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Study and comparison of European and Russian technical documentation of building materials

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Abstract

The development process of European Standards and Eurocodes can serve as an incentive for substantial expansion of scientific cooperation with European colleagues, break technical trade barriers down and make it possible to have common-used design rules for buildings and structures. It is essential to start studying entire array of supporting documents. First and foremost the standards for materials and standards for test methods should be analyzed. This article is focused on investigation of the European standard technical documentation in terms of specifications and test methods for concrete mixes and concretes in comparison with the Russian standards. The first stage of the laboratory practicum development meant for students can be a remote learning course in the moodle system.

Keywords: concrete, concrete mixes, Eurocodes, European standards, laboratory workshop

1. Introduction

The major aim of any contemporary government is to ensure high standards of living for its citizens with their prospective improvement. The way the governments use their resources and possibilities to achieve this aim explicates their ability to compete with other countries in global markets (Steinerts, A., Pakrastinsh, L., Gaile L., 2013). The construction industry makes a significant contribution to development of all the economic sectors - both production and non-production. Each country is concerned with its products to be highly competitive and demanded. Having standard documents in harmony is an important part to solve this problem (James Sommerville, Nigel Craig, Sarah Bowden, 2004).

The idea to have construction standards coordinated with the European ones stems from expansion of market relations with the nearest neighbors and Russia's entry into the World Trade Organization (Dzhinchvelashvili G.A, Dzerzhinsky R.I., 2012). It is necessary to harmonize standard documents in order to eliminate disputes between builders and designers as well as to break technical trade barriers down. Provided this harmonization is ensured the Russian specialists will be able to compete with European ones (Vasanthi R Perumal, Abu Hassan Abu Bakar, 2011). In 2012 the State Duma adopted the Federal law "On ratification of the Protocol on the accession of the Russian Federation to the Marrakesh agreement establishing the world trade organization of April 15, 1994." It was signed by the RF President V. V. Putin. Russia became a member of the WTO after it had been notified on ratification by the WTO Secretariat.

Construction materials are fundamental for construction activity. Knowledge of their particular characteristics and of the ways they must be applied ensures that buildings and constructions will be economically efficient and technically reliable. Concrete and reinforced concrete are the main construction materials according to their technical and economic performance indicators, and they take priority places in the structure of global construction industry (Barabanshikov Y.G., Nikolsky S.G, Belyaeva S.V, 2011). Therefore, it is necessary to begin with studying all the supporting documents. First of all, the standards for materials and standards for test methods should be investigated.

1.1. Work objective

The objective of this work is to study and compare European and Russian standards of technical documentation in terms of specifications and test methods for concrete mixes and concretes. An additional
covering aim is to develop laboratory practicum for students and give sight of the test methods for concrete and concrete mixes in compliance with the European standards.

1.2. History of standardization in the Russian Federation

Industrial standardization in Russia started to develop at an intermediate stage between XVII and XVIII centuries when a number of decrees of the emperor Peter I were declared, which were assigned to ensure endurance testing and interchangeability (Kurochkina A.Y., 2009).

Science, engineering, industry and trade developed rapidly at the beginning of the XIX century in Russia. Metrology and standardization at the same time got completely different development impulse. The formation of the centralized system of standardization in Russia began after revolution in 1920 - 1930 years, and methodological foundations were being actively developed during this period. The category of state standards (GOST) was entered in 1940. The state standards were a must to be used in all the sectors of the national economy of the Soviet Union. Board of Standards, Measures and Measuring Equipment affiliated with the Council of Ministers of the USSR was founded in 1954, and then in 1971 it was transformed into the State Standard of the USSR (Gosstandart of the USSR), and only afterwards to the State Standard of the Russian Federation (Gosstandart of the Russian Federation).

The Federal Law "On technical regulation" adopted in 2002 cancelled provisions of the Law "On Standardization" and revealed a new period of standardization development in our country. An administrative reform was carried out in 2004. Rostechregulirovaniye replaced Gosstandart of the Russian Federation. The current state system of construction standardization in our country includes the State Standards (GOSTs and OSTs), Specifications (TU), Building Codes and Regulations (SNiP), Rules and Regulations (SP), guidelines and instructions.

There are about 500 state standards in construction and building materials industry. The standards on certain building materials specify types and main sizes, specifications, test methods, acceptance rules, marking rules, packing rules, transportation and storages rules. In addition to the general standards the system contains specifications for certain products assigned for building materials production.

1.3. Harmonization problems

Standardization system reform is connected with the requirements assigned for Russia to enter the WTO in respect to have the national standardization system harmonized with the global system implying transition to European standards and Eurocodes and revision of the base of standards (Travush V. I., Almazov V.O., Volkov Y. S., 2011).

