised Annex C of EC7-1 will be reproduced here.)*