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INTRODUCTION OF EUROCODES IN BULGARIA AND IMPLEMENTATION OF EUROCODE 3

SUMMARY

The article describes and discusses the administrative, legislative, academic and educational aspects of the implementation of Eurocodes in Bulgaria and in particular the Eurocode 3. Related with that global process of standard harmonization, educational and regulation changes, some unavoidable economic, social and even psychological problems rose in the professional community of structural engineers in Bulgaria. The presented explanation tries to present the Bulgarian experience, practices and methodology for a smooth and efficient introduction of Eurocodes. The strategic influence of Eurocode 3 for steel construction sector in Bulgaria is analysed as well some executed projects, based on BDS EN 1993 are presented.

Keywords: Eurocodes, Implementation in Bulgarian design practice, Steel structures

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ВВЕДЕНИЕ В ЕВРОКОДОВИТЕ ВО БЪЛГАРИЯ И СПРОВЕДЕНИЕ НА ЕВРОКОД 3

РЕЗИМЕ

Во овој труд се опишуват и дискутираат административните, законските, академските и образовните аспекти на процесот на воведување на Еврокод во Бугарска, особено на Еврокод 3. Диктирани од овој глобален процес на усогласување на стандардите, промени во образовните програми и нормативната база, со војно во неизбежни економски, социјални и дури психолошки проблеми во здружението на градежните инженери. Во претставената студија се претставува бугарското искуство, практики и методолофи за непрекинено и ефикасо имплементирање на Еврокодовите. Анализирано е стратешкото влијание на Еврокод 3 во областа на челичните конструкции и се претставени некои последни имплементации.

Ключни зборови: Еврокод, имплементација во бугарското проектирање, челични конструкции

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1. INTRODUCTION

The political route of Bulgaria in the process of joining the EU started in 1990 and was vastly accelerated after 1998. Since the 1st of January 2007 Bulgaria has become a full member of the European Union and with alignment of Council Directive 89/106/EEC of 21 December 1988 the government and society are obliged to harmonize all regulations, standards and design codes in the field of construction and construction materials sectors. In that direction appears the need of implementation of Eurocodes in Bulgaria and their introduction after 2010.

The first administrative act that legalized Eurocodes as official standard for structural design in Bulgaria was issued in the end of 2011 stating that till 31 December 2013 both national codes and Eurocodes might be used as equivalent alternatives. It was Ordinance No РД-02-20-19 of Minister of Regional Development and Public Works\(^3\). It was announced, that after January 2014 only Eurocodes would stay in force. That administrative act founded two parallel and controversial processes. On one side it speeded up the need for training of the engineer’s community. It reflected in organizing a lot of courses for practicing engineers. Courses were organized by Chambers of Design Engineers (KIIP) and mainly they were structured on one or two day prolongation basis.

The Minister’s ordinance speeded up the preparation, edition and publication of series of books dedicated to the design by Eurocodes. On the other side, the short transition period provoke a lot of Eurocode pessimism, since a big part of engineering community felt they are not ready for such quick and significant change. It reflected into some activities against the quick implementation of Eurocodes. In that process KIIP was engaged to negotiate with the administration for prolongation of the transition period. Finally after about a year of disputes new Minister’s ordinance was issued that is still in force. It stated that all construction sites belonging to category of construction first and second must be designed and constructed in accordance with Eurocodes as well as all projects being organized according to Public Procurement Law. The last ordinance defined the procedure with reconstruction and seismic retrofit of existing bridges. It also gave a free choice of all private investment projects to choose which code they would use either Eurocodes or National Bulgarian Codes.

2. HISTORICAL BACKGROUND OF STRUCTURAL CODES OF STEEL STRUCTURES IN BULGARIA

The first rules for construction regulations in the modern Bulgarian state dates back to 1881. Later, parallel with the historical development of the country, a significant evolution of construction laws has taken place. The first steel structures in Bulgaria were steel bridges, built during the construction of the first railways. They date from 1866 – 1870 during the Ottoman Empire. In the beginning of the XX century, after the liberation of Bulgaria, the steel construction spread to the public buildings as well. The beginning was done by European engineers and European construction companies.

The first generation Bulgarian engineers studied steel structures, had been graduated in Germany, France, Belgium, Austro-Hungary and Czechoslovakia. The university education in construction was established in 1942, where the first generation Bulgarian engineers became first professors. Naturally, they brought with them their knowledge and the first Bulgarian structural engineers were taught according to the West and Central European design practice. The first design guidance were books and handbooks, translated from German, based on the admissible stress design.