Creating a common system of European standards [European Norms (EN)] is one of the elements of the integration process of the developed European countries into the European Union. The European Committee for Standardization CEN was officially established as an international non-commercial organization October 30, 1975. CEN develops standardization and other technical solutions and specifications in respect to European standards development and coordination; it also takes the national features of each country attached to the system of Eurocodes into account (Denton, S.R., 2010). This means that, apart from adopting provisions of international rules in the national standards, it is also necessary to consider climatic, hydrogeological and geological features of each participating country (Steinerts, A., Pakrastinsh, L., Gaile, L., 2011). The amendments to the Federal Law "On technical regulation" adopted by the State Duma have predetermined further integration of Russia into the global, and first of all, European economy. These amendments have obliged technical committees of the Federal Agency on Technical Regulating and Metrology (Rosstandard) to provide recommendations on opportunities to include foreign standards into a list of the documents ensuring requirements of the technical regulations to be met.

The problems of technical regulation in construction are connected with the stage-by-stage introduction of Eurostandards within the territory of the Russian Federation, and also they are related to the production and quality control of building materials and products to a large extent (Yakubson V.M., 2011). At present days uniform criteria for quality assessment in regard to building materials have not been established yet which makes it difficult to harmonize Russian and European construction standards to a full extent. Many provisions of the national standards, such as main requirements for materials, and their classification, various test methods, marking rules and other parameters differ significantly from the European standards which make it difficult to assess compatibility of test results and interchangeability of materials as well. Harmonization of the Russian and European standards for various construction materials has been carried out to eliminate these discrepancies.

The main problems to harmonize the national standards for construction materials with European and international ones are the following:
• There is no sufficient information on whether properties of these materials can be preserved in the Russian climatic conditions and changed while their use.
• Means and methods to test and measure properties of building materials which ensure corresponding results to be accurate.
• There are no harmonized concepts in the field of building materials and construction activities (Blinov V.P., 2011).

The creation of new GOSTs is not based on Eurocodes (Ulybin A.V., Vatin N.I. 2011; Vatin N.I., Ulybin A.V., Ogorodnik V.M. 2011), while regional methodical documents in a great measure based on European standards (Vatin N.I., Kurganov Yu.A., Petakov G. P., Starkov V. N. 2014; Vatin N.I., Dubov V.V., Petakov G.P. 2013). A program developed by the Ministry of Regional Development which provides updates on construction standard documents and ensures a stage-by-stage introduction of Eurocodes in the Russian Federation is operating nowadays. There are a number of standard European and Russian documents setting out specifications for concrete and concrete mixes and the methods to test them as well.

1.4. Studying and comparison of standards

EN 206-1 to be developed for concrete was being carried out from 1989 to the end of 1999 by a technical committee. The amendments are being introduced into this standard up to present days. There was a demand for considerable efforts to be made by experts. Therefore 26 editions of the text of the standard were elaborated.

The European standard EN 206-1 is applied to concrete to be used for construction of structures with in-situ concrete, for production of pre-cast constructions, and also for pre-cast building units and engineering constructions. Concrete production in the form of construction areal concrete, commercial concrete or concrete for prefabricated buildings is allowed. It should be used in accordance with the standards on initial materials and test methods. The standard EN 206-1 is referred to a number of dozens of other standards, both completed ones and the ones under development. The practice of their application in Russian practice has not yet been studied.

Classification, specifications and test methods to be applied for concrete and concrete mixes according to the standard EN 206-1 are presented in the Table 1.

