HARMONIZATION AND STATUS OF GEOTECHNICAL STANDARDS IN EUROPE

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Abstract

The background to the harmonization of geotechnical standards that has taken place in recent years in Europe has been the move to more economic and political integration following World War II that has led to the formation of the European Union. Prior to 2010 the standards used in the European countries for geotechnical design, investigation and testing and for the carrying out geotechnical work, such as the installation of piles, were the different national standards, which were not harmonized. The harmonization of geotechnical standards in Europe started in 1981 with work on a model Eurocode 7 for geotechnical design that led eventually to publication by CEN, the European Committee for Standardization, of the European Standard version of Eurocode 7 in 2004. In parallel with the work on Eurocode 7, a large number of associated harmonized standards have been, and are being, prepared by CEN and by the International Standards Organization (ISO) for geotechnical investigation and testing and for the execution of geotechnical works. Standards published by CEN must be adopted by the CEN member countries and all conflicting standards withdrawn. Hence all the CEN countries have adopted the same the harmonized text of Eurocode 7, but with National Annexes that allow national choice with regard to Design Approach and partial factor values. The adoption of Eurocode 7 and its associated geotechnical standards has removed the barriers to geotechnical activity in Europe due to the presence of different national standards. It has also enhanced the ability of EU firms to compete in the global market.

Background to harmonization of geotechnical standards in Europe

The initial moves towards the harmonization of geotechnical standards in Europe can be related to the economic and political developments that took place in the period immediately following World War II to revive the economies of Western Europe. Europe at that time was divided by a political and, in many places, a physical barrier, known as the Iron Curtain, into two very different and separate zones: communist in the east and non-communist in the west. In 1952 the European Coal and Steel Community (ECSC) was formed, linking 6 countries: Belgium, West Germany, France, Italy, Luxembourg and the Netherlands, and establishing a common market in coal and steel. The ECSC was the first international organization to be established on the basis of supranational principles whereby negotiated power is delegated to an authority by the governments of the member states. In 1957 the ECSC became the European Economic Community (EEC), also known as the Common Market in the English-speaking world, with the aim to bring about economic integration. With the addition of Denmark, Ireland and the UK in 1973 and Greece in 1981, followed by Portugal and Spain in 1986, this led to the formation of the European Union (EU) in 1993. East and West Germany were reunified in 1990, following the fall of the Iron Curtain in 1989. In 1995, Austria, Finland and Sweden joined the EU, and since then the numbers of countries in the EU has increased to 28, many of which are countries that were formerly behind the Iron Curtain.

Prior to World War II and in the period soon after it, codes of practice for structural and geotechnical design were only used in a small number of countries in Western Europe. In addition, these standards were not all published by national standards organizations; some were published by professional and other bodies. Countries, such as Greece and Ireland, which did not publish their own standards, used standards published by other countries, for example British, German or American standards. These codes aimed at describing good engineering practice and were not very systematic in their approach to design (Frank et al., 2004). In the postwar period, there was a widespread rethinking of the civil engineering design approach, with a move away from the former method with global factors of safety towards the adoption of the limit state design method with two calculations and sets of partial factors, one to check that collapse was sufficiently unlikely and the other to check that the deformations were acceptable and did not affect the efficient use or appearance of the structure. The first time the words “limit design” were used in a geotechnical context was by Brinch Hansen (1956). He also linked the limit design concept to the use of partial factors and these two concepts were introduced in the Danish code of practice for foundation engineering (DTP, 1977).

In parallel with the move in Europe towards greater economic and political integration, there was an initiative in 1974 by a number of European universities and representatives of the civil engineering profession to prepare harmonized European standards for structural design. From 1975, this initiative was supported by the Commission of the European Communities (CEC), which decided, as part of its aim to create a single market for the products of its member states, on an action programme in the field of construction. The objective of this programme was the promotion of free trade between the member states by the elimination of technical obstacles to trade and the harmonization of technical specifications (CEN, 2002). Within this action programme the Commission decided to establish the Eurocodes as a set of harmonized technical rules for the design of construction works, which, in a first stage, would serve as an alternative to the national rules in the 9 EEC member states at that time and, ultimately, would replace them. A further objective of the Eurocodes was that they should serve as internationally recognised standards and hence increase the competitiveness of the European civil engineering firms, contractors, designers and product manufacturers in their European and world-wide activities.

