

NATIONAL ANNEXES TO EUROCODES 1 AND 8 IN BOSNIA AND HERZEGOVINA

Sanin Džidić ¹

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Summary: *It is the responsibility of each country that introduces Eurocodes in national standardization to bring national annexes to Eurocodes that regulate nationally determined parameters in elements specific to each country individually. Institute for Standardization of Bosnia and Herzegovina opened this process in 2013. However, the most specific aspect for each country is related to the natural actions to the structures, like snow load, wind, seismic and thermal actions. Definition of such parameters require a comprehensive approach and significant efforts by many stakeholders to uniform levels of safety in construction in Europe and particular country. Institute for Standardization of Bosnia and Herzegovina through its technical committee BAS TC 58 – Structural Design - Eurocodes EN 1990, 1, 7, 8 and 9 and supported by partners from Czech Republic and hydrometeorological institutes from Bosnia and Herzegovina produced, adopted and published national annexes to Eurocodes 1 and 8, that define natural actions to the structures. This enables structural and civil engineers unique approach to the design of load bearing engineering structures by applying the most modern codes for structural design and for highest level of safety in construction practice in Bosnia and Herzegovina.*

Keywords: *Eurocodes, National annexes, Bosnia and Herzegovina*

1. INTRODUCTION

Process of adoption and implementation of Eurocodes in standardization of Bosnia and Herzegovina begun in 2013. Before that time, Bosnia and Herzegovina adopted all Eurocodes by endorsement method in English. This process started when Institute for Standardization of Bosnia and Herzegovina established its first Technical Committee for Eurocodes - BAS TC 58 – Eurocodes. Later on in 2016, two additional technical committees were established BAS TC 61 – Structural Design - Eurocodes 2, 4 and 6 and BAS TC 62 – Structural Design - Eurocodes 3 and 5. Simultaneously the BAS TC 58 was renamed to BAS TC 58 – Structural Design - Eurocodes EN 1990, 1, 7, 8 and 9. The process of adoption of Eurocodes was significantly speeded up by implementation of the project “Support of Capacities of the Institute for Standardization of Bosnia and Herzegovina in the Area of Implementation of

¹ Assoc. Prof. Dr. Sanin Džidić, International BURCH University, Faculty of Engineering and Natural Sciences, Department of Architecture and Department of Civil Engineering and University of Bihać, Technical Faculty, Department of Civil Engineering, phone +387 61 905 480, e-mail: ninsa_d@hotmail.com

EUROCODES” supported under the Czech Republic Development Cooperation and implemented by the Czech Office for Standards, Metrology and Testing (ÚNMZ), launched on January 26, 2015. Some of the results of this project were presented in this paper, like national annexes to Eurocodes 1 and 8, maps and interactive maps. The national annexes to Eurocodes 1 and 8 presented here, were produced by BAS TC 58 – Structural Design - Eurocodes EN 1990, 1, 7, 8 and 9 supported by partners from Czech Republic. This process was also supported by active participation in BAS TC 58 and data share by Federal Hydrometeorological Institute of Federation of Bosnia and Herzegovina and Republic Hydrometeorological Institute of Republika Srpska.

2. CHARACTERISTIC SNOW LOAD ON THE GROUND

The characteristic value of snow load on the ground (s_k) was given in Bosnia and Herzegovina according to the BAS EN 1991-1-3/NA:2018 Eurocode 1: Actions on structures - Part 1-3: General actions - Snow loads - National annex. Part of this national Annex is map of the snow load on the ground for territory of Bosnia and Herzegovina.