Table 1. Classification, specifications and test methods for concrete mixes and concretes in accordance with the standard EN 206-1.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Specifications</th>
<th>Test methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete mixes</td>
<td></td>
<td></td>
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<tr>
<td>Classes in terms of workability (concrete consistency):</td>
<td>Indicators:</td>
<td>selection rules for samples to be tested according to the standard EN 12350-1; slump cone test (concrete mixes classes related to slump cone: S1....S5) according to the standard EN 12350-2; strength testing using the Vebe method (Vebe strength classes: from 3 with (V4) up to ≥ 31 with (V0)) according to the standard EN 12350-3; level of compaction of concrete mixes (classes related to level of compaction: from &gt;1,45 (C3) up to 1,04 (C1)), according to the standard EN 12350-4; flowability testing (classes related to flow cone: F1...F6 ), according to the standard EN 12350-5 and tests for concrete mixes density according to the standard EN 12350-5; test for volume of entrained air according to the standard EN 12350-7; water column test; pressure measurement testing.</td>
</tr>
<tr>
<td>• consistency (slump cone test);</td>
<td>workability (consistency and slump cone, strength, level of compaction, flowability); each group is subdivided into classes according to workability;</td>
<td></td>
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<tr>
<td>• strength;</td>
<td>density;</td>
<td></td>
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<tr>
<td>• level of compaction;</td>
<td>volume of entrained air;</td>
<td></td>
</tr>
<tr>
<td>• flowability (flow cone test);</td>
<td>content of cement and water/cement ratio;</td>
<td></td>
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<tr>
<td>• maximum filling aggregate size.</td>
<td>maximum size of aggregate;</td>
<td></td>
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<td></td>
<td>temperature.</td>
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<tr>
<td>Concretes</td>
<td>The standard EN requirements for concrete are the following ones: component materials; aggregates; volume and quality of mixing water; ultimate admissible content of chlorides in concrete; additions (including minerals and chemicals); compressive strength; bending tension; splitting tension; density; resistance to water permeability; fire safety; chloride</td>
<td>Monitoring and evaluating concrete strength according to the standards EN 12390-1, EN 12390-2, EN 12390-3, EN 12390-5, EN 12350-1; statistical method based on the characteristics of concrete uniformity by strength; Controlled parameters: the actual strength of the series of samples; standard deviation.</td>
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<td>Concretes are classified according to: no risk of corrosion or any attacks; corrosion induced by carbonation; corrosion induced by chlorides (except for the ones of the sea water); corrosion induced by the sea water chlorides; corrosion induced by alternate freezing and thawing attack;</td>
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<tr>
<td>Exposure classes related to environmental impacts:</td>
<td></td>
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</tbody>
</table>

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chemical attack.  

Note: each class is subdivided into indices.  

- Density classes:  
  - normal-weight concrete; heavy-weight concrete; light-weight concrete.  
- Strength classes:  
  - normal-weight concrete and heavy-weight concrete; light-weight concrete.  
  - There are requirements depending on the environmental impacts for the following indicators: water/cement ratio; strength class; cement content; air entrainment.  
  - There are additional requirements for: prescribed concrete; designed concrete; requirements for manufacturer; requirements for supply of ready-mixed concrete.  

Today the majority of the Russian enterprises in building industry are crossing over to new intergovernmental standards harmonized with the European standards. The current legislation of Russia does not provide the possibility to apply foreign standard documents directly. The Federal law "On technical regulation" allows full or fractural use of international standards as the basis for development of technical regulations or standards provided such viability is justified. The following Russian standards have been chosen to be compared:  
- GOST 7473-10 "Concrete mixes. Specifications."  
- GOST 25192-12 "Concretes. Classification and general specifications."  
- GOST 26633-2012 "Heavy-weighted and fine-grained concrete. Specifications".  

These standards have been developed with due account for the main standard provisions of the regional European standard EN 206-1:2013. Therefore there is a possibility for comparison (Nikolsky S.G, Belyaeva S.V., 2008). Classification, specifications and test methods for concrete and concrete mixes according to the Russian standards are presented in the Table 2.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Specifications</th>
<th>Test methods</th>
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</table>
| Types of concrete:  
  - heavy weight concrete mixes;  
  - fine aggregate concrete mixes;  
  - light weight concrete mixes.  
| Workability (each group is divided into marks by workability):  
  - hard;  
  - movable;  
  - spreading.  
| Conventional signs of a concrete mix includes:  
  - abbreviation of concrete mixture in accordance with the type of concrete;  
  - class of concrete by strength;  
  - mark of concrete mix by workability.  
| Concrete mix is characterized by the following quality specifications:  
  - workability;  
  - density;  
  - ability to delaminate;  
  - void ratio;  
  - temperature;  
  - storage properties over time;  
  - volume of entrained air.  
| Depending on the concrete mix workability concrete mixes are divided into marks:  
  - marks by flow cone;  
  - marks by slump;  
  - marks by density;  
  - marks by compaction.  
| Tests for concrete mixes to produce heavy, fine aggregate and light concretes are carried out in accordance with the GOST 10181-2000.  
| The definition of concrete mix workability:  
  - determination of concrete mix mobility; determination of concrete hardness (using Vebe type equipment, method of Krasniy, method of Skramataev).  
| The definition of average density of concrete mix.  
| The definition of void ratio of concrete mix.  
| Volumetric method to determine volume of entrained air; compression method to determine volume of entrained air; calculation method to determine volume of entrained air; determination of volume of intergranular voids in concrete mix.  
| Delamination ability of concrete mixes;  
| Determination of concrete mixes splitting; determination of water segregation;  
| Determination of temperature of concrete mix.  
| Determination of storage properties.  