Development of the Eurocodes and Eurocode 7 under the European Commission

The initial work on the development of the Eurocodes as a set of harmonized standards was overseen by a Steering Committee established by the European Commission's Directorate for the Internal Market and Internal Affairs, DG III. From the start it was decided that the Eurocodes would all be based on the limit state design method and the use of partial factors. This method is set out in the head Eurocode, EN 1990: Basis of structural design (CEN, 2002). It was also decided that there would be a separate Eurocode for each material and a loading code that would be common for all the Eurocodes. When the Steering Committee proposed to start work on the preparation of Eurocode 7 for foundation design, Professor Kevin Nash, Secretary General of the International Society for Soil Mechanics and Foundation Engineering (ISSMGE) wrote in 1980 to the chairman of the steering committee saying that "*the ISSMGE was keenly interested to become involved in the work of Eurocode 7*" and declared its "*willingness to survey the existing foundation codes in Europe and on this basis to draft a proposal for Eurocode 7 to be submitted in 2 to 3 years to the Steering Committee*".

This offer was accepted and a committee was established in 1981, with representatives from nine of the ten EEC countries at that time to prepare a draft model code for Eurocode 7; no representative from Luxembourg was involved. Niels Krebs Ovesen from Denmark was appointed chairman of this committee. Although Professor Nash had envisaged it would take 2 to 3 years to prepare a model code for geotechnical design, it was 6 years before the draft model for Eurocode 7 was submitted to the European Commission in 1987. The reasons why it took 6 years to prepare the draft model code were because of the different traditions for carrying out geotechnical designs in the EEC and the limited experience in these countries in the use of the limit state method for geotechnical design; Denmark was the only EEC country with a geotechnical code that used the limit state method and partial factors. Once the draft model code had been submitted, the CEC took control of the work on Eurocode 7 and a drafting panel was established in 1988, again under Krebs Ovesen, to convert the draft model code into a Eurocode version of Eurocode 7.

Development of Eurocode 7 and the Eurocodes under CEN

As the work on the Eurocodes developed and expanded, with more parts being added so that there were 58 Eurocode parts, and due to the slow progress of this work under the European Commission, it became clear that it was not appropriate for DG III, as a civil service type of organisation, to develop and publish codes of practice for engineering design. Hence, in 1989, after 15 years developing the Eurocodes, the CEC decided that all the work on the Eurocodes should be transferred for further development, issue and maintenance to the European Committee for Standardization (CEN). This decision was appropriate because CEN is the organisation whose role is to publish European Standards, i.e. ENs. Consequently CEN took over the work on Eurocodes on 1 January 1990.

CEN was created in 1975 as an international non-profit association. Its members are European standards organisations, for example the National Standards Authority of Ireland (NSAI) in the case of Ireland and the British Standards Institution in the case of the UK. The transfer of the work on the Eurocodes to CEN in 1990 was soon after the fall of the Iron Curtain and the collapse of the communist regimes in Eastern Europe. An important consequence of this has been to increase the membership of CEN to include many former communist countries from Eastern Europe with the result that in 2013 CEN has 33 members, which are the 28 EU countries, plus 3 EFTA countries (Iceland, Norway and Switzerland), and Macedonia and Turkey. Many of the Eastern European countries have had geotechnical design traditions and codes with partial factors that are based on Russian codes that differ from the Eurocodes and from experience in Western Europe.