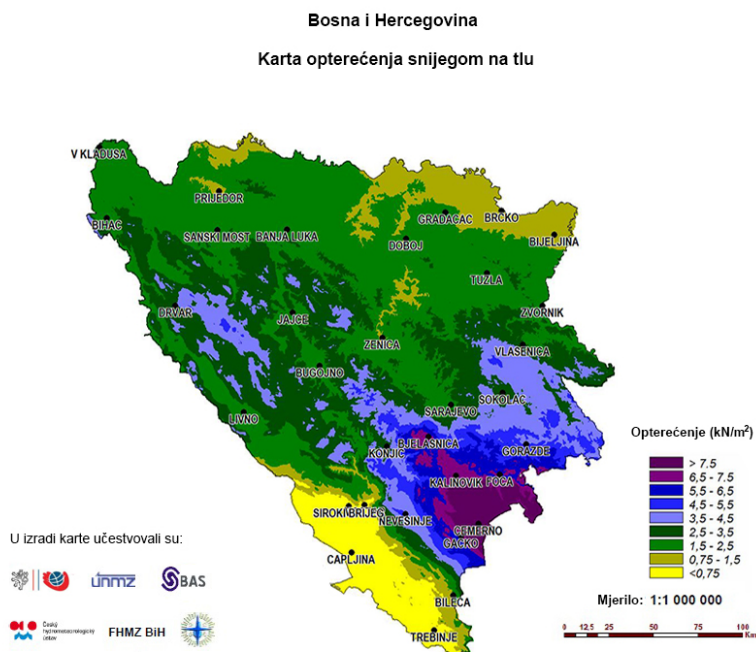


Figure 1. Map for the characteristic value of snow load on the ground in Bosnia and Herzegovina - BAS EN 1991-1-3/NA:2018 [6]

The map shows the characteristic snow load on the ground for a return period of 50 years and the zone number. The digital map shows the spatial distribution of data generated by

Universal Kriging method for snow data for period 1961-1990. The Federal Hydrometeorological Institute of the Federation of Bosnia and Herzegovina guarantees the accuracy of data provided for processing (Gumbel distribution) for return a period of 50 years. The data obtained by processing were used as the input for the digital interactive map as well.

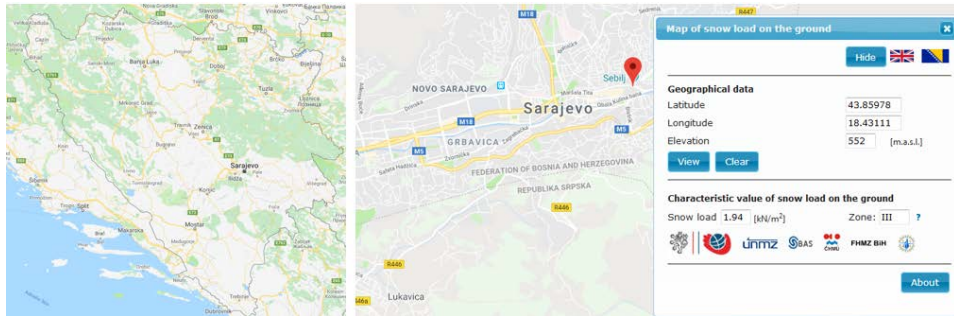


Figure 2. Interactive map for the characteristic value of snow load on the ground in Bosnia and Herzegovina - BAS EN 1991-1-3/NA:2018 [11]

A network of the basic size of $200\text{ m} \times 200\text{ m}$ was used for this map. Relevant values for each square of a network size of $200\text{ m} \times 200\text{ m}$ are defined by Universal Kriging method and displayed on a digital map.

3. BASIC WIND VELOCITY

BAS EN 1991-1-4/NA:2018 Eurocode 1: Actions on structures - Part 1-4: General actions – Wind actions - National annex defines basic wind velocity in Bosnia and Herzegovina, where zone map and interactive map are also parts of this National Annex.