The first issue of Bulgarian code of design of steel structures came in the late 50’s and then the limit state design was introduced in Bulgaria. Since then and till the democratic changes in the country, all design codes have been fully influenced by Soviet Union SNiP’s. Further update and upgrade of the steel structure codes appeared in 1959, 1973 and 1987. After the political changes in 90’s till now, no Bulgarian code for steel structures has been issued or changed till the introduction of Eurocodes. The following conclusions might be derived about the evolution of structural codes and practises in Bulgaria. The Bulgarian school starts from German one and redirects to Russian school in the last half of XX century – figure 1. Bulgarian engineers have become familiar with the limit state design since

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\(^3\) That is the formal name of the Ministry of Construction which is responsible for Eurocodes introduction in Bulgaria
the Seventies. The starting position of Introducing Eurocode 3 was controversial. On one side knowledge of limit state design make it easy, but on the other side the long pro-Russian orientation of the country make it difficult. The first acquaintance with Eurocode 3 and Eurocode 8 started in the middle of the last decade of 20 century, done by academic people. Actual public interest towards Eurocodes was stimulated after 2008, in the period 2010 - 2012.

![Figure 1. Historical evolution of the legislation in the sector of steel structures in Bulgaria](image)

3. ADMINISTRATIVE PREPARATION OF LEGISLATION

The Spatial Development Act was firstly prepared and put in force in 2004. It is the law of pro-European generation that defines the urban territories rules and constitutes the responsibilities in the construction investment process, including pre-design investigation, design and construction, supervising & control, commissioning and operating. Since its first issue, it has been constantly developed, updated or modified. The law is fully consistent with Council Directive 89/106/EEC and later with Reglament №305/2011. It defines the main objectives that have to be achieved by design and construction as Mechanical strength and stability, Safety operating, Fire resistance and durability of construction products. The Spatial Development Act establishes the global legislation basis for the construction sector, but for real driving the sector to the new European level it is required more.

The complex process of implementation of Eurocodes in Bulgaria requires vast pre-introduction reforms. The Bulgarian approach in that direction was focused on some major steps, done through administrative reforms in legal basis. The major steps are:

- Adjustments of the Bulgarian National Codes for Load and Actions and Seismic Resistant Design Code;
- Establishing of national executive body for standardization, member of CEN;
- Preparation of National Annexes and definition of NDP in them;
- Making Eurocodes available on reasonable price.

In the last decade a very active adjustment process of the Bulgarian National Codes for Load and Actions and the Seismic code was realized. The main objective of the so called adjustment was to tune the national codes as close as possible to Eurocode. The national code for loads and actions was edited and issued in 2004 and put in force in the same year. It was prepared by a working group from the Bulgarian Academic of Sciences. The main difference comparing with the old version was the
characteristic values of the snow and the wind loads. In the adjusted code the probability of the atmospheric loads was changed and was put on 25 year period of exceedance. Comparing with Eurocode it was still below, but comparing with the previous version where the probability is 5 years, it was a large step ahead. Finally that last edition of the National Loads and Actions Code [1] performs its positive role to prepare the engineers for the new characteristic values of atmospheric loads coming from Eurocode.

National Seismic Code [2] was issues and maintained twice within the transition period. The first issue was in 2004 and the second one was in 2012. According to the authors of this article, these intermediate editions were more or less artificial trials for adjustments which were not so successful. It might be said that there are some conceptual differences between the Bulgarian Seismic Code and Eurocode 8, sourced mainly in the Capacity design principles. That is why using adjustment technique some parameters can be changed only, but the code philosophy remains unchanged. It is worth mentioning that some positive improvements were done. Among them is the implementation of criteria for regularity in plan and in height and the relation between regularity and the response factor⁴.

As second positive improvement might be recognized the updated response factors, correlated with the behaviour factors in Eurocode as well as introduction of inverted pendulum type structures. Also some changes in soil type, response spectrums, importance coefficients, etc. describing the seismic action were introduced making the National Seismic Code consistent with the relevant parts of Eurocode 8.

During the historical and political development of Modern Bulgaria, the first activities in the standardization appeared in 1932. The first standardization organization was established in 1938. Related with the membership of Bulgaria in European Union and the implementation of Eurocodes in Bulgaria, The Bulgarian Institute of Standardization (BIS) www.bis.bg was founded in 2002. The law for the pro-European standardization was elaborated and voted by the National Parliament in 2005. BIS was constituted as The National Executive Body for standardization, member of CEN in 2007. BIS is a full member of CEN and CENELEC.

