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## Adoption and implementation of Eurocode 8 as national standard for seismic design in the Balkan countries

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### Abstract

The Joint Research Centre (JRC) of the European Commission is engaged in activities supporting the implementation, further development and promotion of European policies and standards for sustainable construction. Such activities include the Eurocodes (EN 1990 – EN 1999), the European Standards providing common rules for the design of buildings and other construction works to check their strength and stability. Among the countries that have shown strong commitment and progress in the adoption of the Eurocodes are the non-EU Balkan countries. In the period 2013–2016, the JRC, within the Enlargement and Integration (E&I) Action, has organized specialized dissemination and training events to support the adoption and implementation of the Eurocodes in the region. A roadmap for continuing the activities was elaborated in 2016 anticipating technical assistance at implementation, practical use and maintenance level. A workshop in Tirana (2018) focused on the implementation level in the National Regulatory Framework (NRF). It was shown that significant progress has been achieved by all non-EU countries in the Balkan region in the adoption of the Eurocodes since 2016. However, there was still lack of sufficient coordination between the National Authorities and the National Standardization Bodies on the implementation of the Eurocodes. Due to the high seismicity of the Balkan region, most non-EU countries in the region are close to, or are intending to, formally adopt EN 1998 (“Eurocode 8: Design of structures for earthquake resistance”). JRC plans to provide technical assistance for the Eurocode 8 implementation by the practitioners, addressing the seismic design of concrete buildings through a Eurocodes Balkan Summer School. The paper provides an overview of the JRC Eurocodes training activities held and planned for the Balkan region, along with an update on the Eurocodes implementation status.

**Key words:** Eurocodes, National Regulatory Framework, implementation, construction, Balkans, Eurocodes Balkan Summer School

# 1 Introduction

The construction sector is of strategic importance to the European Union (EU), as it delivers the buildings and infrastructures needed by the rest of the economy and society, having a direct impact on the safety of persons and the quality of citizens' life. The sector contributes to about 11.5 % of the EU's Gross Domestic Product (GDP), providing directly about 12 million jobs in 3.3 million of companies (EUROSTAT 2018, Structural Business Statistics). In this context, the Joint Research Centre (JRC) of the European Commission is engaged in a wide range of activities supporting the implementation, further development and promotion of European policies and standards for sustainable construction, including the Eurocodes.

The Eurocodes are set of European standards which provide common rules for the design of construction works to check their strength and stability (<https://eurocodes.jrc.ec.europa.eu/>). The Eurocode were published in 2007 and their implementation in the European countries started in 2010. Following their publication, third countries have shown strong interest in their adoption and now such process is gaining international momentum. The second generation of the Eurocodes is currently under development following the Commission's Mandate M/515 to the European Standardisation Committee (CEN) and they are expected to be published after 2023.

The construction sector is an important part of the economy of the non-EU Balkan countries. Referring to data by the World Bank (<https://databank.worldbank.org/home.aspx>), industry (including construction) has an added value to the national GDPs in the region in the range between 14.4 % up to 25.8 %. The activities of promotion of the construction sector outside the EU are part of the JRC efforts to support the EU policies and standards for sustainable construction. In line with the Commission Recommendation of 11th December 2003 (Commission Recommendation of 11 December 2003 on the implementation and use of Eurocodes for construction works and structural construction products), the JRC activities comprise guidance and training to the countries showing commitment to adopt and implement the Eurocodes and the European policies and tools for sustainable construction.

## 2 JRC support for adoption and implementation of the European standards for construction in the Balkan region in the period 2013-2018

The considerable interest in implementation and adoption of the Eurocodes in the Balkan region is based on the opportunity to have an advanced common standardization environment, which is adaptable to the specific requirements of each country regarding the geographical, geological or climatic conditions and also allowing selecting the level of safety. Moreover, adoption and implementation of Eurocodes will help the Candidate Countries to fully implement EU acquis at the time of accession and support Potential Candidate Countries to progressively align themselves with the EU acquis.

Among the countries that have shown strong commitment and progress in the adoption of the Eurocodes are the non-EU Balkan countries. In the period 2013–2016, the JRC, within the Enlargement and Integration (E&I) Action, has organized specialized workshops to support the adoption and implementation of the Eurocodes in those countries. The focus of past activities was to assess the progress and specific needs of non-EU Balkan countries towards the adoption of the Eurocodes. JRC training activities and workshops on the Eurocodes for the Balkan region were held in Milan (2013), Skopje (2014), Zagreb (2015), Skopje (2016) and Tirana (2018). More than 250 stakeholders from the Balkan region has participated in these workshops.