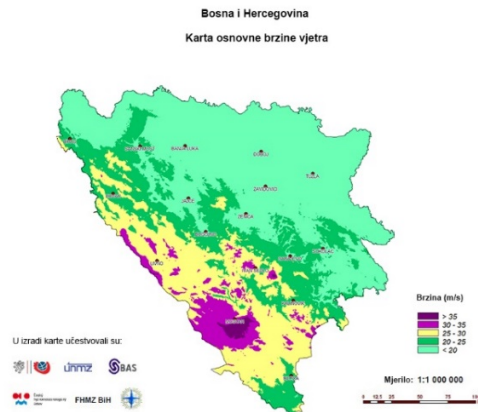


Figure 3. Map for the basic wind velocity in Bosnia and Herzegovina - BAS EN 1991-1-4/NA:2018 [7]

In addition to the basic wind velocity and zone, the interactive map also shows some geographical data (latitude, longitude and elevation above sea level).

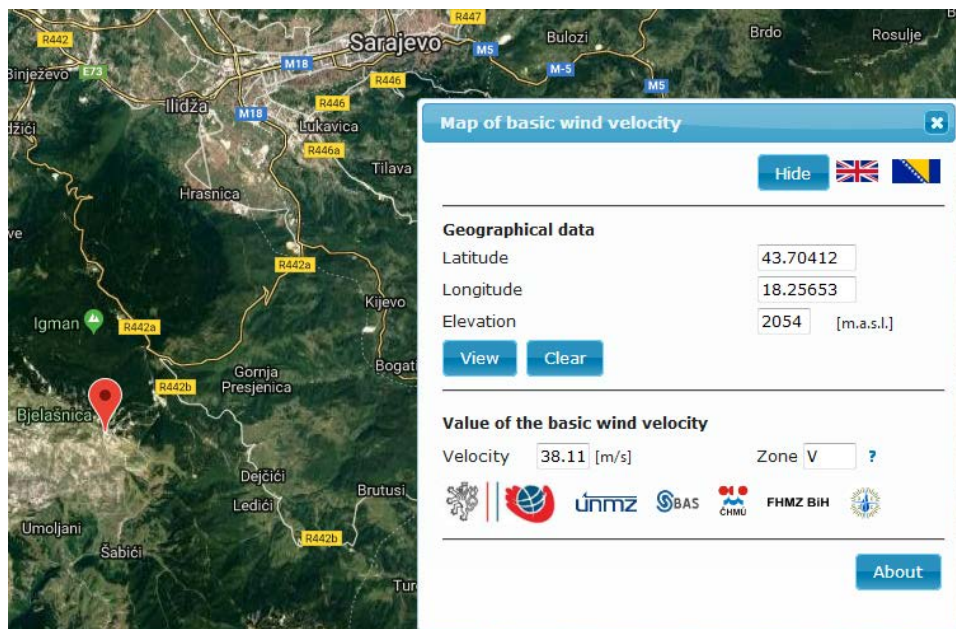


Figure 4. Interactive map for the basic wind velocity in Bosnia and Herzegovina - BAS EN 1991-1-4/NA:2018 [12]

The map was developed based upon the same principles as map for characteristic snow load on the ground, from data by Federal Hydrometeorological Institute of the Federation of Bosnia and Herzegovina (1961-1990) for return period of 50 years, and using Universal Kriging method and Gumbel distribution and network 200 m x 200 m.

It is possible to do a map transfer between the geographic and satellite maps, and the map scale can also be enlarged to the level of the particular location itself.

4. MINIMAL AND MAXIMAL AIR TEMPERATURES

As part of the preparation of the National Annex for BAS EN 1991-1-5/NA:2017 Eurocode 1 - Actions on structures - Part 1-5: General actions - Thermal actions - National annex, two isotherm maps of the minimal and maximal air temperatures in the shade were made for Bosnia and Herzegovina with a probability of exceeding the annual minimum (maximum) of 0,02 (corresponding to the 50-year return period). [1]

The maps show the spatial distribution of the data generated by MWLR method (Multi Weighted Linear Regression) based on data from 1961-1990 and Federal Hydrometeorological Institute of Federation of Bosnia and Herzegovina and the Republic Hydrometeorological Institute of the Republika Srpska guarantee the accuracy of the data given for processing (Gumbel distribution) for a return period of 50 years. The data obtained by processing were used as the input for the maps.