Table 2. Classification, technical requirements and test methods for shown to concrete and concrete mixes in accordance with Russian standards.
European and Russian standard documents as follows:

- Normal-weight concrete; heavy-weight concrete;
- Atmospheric one (autoclave concrete).
- Concrete used in environment without risk of corrosion; concrete used in environment, causing corrosion induced by carbonization; concrete used in environment, causing corrosion induced by chlorides; concrete used in environment, causing corrosion induced by alternate freezing and thawing; concrete used in environment causing chemical corrosion.
- Concrete used in environment, causing corrosion induced by carbonization; concrete used in environment, causing corrosion induced by chlorides; concrete used in environment, causing corrosion induced by alternate freezing and thawing; concrete used in environment causing chemical corrosion.
- Concrete in environment, causing corrosion induced by carbonization; concrete used in environment, causing corrosion induced by chlorides; concrete used in environment, causing corrosion induced by alternate freezing and thawing; concrete used in environment causing chemical corrosion.

Specifications are set for quality of concretes in accordance with the standard requirements depending on the purpose of use and work conditions in building constructions and structures:

- For standards on concrete of a certain category (type);
- For standards and technical conditions on precast and reinforced concrete products;
- For working drawings of in-situ concrete and reinforced concrete structures.

Standardized quality performance indicators of concrete which are to be monitored while structures production shall be defined in standard or technical documents for specific types of concrete.

Standardized quality performance indicators should have a standardized method for determining. Materials for preparation of concrete mixes (binders, aggregates, fillers) and the concrete structure are defined in standard, technical and in technological documentation for certain type of concrete.

Standardized technological performance indicators of concrete mixes and production technologies on manufacturing of concrete and reinforced concrete structures must be in technical documentation (project execution plan, technological regulations or flow diagram) to produce specific structures in specific enterprises.

The values of standardized quality performance indicators of concrete should be determined by testing specially manufactured samples or testing concrete in structures in accordance with standardized methods. The values of quality performance indicators of concrete are allowed to be determined by a number of methods. It is necessary to ensure possibility to compare results by means of comparability conversion coefficients or by other methods. The fact whether quality performance indicators of concrete meet design requirements can be determined by estimating test results with due account for uniformity indicators for controlled quality performance score.

When comparing standard and technical documentation in terms of specifications and test methods for concretes and concretes, a number of differences in classification of concrete mixes have been found in European and Russian standard documents as follows:

- GOST 7473-10 gives a classification of concrete mixes and types of concrete;
- EN 206-1 introduces aggressive environment (corrosion caused by exposure to sea water).
- There are differences in terms of concrete as well:
- GOST 25192-12 introduces a separate class of extremely light concretes;
- EN 206-1 uses additional signs for classes of light concrete.
• Also there are a number of differences in specifications for concrete mixes:
  • GOST 7473-10 imposes requirements for ability to delaminate and store properties over time;
  • EN 206-1 imposes requirements for cement content, water/cement ratio and maximum size of aggregate;
  • According to EN 206-1 minimum consumption of cement is determined depending on environmental impacts
    and concrete class.
  • There are differences in terms of concrete as well:
  • EN 206-1 introduces classes according to content of chlorides in concrete;
  • EN 206-1 imposes requirements depending on environmental impacts according to the following parameters:
    maximum water/cement ratio; strength classes; cement content; air entrainment;
  • EN 206-1 sets additional requirements: prescribed concrete, designed concrete; requirements for
    manufacturers; requirements for supply of ready-mixed concrete.

Despite these differences European and Russian technical documentation in terms of specifications and
testing methods of concrete mixes and concretes are similar to a large extent.

2. Conclusion

At present days in modern life standardization calls for contributing to a turning point of the national
 economy to a new innovative way of development leveling up to rapid and sustainable growth based on state-of-
 the-art technologies. There are great expectations in respect to standardization which may lead to ensuring new
 standards in scientific sphere, equipment and technologies, work organization and management in general. It is
 being restructured to secure market-based environment in accordance with the rules and standards of
 international standardization. Our work is only a starting point to study and compare European and Russian
 technical documentation in terms of specifications and test methods for concrete mixes and concretes. Our
 prospective work will be focused on an in-depth study of the test methods for concrete and elaboration of
 manuals for concrete designing in accordance with the European standards.

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BS EN 12390-1:2012 Testing hardened concrete Shape, dimensions and other requirements for specimens and moulds.
BS EN 12390-2:2009 Testing hardened concrete Making and curing specimens for strength tests.
BS EN 12390-3:2009 Testing hardened concrete Compressive strength of test specimens.
BS EN 12390-5:2009 Testing hardened concrete Flexural strength of test specimens.
GOST 25192-2012 Concretes. Classification and general technical requirements.
GOST 26633-2012 Heavy-weight and sand concretes. Specifications.
GOST 10181-2000 Concrete mixtures. Methods of testing.
GOST 18105-2010 Concretes. Rules for the strength control.