## 2.1 A first cycle of Eurocodes activities in the non-EU Balkan countries (2013–2016)

### **First Workshop** - Adoption of the Eurocodes in the Balkan region (2013)

The workshop was held on 5–6 December 2013 in Milan and at the Joint Research Centre of the European Commission (JRC) at Ispra, Italy ([http://eurocodes.jrc.ec.europa.eu/showpage.php?id=2013\\_12\\_WS\\_Balkan](http://eurocodes.jrc.ec.europa.eu/showpage.php?id=2013_12_WS_Balkan)) [1]. The workshop was focused on the progress and specific needs for adoption and implementation of the Eurocodes and related EN standards in the Balkan region. The important conclusion was that most of the non-EU countries in the Balkan region are planning to use the Eurocodes as primary standards. There was good progress on Eurocodes translations but the process of elaboration of Nationally Determined Parameters (NDPs) and National Annexes (NA) was in the initial phase. In most of the countries there was a lack of relevant institutional support for adoption and implementation of the Eurocodes, so creating a regional platform for collaboration was pointed as one of the drivers in the process.

### **Second workshop** - Building capacities for elaboration of NDPs and NAs in the Balkan region (2014)

The workshop was held on 4–5 November 2014 in Skopje. It was focused on further adoption and implementation of the Eurocodes in non-EU countries in the Balkan region ([http://eurocodes.jrc.ec.europa.eu/showpage.php?id=2014\\_11\\_WS\\_Balkan](http://eurocodes.jrc.ec.europa.eu/showpage.php?id=2014_11_WS_Balkan)). The main goal was to assess recent progress, difficulties and needs for the definition of the NDPs and NAs since the first workshop held in 2013, and to boost regional collaboration for cross-border harmonization of NDPs [2]. Most non-EU countries in the Balkan region (except Bosnia and Herzegovina and Turkey) had started with the definition of NDPs. Albania and Serbia were the most advanced with around 60 % of NDPs already defined. The RN Macedonia reported that 71 % of NAs are in the phase of public enquiry. The average percentage of acceptance of the recommended values for the NDPs was more than 80 % which agreed with average of 73 % acceptance rate for the EU Member States (*based on the uploaded 67.8 % of NDPs in the JRC Eurocodes NDPs database -data refers to 22 April 2016*).

**Third Workshop** - Elaboration of maps for climatic and seismic actions for structural design in the Balkan region (2015)

The workshop was held on 27-28 October in Zagreb, Croatia ([http://eurocodes.jrc.ec.europa.eu/showpage.php?id=2015\\_10\\_WS\\_Balkan](http://eurocodes.jrc.ec.europa.eu/showpage.php?id=2015_10_WS_Balkan)). The Workshop was aimed at further adoption and implementation of the Eurocodes in the non-EU countries in the Balkan region and to strengthen the capacities of stakeholders for the elaboration of maps for climatic and seismic actions. The main conclusion was that the elaboration of seismic hazard maps was in the advanced phase while the elaboration of maps for climatic actions is lagging mainly due to insufficient data being available [3].

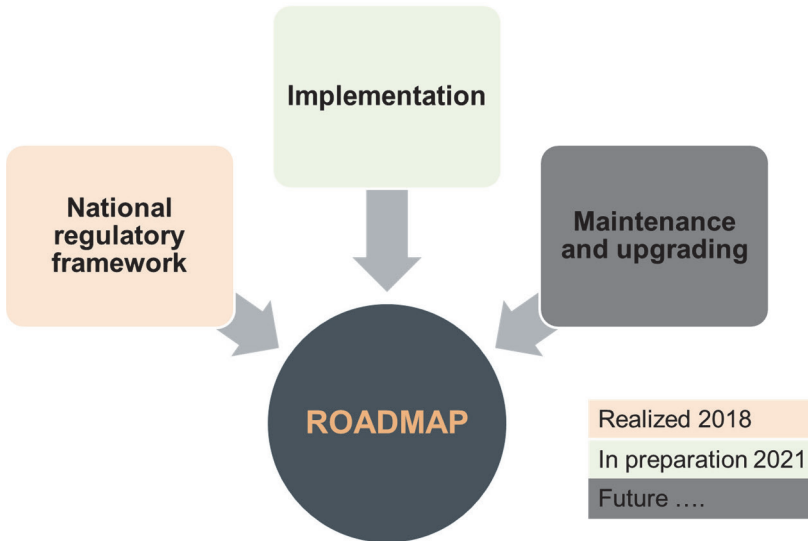
**Fourth Workshop** - Current status of the Eurocodes in the Balkan region (2016)