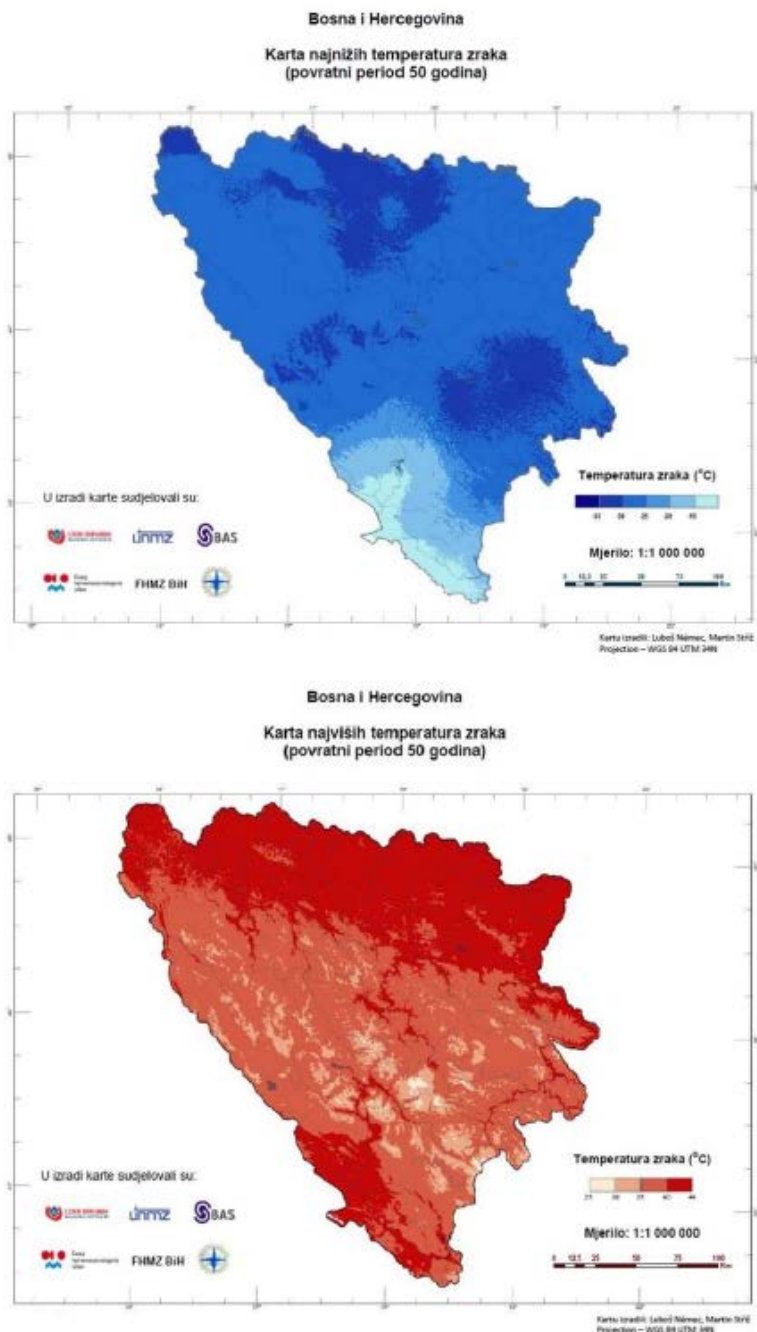


Figure 5. Maps for the minimal and maximal air temperatures in Bosnia and Herzegovina - BAS EN 1991-1-4/NA:2018 [8]

The MWLR method has the advantage that for surface interpolation it does not use solely the nearest stations, but the most appropriate stations allowing the configuration of terrain to be taken into consideration. The most appropriate stations are chosen objectively by the method of the most appropriate factors.

Based upon these data, the digital interactive map of minimal and maximal air temperatures has also been produced for each square of the network size 100 m x 100 m.