Within BIS, a technical committee TK 56 was established in order to develop the National Annexes to each Eurocode. TK 56 is directly related to the activities of CEN/TC 250 and is structured in 10 working subgroups, responsible for the 10 main subparts of Eurocode (EN 1990, EN 1991, EN1992, EN1993, EN1994, EN1995, EN1996, EN1997, EN1998 and EN1999). TK 56 is constituted by an expert committee, where leading academic professors and practicing engineers work together.

The real work for adaptation and translation of Eurocodes in Bulgaria started in the Nineties of previous century, before constituting of BIS. For that purpose the so named “Construction Centre” was founded and financed under the management of Construction Ministry. All leading university and science experts from all engineering directions were invited and engaged for long term project of the Eurocode adaptation and introduction. After year 2002, the Construction Centre was closed and its activities and tasks were redirected towards Bulgarian Institute of Standardization in TK 56. During the period from 2007 to 2012, the translation of almost all parts and subparts of Eurocode was completed and all National Annexes (NA) were issued. In the end of 2011, Bulgaria was fully prepared in the sense of translated standards and available National Annexes.

In the field of popularization of Eurocodes and making them available for the structural engineers on reasonable price, BIS did a great job. A specialized set of ten books covering the full range of Eurocode was edited and published by BIS (Figure 2). The books are collated by subjects and contain the information from the original standards and NAs as well. They are available in the technical literature bookstores on really reasonable price. All Eurocode standards are available in BIS and they can be purchased either online or in the building of the Institute. Since the market interest towards NA has been recognized, a process of translation from Bulgarian to English is ongoing. In the next year the Bulgarian NAs in English will be available as well.

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⁴ Response factor $R$ is a parameter similar to Eurocode behaviour factor $q$ with relation $R = 1/q$. Response factor comes from force reduction coefficient popular in the North America seismic codes.
4. EDUCATIONAL BACKGROUND AND THE ROLE OF THE UNIVERSITIES

The proper educational background of the engineers is the foundation of the proper engineering practice. In the perspective of implementation of the Eurocodes in Bulgaria, the Bulgarian universities teaching structural engineering had to change their curricula and adjust the teaching process towards the new requirements. The article describes the approach of the University of Architecture, Civil Engineering and Geodesy [http://uacg.bg/]. The policy of the rest Bulgarian Universities was similar, but it is not included in the analysis here.

In the period 2008 till 2010 the courses included some information about Eurocode methodology and design procedures, but they were performed on the comparison basis with the Bulgarian National Codes. The student’s diploma works were supposed to be developed either according to Eurocodes or National codes. The pro-Eurocode curricula were introduced in 2010/2011 academic year. All courses in the so called profiled subjects were converted towards the Eurocode and all diploma works were fully based on Eurocode. Thus the Faculty of Civil Engineering has started the education of its students fully based on the Eurocodes since 2011.

Building up the new educational infrastructure required trained university professors, lecturers and assistant professors. The fluent training of the academic staff started in about year 2000 and continues till nowadays. In that direction the European project for cross-border exchange and lifelong learning as Tempus, Erasmus, Leonardo da Vinci programme etc. helped a lot of the academic staff. The regular participation of people from the teaching staff in the seminars of JRC “Eurocode Background and Applications” in the period 2009 till 2014 is also helpful in the direction of exchange of the best teaching practices, insight to code background studies, exchange of work examples and other supplementary literature.

The period from 2006 till 2013 was the most fruitful one for writing and publishing of new textbooks, handbooks and working examples(Figure 3). During that period the first generation of technical books covering all the aspects of design and construction of steel structures, including load analysis, global analysis, member and connection design, execution and erection, philosophy of Eurocode 3 and Eurocode 8, etc. appeared on the market. We are proud to announce that these books were written by the academic staff of the Department of Steel Structures in UACEG. The books are shown in Figure 3 and also described in references [3] to [11]. It is worth announcing that the book publishing process has been supported by KIIP, which is highly acknowledged.

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5 The formal name is “Department of Steel, Timber and Plastic Structures”, but for convenience it will be named Steel Structures department within the article.
In order to encourage that educational process and to speed up the student’s interest toward the advantages of design and construction of steel structures according to Eurocode, the Department of Steel structures in UACEG established student competition named “The best diploma project”. Later the rest structural departments recognised that occasion and joined the student’s competition. It is now traditional and popular faculty event. According to the competition’s regulations, a novelty procedure of awarding was implemented. The jury consists of three or more practicing engineers who do not belong to the academic staff. That external jury endorse the winners, which works will be awarded.