The Workshop was held on 9 June 2016, in Skopje, RN Macedonia as a side event of 12<sup>th</sup> Annual meeting of the CEN&CENELEC ([https://eurocodes.jrc.ec.europa.eu/showpage.php?id=2016\\_06\\_WS\\_Balkan](https://eurocodes.jrc.ec.europa.eu/showpage.php?id=2016_06_WS_Balkan)). The main objectives of the workshop were to: (1) assess recent progress, difficulties and needs (current status) for adoption and implementation of the Eurocodes in non-EU countries from the Balkan region; (2) explore opportunities to facilitate the process of adoption and implementation of the Eurocodes and (3) announce the possibilities DG JRC will offer in opening its research infrastructures to external users linked to the Enlargement and Integration Action of DG JRC. All countries reported significant progress in the process of adoption of the Eurocode since the first workshop in Milan (2013). Most National Standardisation Bodies have adopted the Eurocodes as standards, in parallel with existing national codes that are part of the National regulatory framework. Also, in most countries practitioners use National codes and Eurocodes in parallel (as long as National regulatory frameworks are respected). None of the countries have adopted and implemented the Eurocodes in the National regulatory framework.

## 2.2 A second cycle of Eurocodes activities in the non-EU Balkan countries (2018-2022)

A second cycle of Eurocodes activities in the Balkan region was designed for the period 2018-2022 in the framework of JRC's E&IA. It aims to enhance building capacities within the National Authorities and facilitate the implementation of the Eurocodes in the region in day-to-day practice. A roadmap for continuing the JRC activities of the Eurocodes promotion was elaborated and aims to offer technical assistance at three different levels (Fig. 1):

1. Implementation level - facilitate the implementation of the Eurocodes in the National regulatory framework (NRF)
2. Practical level - assist the training of practitioners, enabling their understanding and use of the Eurocodes in day-to-day design practice (Section 3 of the paper)
3. Maintenance and upgrade level - increase awareness of the National Authorities (NAs) and National Standardization Bodies (NSBs) of the need for maintaining the existing Eurocodes and keep pace with the second generation of the Eurocodes.



**Figure 1. Roadmap and level of technical assistance**

**Fifth Workshop - The way forward for the Eurocodes implementation in the Balkans, (2018)**

The workshop in Tirana was an opportunity to collect and share the experience of EU Member States in the Eurocodes implementation in the national regulatory system through the presentation of case studies ([https://eurocodes.jrc.ec.europa.eu/showpage.php?id=2018\\_10\\_WS\\_Balkan](https://eurocodes.jrc.ec.europa.eu/showpage.php?id=2018_10_WS_Balkan)) [4, 5]. Representatives from the participating Balkan countries also presented the status of the Eurocodes implementation at national level and reported on the challenges faced. The workshop also served as an opportunity for the JRC to present the concept of the Eurocodes Community of Practice in the Balkans (CoP – Eurocodes Balkans). The vision for the CoP– Eurocodes Balkans is to provide continuous support in future actions related to the Eurocodes implementation in the Balkans (e.g. mapping knowledge and identifying gaps, exchanging practical examples of structures designed with the Eurocodes, discussing developments related to the publication of the National Annexes to the Eurocodes, organizing visits and other local events, assisting with regional training activities).

**2.3 Recent developments in adoption and implementation of the Eurocodes in the non-EU Balkan countries**

The recent state of the play of the adoption and implementation of the Eurocodes in non-EU Balkan countries was presented at the International Symposium of Durres – Earthquakes and Eurocodes, 21-22 September 2020 (Fig. 2). In three of the Balkan countries, namely the RN Macedonia, Montenegro and Serbia, the Eurocodes are already incorporated in the National Regulatory Framework.

### 3 Eurocodes Balkan Summer School “Seismic design of concrete buildings” (2021)

#### 3.1 The concept

The Western Balkan region has suffered numerous and powerful earthquakes in the past decades. In 1961, a 6.1-magnitude earthquake in Skopje killed 1,100 causing major damages in the city. In 1969, Banja Luka suffered a Mw 6.4 major quake. In 1979 in Montenegro a Mw 6.9 earthquake left 136 dead, more than one thousand injured and over 100,000 people homeless. Far smaller quakes have been a regular occurrence throughout the region for decades.