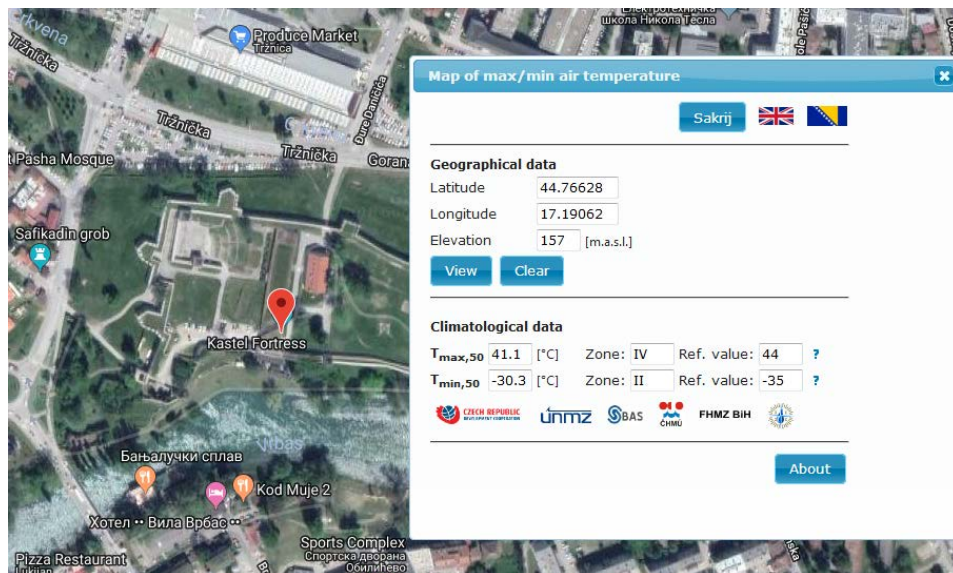


Figure 6. Interactive map for the minimal and maximal air temperatures in Bosnia and Herzegovina - BAS EN 1991-1-4/NA:2018 [13]

5. SEISMIC HAZARD

The most recent national annex to Eurocodes that was adopted as official standard in Bosnia and Herzegovina is BAS EN 1998-1/NA 2018 Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings - National annex.

The maps of seismic hazard of Bosnia and Herzegovina are based on the Probabilistic Seismic Hazard Assessment (PSHA) approach. According to Eurocode 8, seismic hazard is represented in terms of the Peak Ground Acceleration (PGA) and seismic action in the terms of the value of the reference peak ground acceleration on type A ground, which corresponds to the return period of the seismic action of 475 years. Base ground corresponds to ground type A based on Eurocode 8 and that is the ground that in the upper 30 m of the soil has average value of propagation of shear wave velocity greater than 800m/s.

Earthquake catalogue with main independent events for the territory of Bosnia and Herzegovina and surroundings up to about 100 km was used for calculation of seismic

hazard. Calculation of acceleration was done with 10 km × 10 km cell dimension and increment interval of 0,02 g.