Under CEN, a trial version of Eurocode 7: Part 1, ENV 1997-1, was published in 1994, which was followed by a period of trial use between 1994 and 1998 before work started on the preparation of the EN version of Eurocode 7. In order for a standard to be published by CEN as an EN, consensus is required amongst the CEN member countries, where what constitutes consensus for a CEN standard is explained in the following section. Orr (2012) has identified the following three challenges that faced those preparing Eurocode 7 as a limit state geotechnical design code and that had to be overcome in order to achieve consensus, which were that it had to:

- Harmonize geotechnical design with structural design through being consistent with the limit state design method in EN 1990 that had been conceived originally for the design of structures,
- Take account of the special features of soil that affected geotechnical design,
- Be acceptable to the European geotechnical community.

After many meetings and much discussion, these challenges were overcome and thus in 2004, 23 years after work started on the drafting of Eurocode 7 as a harmonized standard for geotechnical design, the EN version of Eurocode 7 was published, with three Design Approaches, which allow countries to apply partial factors either to soil parameter values or to resistances. The values of the parameters in the Eurocodes, such the partial factors and other factors that set the safety level for designs in a particular country, are chosen by each CEN member. These parameters are termed Nationally Determined Parameters (NDPs) and are published in National Annexes to the Eurocodes by the standards body for each country. Part 2 of Eurocode 7, which provides the requirements for geotechnical investigations and the determination of geotechnical parameter values from field and laboratory tests, was published in 2007. In 2010, Eurocode 7 plus all the other Eurocodes, replaced the national standards, which were withdrawn in the CEN member countries, except for a limited period in a few countries where National Annexes or other supporting documents were not yet available. More details about the history of the development of Eurocode 7 are given by Orr (2008).

EU Regulations and status of the Eurocodes and CEN and ISO standards

As part of the economic and political integration that has occurred in Europe, the European Parliament and Council passed, in 1988, the Construction Products Directive (89/106/EEC) that specifies the essential requirements to ensure that building and civil engineering works in the member states are designed and executed in a way that does not endanger the safety of persons, domestic animals and property. This Directive was replaced in 2011 by the Construction Products Regulation 305/2011, which lays down harmonized conditions for the marketing of construction products. EU regulations and directives are implemented in the EU member states by national legislation. The Eurocodes serve as reference documents as a means of demonstrating compliance with the essential requirements for building and civil engineering works in the Construction Products Directive and Regulation. In some countries, such as Ireland and the UK, the essential requirements are given in national building regulations that refer to the Eurocodes as documents which, when complied with, designs are deemed to satisfy the regulations. In other countries, such as Italy, compliance with the Eurocodes is a legal requirement.

In producing European standards, CEN serves as a facilitator, removing trade barriers for European industry and consumers so as to foster the European economy in global trading, the welfare of European citizens and the environment. CEN standards have a unique status since they are also issued as national standards in each of the CEN member countries, for example in Ireland CEN standards are issued as Irish standards with the prefix I.S. EN and in the UK they are issued as British Standards with the prefix BS EN. Hence, with one common standard in all the CEN member countries and all conflicting national standard withdrawn, the European standards can reach a far wider market with much lower development and testing costs than national standards.

While CEN is only composed of European members, its international counterpart, ISO (International Organization for Standardization), which was founded in 1947, has members from 164 countries worldwide. To avoid duplication of work, the Vienna Agreement between CEN and ISO was signed in 1991. This agreement aims to ensure technical cooperation between CEN and ISO by correspondence, mutual representation at meetings and coordination of meetings. Also a document developed within one body is notified for the simultaneous approval by the other so that the same text is adopted as both an ISO Standard and a European Standard. As a result of the Vienna Agreement, there has been much collaboration between CEN and ISO in the preparation of harmonized standards relating to geotechnics.