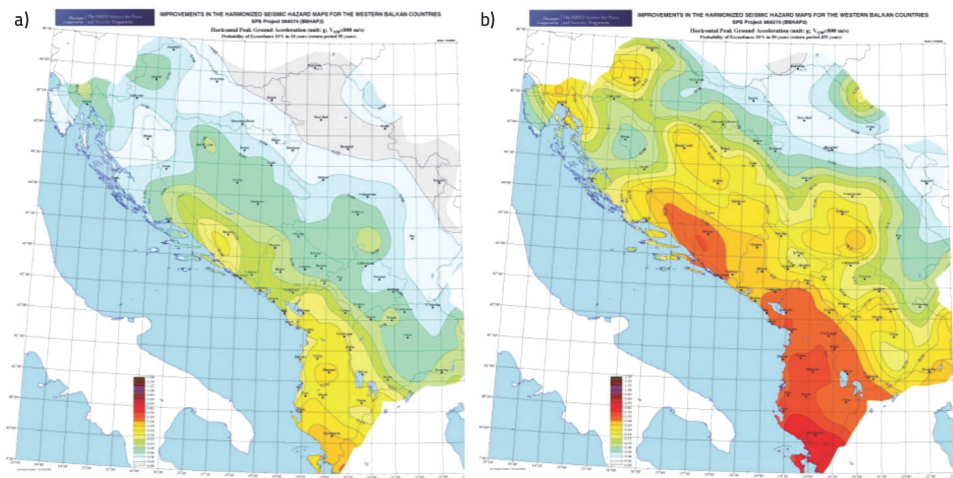
Country	Status
Albania	All 58 EN Eurocodes Parts are published by GDS as Albanian standards (SSH Standards), ( <a href="http://www.dps.gov.al/standard/index.php?national_committee_id=17&amp;item_from=20">http://www.dps.gov.al/standard/index.php?national_committee_id=17&amp;item_from=20</a> ). NAs are elaborated (ref: Hasanaj (GDS), approval is ongoing (ref: Pojani (UPT))).
Bosnia and Herzegovina	All 58 EN Eurocodes Parts are published by GDS as Bosnian standards (BAS Standards) ( <a href="http://eurokodovi.ba/?page_id=57">http://eurokodovi.ba/?page_id=57</a> ). NAs of EN 1990, 1991, 1992, 1993, 1996 and 1998 are elaborated ( <a href="http://eurokodovi.ba/?page_id=44">http://eurokodovi.ba/?page_id=44</a> ). EN 1992 & EN 1996 incorporated in the federal Rulebook on technical regulations.
Kosovo*	All 58 EN Eurocodes Parts are published by KSA as Kosovo standards (SK Standards) due to the cooperation with General Directorate of Standardization of Albania ( <a href="https://aks.rks-gov.net/standard/index.php?national_committee_id=25&amp;item_from=0">https://aks.rks-gov.net/standard/index.php?national_committee_id=25&amp;item_from=0</a> ). NAs aren't elaborated, and Eurocodes aren't incorporate in the NRF.
Montenegro	Government of Montenegro brought decision for mandatory application of the Eurocodes for the building's construction through different Rulebooks ( <a href="http://www.mrt.gov.me/rubrike/zakonska-regulativa/131438/Zakonska-regulativa-iz-oblasti-gradevinarstva.htm">http://www.mrt.gov.me/rubrike/zakonska-regulativa/131438/Zakonska-regulativa-iz-oblasti-gradevinarstva.htm</a> ). For each structural material design is regulated by corresponding group of nationally adopted EN standards and related NAs. National regulations for design of structures will be effective till August 1, 2020.
North Macedonia	Officially adopted on 02.09.2020 as national codes for design of construction works with 3-year coexistence period with the current national regulations. [Official Gazette of the Republic of North Macedonia no. 211 dated 02.09.2020]
Serbia	Officially adopted on 26.12.2019 as national codes for design of construction works with 1-year coexistence period with the current national regulations. ( <a href="https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/elli/rep/sqrs/ministarstva/pravilnik/2019/89/2/rea">https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/elli/rep/sqrs/ministarstva/pravilnik/2019/89/2/rea</a> )

\* This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

Figure 2. State of the play of the Eurocode adoption and implementation in the Balkan countries

More recently, on 26 November 2019, a Mw 6.4 earthquake hit Albania, with epicenter 34 km northwest of its capital, Tirana, near the coastal city of Durrës. 51 people were killed, hundreds were sent to hospitals and thousands were left homeless. Four months later, on 22 March 2020, a Mw 5.3 earthquake struck a wide area north of Croatia's capital, Zagreb, the largest to affect the city in 140 years. At least 17 people were injured, and widespread damage was reported, including Zagreb's iconic cathedral. The latest series of earthquakes hit the region of Sisak & Petrinje, with the largest stroke on 29 December 2020 with Mw 6.4.