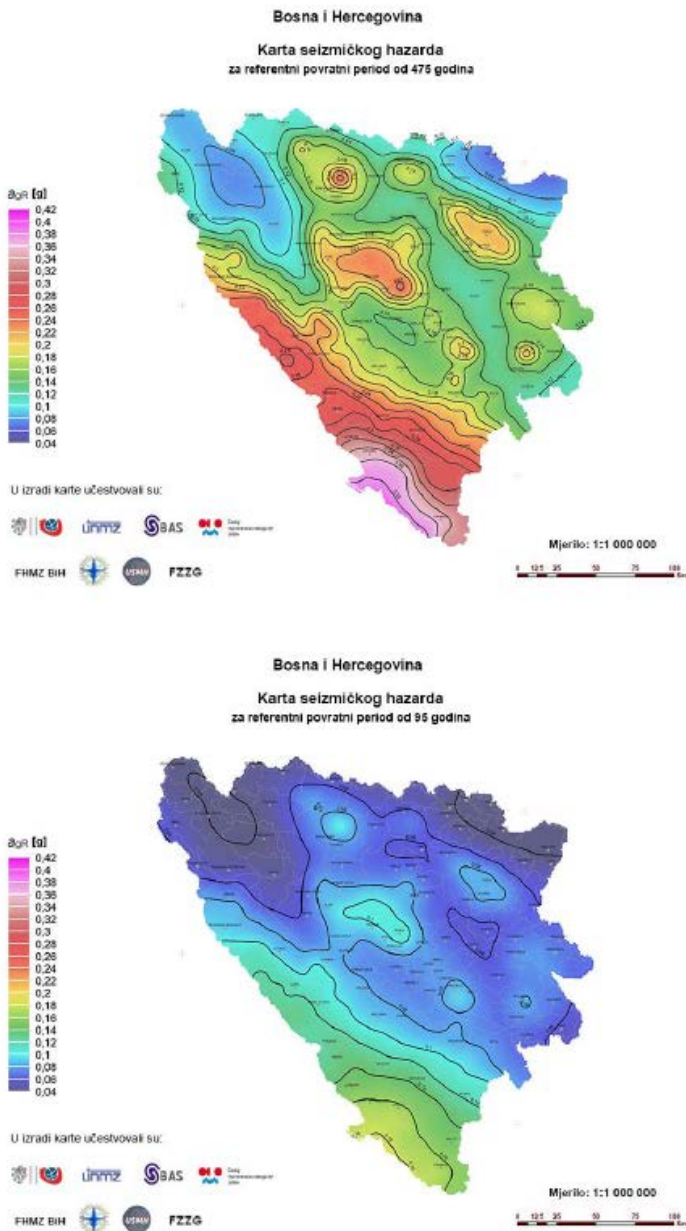


Figure 7. Maps of the seismic hazard for return period 475 and 95 years in Bosnia and Herzegovina - BAS EN 1991-1-4/NA:2018 [10]

According to Eurocode 8, the input parameters for seismic analysis were derived from the condition that Ultimate Limit State (ULS) is related to the requirement that the structure of the average service life of 50 years does not collapse, which corresponds to seismic action with a probability of exceedance of 10% in 50 years, i.e. to the return period of 475 years; while Serviceability Limit State (SLS) is related to the requirement that limited damages may arise only as consequence of an earthquake action for which there is a probability of exceedance of 10% in 10 years, i.e. earthquake that has average return period of 95 years. The interactive map of seismic hazard was also produced as part of this National Annex.