For the CEN member countries, the formal adoption of a document as an EN is on the basis of a weighted majority vote of all the CEN members. It is then binding on all the CEN members, who are obliged to implement it as a national standard and withdraw any conflicting national standards. CEN aims to adopt new standards on the basis of consensus, where consensus does not necessarily imply unanimity but is general agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. Consensus reflects the voluntary character of EN standards and ensures that the standards are wanted by the parties concerned and are prepared with the voluntary commitment to their use. The draft of a standard is issued for public enquiry by CEN as a prEN and by ISO as an ISO/DIS. Where sufficient consensus is not achieved for publication of a document as a European Standard, it may be published as a Technical Specification, i.e. as a TS, while further development is carried in order to achieve a consensus. Meanwhile conflicting national standards may continue to exist. After a European Standard has been published, it is periodically reviewed. During this review period and any consequential revision, a standstill applies to the EN, apart from any corrections or minor amendments. Under the normal CEN rules, an EN is reviewed at least within five years from its publication or earlier when requested.

In the case of ISO, its standards are produced in response to a need in the market and a request from industry or other stakeholders. As in the case of CEN, ISO has a consensus-based approach for the development of new standards and comments from stakeholders are taken into account. In ISO consensus may be considered to occur when two-thirds of the participating members of the relevant technical committee vote affirmatively. ISO standards are voluntary and, unlike CEN, ISO has no powers to enforce its members to adopt its standards as national standards and withdraw existing conflicting national standards. However, those standards that are developed by ISO in cooperation with CEN are published as national standards by the CEN member states. Another difference between ISO and CEN is that, due to the large number of ISO members and their spread geographically, the development of ISO standards has often been slower than the development of CEN standards, for example there had been little development of a proposed ISO standard for foundations, retaining structures and earthworks before work on this ceased, as noted in the next section, due to the work on development of Eurocode 7 by CEN.

CEN and ISO Standards for Geotechnical Design, Investigation and Testing

Work on the development of EN 1997: Eurocode 7, the CEN standard for geotechnical design, is carried out by sub-committee SC7 of the CEN technical committee *TC 250: Structural Eurocodes*. The following two parts of Eurocode 7 have been published:

- EN 1997-1:2004 - Eurocode 7: Part 1 – General rules
- EN 1997-2:2007 - Eurocode 7: Part 2 – Ground investigation and testing.

In view of CEN TC 250/SC7 developing a standard for geotechnical design, the ISO technical committee TC 182/SC3, with the brief to prepare international standards for the design of foundations, retaining structures and earthworks, is no longer active, as noted above.

CEN and ISO have established parallel technical committees, TC 341 *Geotechnical Investigation and Testing* and TC 182/SC1 *Geotechnics* to prepare a very comprehensive range of standards for geotechnical investigation and the carrying out of laboratory and field tests for the determination of geotechnical parameters. These committees have prepared or are preparing the following 9 standards with the number of parts listed below, amounting to 48 parts in total:

- 14688: *Identification and classification of soil*	2 parts
- 14689: *Identification and classification of rock*	1 part
- 17628: *Geothermal testing*	1 part
- 17892: *Laboratory testing of soil*	12 parts
- 18674*: Geotechnical monitoring by field instrumentation*	1 part
- 22282: *Geohydraulic testing*	6 parts
- 22475: *Sampling methods and groundwater measurements*	3 parts
- 22476: *Field testing*	14 parts
- 22477: *Testing of geotechnical structures*	8 parts
Total	48 parts

Details about the different parts of these standards and their status are given in the following paragraphs. All of these standards have the umbrella label: *Geotechnical investigation and testing*.

The standard *14688: Geotechnical investigation and testing - Identification and classification of soil*, has two parts, *Part 1: Identification and description*, and *Part 2: Principles for a classification*, both of which have been published by CEN as ENs, as shown in Table 1. The label A1 indicates an amendment.

Table 1: Parts of 14688: Geotechnical investigation and testing - Identification and classification of soil

Reference	Date	Title
EN ISO 14688-1	2002	Part 1: Identification and description
EN ISO 14688-2	2004/A1: 2013	Part 2: Principles for a classification

The standard *14689: Geotechnical investigation and testing - Identification and classification of rock*, has just one part, *Part 1: Identification and description*, which has been published by CEN as an EN, as shown in Table 2.