Indeed, due to the high seismicity of the Balkan region, (Fig. 3) [5], most non-EU countries in the Balkan region are close to, or are intending to, formally adopt Eurocode 8 (EN 1998 Eurocode 8: Design of structures for earthquake resistance), which provides the principles for the design of structures for earthquake resistance. JRC plans to provide for technical assistance at the Eurocodes implementation level addressing the seismic design of concrete buildings through a Eurocodes Balkan Summer School. The Eurocodes Balkan Summer School aims to assist the training of practitioners (design engineers) in the use of the Eurocodes in their day-to-day design practice. The School will provide hands-on training on the Eurocodes use (i.e. lectures with worked examples and interactive sessions for the participants) in addition to plenary sessions and keynote lectures given by experts in the field. As the topic to be addressed is the seismic design of concrete buildings, the main focus will be on Eurocode 8 also covering relevant parts of Eurocode 2, Eurocode 0, Eurocode 1 and Eurocode 7.



**Figure 3. Seismic hazard maps of Western Balkans showing peak ground acceleration for VS30 site condition of 800 meters per second, [4]: a) RP=95 years, b) RP=475 years**

The event will provide an opportunity to build upon the experience, initiatives, difficulties and solutions concerning the implementation of the European standards and policies for construction in the Balkan region. The training material may serve as a reference not only for practitioners in the Balkans but also worldwide as there are many third countries interested in the adoption of the Eurocodes and in particular Eurocode 8.

### 3.2 The aim and main topics

The aim of the School is to provide the participants with an overview on seismic design procedures for typical multistorey reinforced concrete buildings. At the end of the School, the participants are expected to:



- Have an overall understanding of the seismic design concepts, procedures and current practices using the Eurocodes, enabling them to plan and direct the construction activity appropriately.
- Understand the methodology of seismic design to be able to execute a proper design using Eurocode 8 and relevant Eurocodes.
- Have a better appreciation of various construction details with respect to seismic response when applying the Eurocodes.

The main topics addressed are given in the Table 1. A survey on the existing national/ commonly used regulations for seismic design of buildings in the Balkan non-EU countries, along with an update on the Eurocodes implementation status and definition of NDPs in the countries, progress made, challenges encountered, and identification of good practices is foreseen before start of the School. The obtained results will be available to the scientific community via the JRC Eurocode web site<sup>[1]</sup>.

**Table 1. Main topics addressed**

Topics related to Eurocode 2 and Eurocodes 0, 1 and 7:	Topics related to Eurocode 8 and Eurocode 7
<ul style="list-style-type: none"> <li>▪ Introduction to design of buildings with Eurocode 2 (to also cover relationship to other Eurocodes);</li> <li>▪ Basis of design, combinations of actions with design examples;</li> <li>▪ Preliminary (conceptual) design of RC buildings;</li> <li>▪ Materials, durability, structural analysis;</li> <li>▪ Limit state design (ULS - SLS);</li> <li>▪ Geotechnical aspects (foundation design);</li> <li>▪ Detailing of structural elements</li> </ul>	<ul style="list-style-type: none"> <li>▪ Introduction to seismic design of buildings with Eurocode 8;</li> <li>▪ Seismic hazard and earthquake actions</li> <li>▪ Structural analysis</li> <li>▪ Basic seismic design principles for buildings (capacity design);</li> <li>▪ Seismic design of concrete buildings</li> <li>▪ Shallow and pile foundations</li> </ul>

## 4. Conclusions

Significant and important progress has been achieved by all non-EU countries in the Balkan region in the adoption and implementation of the Eurocodes since 2013.

The JRC support during the past seven years was important and contributed in the facilitation of the Eurocodes implementation in the National Regulatory Framework in three non-EU Balkan countries. Extensive transfer of knowledge has been done through the first training cycle addressing topics such as the policy of the Eurocodes implementation, drafting of the National Annexes to the Eurocodes, co-existence with National Codes, and the Eurocodes system as a whole concept. With the foreseen Balkan Summer School, one of the most important hazards in the region is addressed namely seismic hazard and practical training is launched consisting of comprehensively describes design examples of uilding structures design according to Eurocode 8.

There is also evidence of strengthened collaboration and information sharing among the non-EU Balkan countries and support given to the countries by neighboring EU Member States; such activities are important good practices that need to continue and

be further elaborated in the future. With this perspective, launching of the Community of Practice platform will facilitate implementation of the Eurocodes and keep pace their second generation.

## Acknowledgements

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