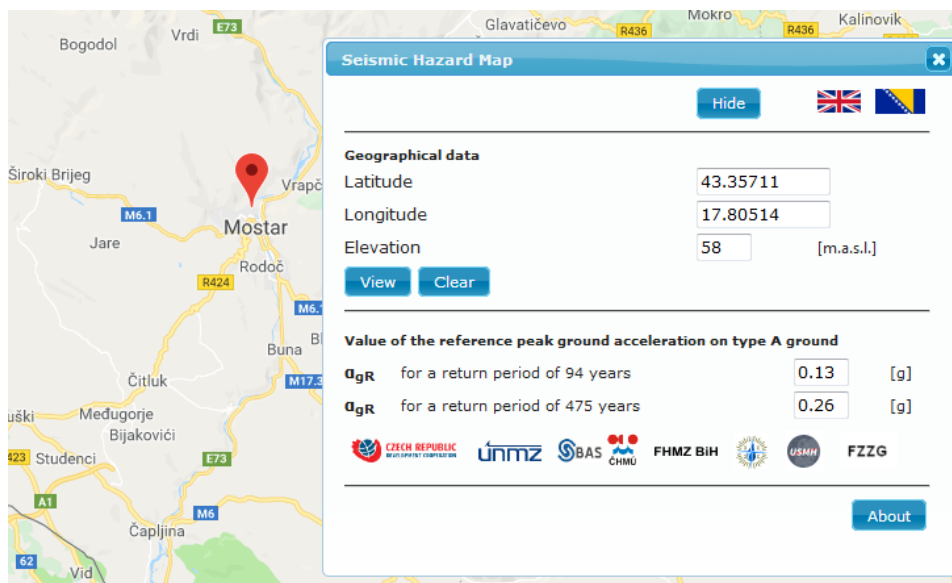


Figure 8. Interactive map of the seismic hazard for return period 475 and 95 years in Bosnia and Herzegovina - BAS EN 1991-1-4/NA:2018 [14]

6. OTHER NATIONAL ANNEXES TO EUROCODE 1

The national annexes BAS EN 1991-1-1/NA:2016 Eurocode 1 - Actions on structures: Part 1-1: General actions - Densities, self-weight and imposed loads for buildings - National annex and BAS EN 1991-1-2:2015 Eurocode 1: Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire have been also published and official standards in Bosnia and Herzegovina by the Institute of Standardization Bosnia and Herzegovina. It is expected that the remaining national annexes to Eurocode 1 and Eurocode 8 will be published in 2019.

7. CONCLUSION

Structural and civil engineers in Bosnia and Herzegovina applied JUS Standards and Yugoslav regulations for natural actions and loads on the structures in structural design. Some of these regulations were insufficient and outdated. Realizing that, engineers started to apply different values, usually higher to overcome imprecisions in these regulations, based upon lessons learned from the actual incidents or structural failures. Appearance of Eurocodes in Europe gave the new opportunity of application the most modern codes for structural design, but this process again was incomplete in Bosnia and Herzegovina (like in other non-EU European countries) lacking national annexes to Eurocodes 1 and 8, that define natural actions and loads to the structures. With introduction and adoption of national annexes to Eurocodes 1 and 8 in standardization of Bosnia and Herzegovina, presented in this paper, structural design becomes more reliable and safety oriented, but also professional to the highest engineering level, like is in Europe.

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- [11] <http://eurokodovi.ba/snijeg/>
- [12] <http://eurokodovi.ba/vjetar/>
- [13] <http://eurokodovi.ba/temperature/>
- [14] <http://eurokodovi.ba/seizmika/>

НАЦИОНАЛНИ ДОДАЦИ ЕВРОКОДОВИМА 1 И 8 У БОСНИ ХЕРЦЕГОВИНИ

Резиме: Обавеза је сваке земље која је увела Еврокодове у своју националну стандардизацију да донесе националне додатке уз Еврокодове, који регулишу национално одређене параметре у елементима специфичним за сваку земљу понаособ. Институт за стандардизацију Босне и Херцеговине је ушао у овај процес 2013. године. Међутим, најспецифичнији аспекти за сваку земљу се односе на природна дејства на носиве конструкције, као што су оптерећење снијегом, дејства вјетра, термичка и сеизмичка дејства. Дефинисање ових параметара захтјева свеобухватан приступ и значајне напоре бројних заинтересованих страна, како би се постигао уједначен ниво сигурности у грађевинарству у Европи и свакој земљи понаособ. Институт за стандардизацију Босне и Херцеговине је кроз свој технички комитет BAS TC 58 – Пројектовање грађевинских конструкција - Еврокодови EN 1990, 1, 7, 8 и 9, те уз подршку партнера из Чешке Републике и хидрометеоролошких завода у Босни и Херцеговини направио, усвојио и објавио националне додатке уз Еврокодове 1 и 8, који дефинишу природна дејства на носиве конструкције. Ово омогућава грађевинским инжењерима и инжењерима конструкторима уједначен приступ у пројектовању носивих грађевинских конструкција, уз примјену најсавременијих прописа за пројектовање носивих

грађевинских конструкција и највиши ниво сигурности у грађевинској пракси у Босни и Херцеговини.

Кључне ријечи: Еурокодрави, Национални додаци, Босна и Херцеговина