Table 2: 14689: Geotechnical investigation and testing - Identification and classification of rock

Reference	Date	Title
EN ISO 14689-1	2003	Part 1: Identification and description

The standard *17628: Geotechnical investigation and testing - Determination of thermal conductivity of soil and rock using a borehole heat exchanger*, has been published by CEN as a pre-standard, i.e. as a prEN, as shown in Table 3 and in December 2013 is awaiting approval by the CEN members.

Table 3: 17628: Geotechnical investigation and testing -Determination of thermal conductivity of soil and rock using a borehole heat exchanger

Reference	Date	Title
prEN ISO 17628	2013	Geotechnical investigation and testing - Determination of thermal conductivity of soil and rock using a borehole heat exchanger

All 12 parts of the standard *17892: Geotechnical investigation and testing – Laboratory testing of soil* were published by CEN and ISO as TSs in 2004, with amendments in 2005, since sufficient consensus had not been obtained to published them as ENs. Since 2005, further redrafting has been carried out on the different parts of 17892, so that the status of its parts in December 2013 is as indicated in Table 4: Parts 1 and 2 have been published as pre-standards for approval by the CEN members with dates of

Table 4: Parts of 17892: Geotechnical investigation and testing – Laboratory testing of soil

Reference	Publication date/status	Part title
prEN ISO 17892-1	2013/Under approval DAV 2015-01	Part 1: Determination of water content
prEN ISO 17892-2	2013/Under approval DAV 2015-01	Part 2: Determination of density of fine-grained soil
CEN ISO/CS 17892-3	Being redrafted/Due for comment spring 2014	Part 3: Determination of particle density - Pycnometer method
CEN ISO/CS 17892-4	Being redrafted/Due for comment spring 2014	Part 4: Determination of particle size distribution
CEN ISO/TS 17892-5	Being redrafted/Due for comment summer 2014	Part 5: Incremental loading oedometer test
CEN ISO/TS 17892-6	Being redrafted/Due for comment summer 2014	Laboratory testing of soil - Part 6: Fall cone test
CEN ISO/TS 17892-7	Redrafting not yet started	Part 7: Unconfined compression test on fine-grained soils
CEN ISO/TS 17892-8	Being redrafted/Due for comment late 2014/early 2015	Part 8: Unconsolidated undrained triaxial test
CEN ISO/TS 17892-9	Being redrafted/Due for comment late 2014/early 2015	Part 9: Consolidated triaxial compression tests on water-saturated soils
CEN ISO/TS 17892-10	Redrafting not yet started	Part 10: Direct shear tests
CEN ISO/TS 17892-11	Redrafting not yet started	Part 11: Determination of permeability by constant and falling head
CEN ISO/TS 17892-12	Being redrafted/Due for comment late 2014/early 2015	Part 12: Determination of Atterberg limits

availability (DAV) of January 2015; Parts 3 to 6 are being redrafted and due to be issued for comment in the spring or summer of 2014; Parts 8, 9 and 12 are at an earlier redrafting stage, being due to be issued for comments in late 2014 or early 2015; no redrafting has yet started on Parts 7, 10 or 11.

The standard *18674: Geotechnical investigation and testing – Geohydraulic testing – General rules* with one part, as shown in Table 5, is at the pre-standard stage and hence has been published as a prEN by CEN, with an anticipated DAV of May 2015.

Table 5: Parts of 18674: Geotechnical investigation and testing – Geohydraulic testing

Reference	Date/status	Title
prEN ISO 18674	2013/Under approval DAV 2015-05	Geohydraulic testing - General rules

The standard 22282: *Geotechnical investigation and testing – Geohydraulic testing* has 6 parts, as shown in Table 6. All of these parts have been published by ISO and CEN in 2012 as standards.

Table 6: Parts of 22282: Geotechnical investigation and testing – Geohydraulic testing

Reference r	Date	Part title
EN ISO 22282-1	2012	Part 1: General rules
EN ISO 22282-2	2012	Part 2: Water permeability tests in a borehole using open systems
EN ISO 22282-3	2012	Part 3: Water pressure tests in rock
EN ISO 22282-4	2012	Part 4: Pumping tests
EN ISO 22282-5	2012	Part 5: Infiltrometer tests
EN ISO 22282-6	2012	Part 6: Water permeability tests in a borehole using closed systems

The standard *22475**:** Geotechnical investigation and testing - Sampling methods and groundwater measurements* has 3 parts, as shown in Table 7. *Part 1: Technical principles for execution* has been published as an EN, while the other two parts, *Part 2: Qualification criteria for enterprises and personnel* and *Part 3: Conformity assessment of enterprises and personnel by third party*, have been published as TSs.

Table 7: Parts of 22475: Geotechnical investigation and testing – Sampling methods and groundwater measurements

Reference	Date	Part title
EN ISO 22475-1	2006	Part 1: Technical principles for execution
CEN ISO/TS 22475-2	2006	Part 2: Qualification criteria for enterprises and personnel
CEN ISO/TS 22475-3	2007	Part 3: Conformity assessment of enterprises and personnel by third party

The standard *22476: Geotechnical investigation and testing - Field testing* has 14 parts, as shown in Table 8. Eight of these parts, Parts 1 – 5, 7 and 12, have been published as ENs. Two parts, *Part 10: Weight sounding test* and *Part 11: Flat dilatometer test*, have been published as TSs. One part, *Part 9: Field vane test*, is under approval with an anticipated DAV of December 2014, and no progress has been reported on the remaining three parts, *Part 6: Self-Boring pressuremeter test*, *Part 8: Full displacement pressuremeter test* and *Part 13: Plate loading test*.

Table 8: Parts of 22476: Geotechnical investigation and testing – Field testing

Reference	Date/status	Part title
EN ISO 22476-1	2012/AC:2013	Part 1. Electrical cone and piezocone penetration tests
EN ISO 22476-2	2005/A1:2011	Part 2: Dynamic probing
EN ISO 22476-3	2005/A1:2011	Part 3: Standard penetration test
EN ISO 22476-4	2012	Part 4: Ménard pressuremeter test
EN ISO 22476-5	2012	Part 5: Flexible dilatometer test
ISO 22476-6	No progress reported	Part 6: Self-Boring pressuremeter test
EN ISO 22476-7	2012	Part 7: Borehole jacking test
ISO 22476-8	No progress reported	Part 8: Full displacement pressuremeter test
prEN ISO 22476-9	Under approval DAV 2014-12	Part 9: Field vane test
CEN ISO/TS 22476-10	2005	Part 10: Weight sounding test
CEN ISO/TS 22476-11	2005	Part 11: Flat dilatometer test
EN ISO 22476-12	2009	Part 12: Mechanical cone penetration test (CPTM)
EN ISO 22476-13	No progress reported	Part 13: Plate loading test
prEN ISO 22476-15	Under approval DAV 2015-12	Part 15: Measuring while drilling

According to the ISO website, TC 182 has plans for 8 parts of the standard *22477: Geotechnical investigation and testing - Testing of geotechnical structures*, as shown in Table 9. Many of these standards involve the test loading of pile foundations. Progress on the preparation of these parts has been slow and difficult and none is currently published as a standard by ISO or CEN. As indicated in Table 9, development is only taking place at present on *Part 6: Testing of nailing* and *Part 10: Testing of piles: rapid load testing*. Part 6 has the label WD to indicate it is a working draft at the preliminary stage of standard preparation, while Part 10 has the label CD to indicate it is at the committee stage of standard preparation. It should be noted that the *Rapid load testing* part is listed as Part X on the ISO website, but as Part 10 on the CEN website with a DAV of December 2015. There has been no progress on *Part 1: Pile load test by static axially loaded compression test*, so it has been deleted. Similarly *Part 5: Testing of ground anchorages* was issued for comment in 2009, but this part has also been deleted. This part will need to be revised as a consequence of the 2013 revision to EN 1537: *Execution of special geotechnical works – Ground anchors*, and the issuing of a revised version of the section of EN 1997-1 on the design of ground anchors. There has been no progress on Parts 2. 3. 4 and 7.

Table 9: Parts of 22477: Geotechnical investigation and testing – Testing of geotechnical structures

Reference	Status	Part title
ISO 22477-1	Deleted	Part 1: Pile load test by static axially loaded compression test
ISO 22477-2	No progress	Part 2: Pile load test by static axially loaded tension test
ISO 22477-3	No progress	Part 3: Pile load test by static transversely loaded tension test
ISO 22477-4	No progress	Part 4: Pile load test by dynamic axially loaded compression test
ISO 22477-5	Under development	Part 5: Testing of anchorages
ISO/WD 22477-6	Under development	Part 6: Testing of nailing
ISO 22477-7	No progress	Part 7: Testing of reinforced fill
ISO/CD 22477-10	Under development	Part 10: Testing of piles: rapid load testing

CEN Standards for Execution of Geotechnical Works

Since the safety of geotechnical structures depends not only reliability of the design but also on how well the work is carried out, i.e. how well it is executed, CEN established technical committee TC 288 to prepare a set of harmonized European standards for the execution of certain geotechnical works. This TC has published 13 execution standards, all with the umbrella title “Execution of special geotechnical works” and the details of which are given in Table 10. The following 4 of these standards involve the installation of piles:

- EN 12063 Sheet-pile walls
- EN 12699 Displacement piles
- EN 14199 Micropiles
- EN 1536 Bored piles.

Table 10: Standards for Execution of special geotechnical works

Reference	Date/status	Title: all preceded by “Execution of special geotechnical works
prEN 12063	Under approval DAV 2015-2	Sheet-pile walls
prEN 12699	Under approval DAV 2015-3	Displacement piles
EN 12715	2000	Grouting
EN 12716	2001	Jet grouting
prEN 14199	Under approval DAV 2015-3	Micropiles
EN 14475	2006, AC 2006	Reinforced fill
EN 14490	2010	Soil nailing
EN 14679	2005, AC 2006	Deep mixing
EN 14731	2005	Ground treatment by deep vibration
EN 15237	2005	Vertical drainage
EN 1536	Under drafting DAV 2015-6	Bored piles
EN 1537	2013	Ground anchors
EN 1538	Under drafting DAV 2015-6	Diaphragm walls

The letters AC in Table 10 refer to an amendment corrigendum to a standard. The most recently issued execution standard is the 2013 version of *EN 1537: Ground anchors*, which is a revision of the 2010 version to make it consistent with the recently revised section of EN 1997-1 on the design of ground anchors. Following revision, *12063: Sheet-pile walls* and *12699: Displacement piles* are awaiting approval from the CEN members and are due to be available as ENs in February and March 2015, respectively. The 2010 versions of *EN 1536: Bored piles* and *EN 1538: Diaphragm* walls are being redrafted and the revised versions are due to be available as ENs in June 2015.

Other CEN and ISO Geotechnical Standards

In addition to the 2 standard parts for geotechnical design and 61 standard parts for investigation, testing and the execution of geotechnical works, making 63 parts in total, listed in the previous section, CEN and ISO have also been preparing, through other TCs, a number of standards relating to other aspects of geotechnical engineering. Many of these standards have now been published by CEN and ISO and some are referred to in Eurocode 7. One such standard, which is referred to in Eurocode 7 Part 1, is *EN-ISO 13793: 2001 - Thermal performance of buildings –Thermal design of foundations to avoid frost heave*. The CEN TC 189 and ISO TC 221 for Geosynthetics have produced a large number of standards covering different aspects of the use of geosynthetics in geotechnical engineering, for example:

- EN ISO 13433:2006 – *Geosynthetics. Dynamic perforation test (cone drop test,)* and
- EN ISO 13437:1998 – *Geotextiles and geotextile products. Method for installing and extracting samples in soil, and testing specimens in laboratory*.

Another CEN committee established to prepare standards that are relevant to geotechnical engineering is TC 396: Earthworks. According to the January 2010 Business Plan for this TC on the CEN website, it has the following working groups to prepare standards for earthworks that comply with Eurocode 7:

- WG 1: General matters - Earthwork principles, design rules, environmental aspects, terminology, national practices
- WG 2: Classification systems for earthwork purposes and characterisation of excavatability
- WG 3: Construction procedures
- WG 4: Quality control and monitoring
- WG 5: Hydraulic fill

At the present time, December, 2013, TC 396 has not produced any standards or drafts of standards that have been published by CEN.

Use of the Eurocodes outside Europe

According to European Commission's Joint Research Centre (JRC, 2008), the Eurocodes are already being used in several countries outside Europe for the revision of existing codes and for the creation of new codes; South Africa is an example. Several countries are planning the direct implementation of the Eurocodes and some international projects are being designed to the Eurocodes. Countries outside the EU and CEN members where there has been particular interest in the Eurocodes have been those countries:

- Whose national standards were based on European national standards that have been withdrawn following the adoption of the Eurocodes;
- Who want to update their national standards based on technically advanced codes;
- Who are interested in trading with the European Union and EFTA member states (i.e. Iceland, Liechtenstein, Norway and Switzerland).

The reasons why Eurocode 7 and the other Eurocodes for geotechnical and structural design, together with their associated harmonized and consistent set of standards for materials, testing and the execution of construction works, are of interest outside Europe as well as within the CEN member countries are because they are:

- A complete set of harmonized design standards that cover in a comprehensive manner all principal construction materials, all major fields of structural engineering and a wide range of types of structures and products;
- The most up-to-date codes of practice;
- Flexible, offering the possibility for each country to adapt the Eurocodes to their specific conditions regarding climate, seismic risk, traditions, etc. through the Nationally Determined Parameters. NDPs can also be adapted to the national approach and setup regarding risk and safety.

Future development of the Eurocodes

The European Commission recognised that, for the European construction sector to remain competitive in the world construction industry, it was essential that the Eurocodes, once published, should remain the most up-to-date, useable international codes of practice, meeting the requirements for a profession practicing in a competitive environment (EC, 2003). Hence development and revision of the Eurocodes, including Eurocode 7, is an on-going process. The CEN committee, TC250/SC7, responsible for Eurocode 7 has prepared plans for the revision of Eurocode 7, aiming to restructure it so as to make it clearer, easier to use with a reduction in the number of Nationally Determined Parameters and a simplification of the Design Approaches, more consistent with EN 1990 and the structure of the other Eurocodes, and also consistent with the associated CEN and ISO standards for geotechnical investigation, testing and the execution of geotechnical works. The timetable for the revision of all the Eurocodes is short and is due to take place simultaneously. Plans have already been prepared and submitted to CEN for approval. The work is due to start in 2014 and to be completed in 2018, with a vote by the CEN members on revised versions in 2019 and publication of the revised versions in 2020.

Conclusions

The economic and political developments in Europe since World War II that have led to the formation of the European Union have been accompanied by a move to eliminate the technical obstacles to trade, including trade in construction, and hence to the harmonization of geotechnical standards. The results of this harmonization are:

- The same version of Eurocode 7 has been adopted as the harmonized national standard for geotechnical design in all the CEN member countries with National Annexes that allow national choice for the Design Approach and the values of the partial factor and other safety elements,
- 61 associated CEN and ISO standards for geotechnical investigation and testing and for the execution of geotechnical structures have been or are being prepared to support Eurocode 7,
- Eurocode 7 provides a common geotechnical "language" for all the CEN member countries and hence removes the barriers to geotechnical activity throughout Europe that had existed previously due to different national standards for geotechnical design,
- Eurocode 7 harmonizes geotechnical design with structural design,
- As well as removing the trade barriers in Europe, the Eurocodes are of interest to countries outside Europe, being adopted by some, and enhance the ability of EU firms to compete in global markets.
- The Eurocodes and other CEN standards are not static documents but are regularly reviewed and revised as necessary to keep them up-to-date, with a revised version of Eurocode 7 due in 2020.

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