5. THE ROLE OF THE PROFESSIONAL ORGANIZATIONS

The Chamber of Engineers in Investment Design (KIIP) is the leading professional non-profit organization in Bulgaria. It unites and supports the professional activities of more than 11 000 engineers, 5 000 of them being structural. Its role into the transition period of code changes was very important.

The introduction of Eurocode affects significantly the practice of design engineers, proof engineers, supervisors and technical authorities. It was recognized by KIIP, and the chamber started to be the main promoter and organizer of short term courses for different objectives in the field of Eurocodes. The courses were held in all over the country and lasted 6 to 18 academic hours structured in one or two days. The lecturers were mostly professors from UACEG, but not only. All supplementary teaching presentations with work examples were distributed among the course participants, mostly on electronic basis. The process of short-term course teaching lasts more than 3 years and the interest towards them is still quite high. Since the KIIP has been initiating and supporting the courses, their prices are quite reasonable.

In November 2013, KIIP and in particular the national sub-body of the structural engineers in cooperation with the University of Architecture, Civil Engineering and Geodesy organized an International conference with eminent European professors and well known Bulgarian academic experts under the slogan “Design according to the Eurocodes in Bulgaria”(Figure 4). The main objective of the conference was exchange of experience between the engineering communities for smooth and fluent transition towards Eurocode. Presentations were performed by invited speakers as Prof.P. Fajfar from Slovenia, Prof.D. Dubina from Romania, Prof.L. Calado from Portugal, Prof.I. Vayas from Greece and Prof.F.M. Mazzolani from Italy, as well as several leading Bulgarian specialists. Discussions about administrative, educational and training problems in the route of Eurocodes implementation were held.
The conference was carried out under great interest among professional engineers. The general conference conclusion was that among all over the European engineering communities the process of Eurocode implementation goes with inconstant success, requires a lot of efforts and provokes pro and con attitude of the applicants.

For the sake of objectivity, it shall be added that very significant part of the engineering community in Bulgaria are strongly against the Eurocodes. Different arguments have been put on the discussion table like, that Bulgarian structural engineers are not prepared for such a big change in such a short period, like that there is shortage of supporting literature, like that the engineering productivity will drop down and like that the market cannot accommodate the unavoidable increasing of the construction cost. Some speculation about the effect on the construction price, caused by designing according to the Eurocodes appeared, despite that they were not rooted on real comparison analysis or market investigation. These disputes occupied the members of KIIP and they became one of the main topics the Chamber's policy was focused on. The majority of KIIP members were on the position that the Introduction of Eurocode should be postponed. That position does not coincide with the personal opinion of the authors of this article, but it has become official position of the Chamber. Finally after long disputes on different levels, the Minister of Construction issued new ordinance that constituted the current state in Bulgaria. Details about it were given in Section 1. The current state is a kind of compromise between the real need for Eurocode introduction and the real readiness of the engineering community for the actual start.

It might be seen that there is a kind of division of the positions that different generations of engineers stay behind. The first group constitutes mostly of young and middle age engineers who see in the introduction of the Eurocodesa possibility for acceleration of convertibility of the engineering service, opportunity for export design and even a way for improvement of the public awareness and respect towards the professions of the structural design engineer. The second more experienced group, which dominates as number of followers, sees in Eurocode a danger and risk of loss of professional positions as well possibility for errors and loss of work efficiency. It can be stated that there are Eurocode optimists and Eurocode pessimists that argue between each other and create a generation gap. This process should not be underestimated because it may call into question the future of united engineering community.

6. STRATEGIC INFLUENCE OF EUROCODE 3 FOR STEEL CONSTRUCTION SECTOR IN BULGARIA

The steel construction sector in Bulgaria is deeply influenced by the introduction of Eurocodes, especially EN 1993 and EN 1090-2. The introduction affects design offices, software developers and dealers, steel structures fabricators, notified bodies and NDT laboratories.

The design offices have to spend more time in self-training and to invest money in buying standards, textbooks and handbooks. A lot of engineers invest money in attendance of specialized short-term courses organized by KIIP. The need appears of buying new software for member and connection calculations as well the need of exploring and improving the navigation of that software. It is difficult
to be said, but according to the personal estimation of the authors of the paper, the full implementation of Eurocode 3 and the related with it standards as EN1990, EN1991, EN 1997 and EN 1998 takes about 18-24 months. Nobody in Bulgaria has done estimations how much drops the designers productivity, but obviously there is such phenomena especially in the first year of implementation. Last but not least, the design experience collected in the years by engineers is no more so powerful tool in the routine design calculations, when the code is brand new. On the other side the hard work for introduction of Eurocodes in the normal engineering practice could bring new opportunities of the design offices. The major opportunity is the establishment of international convertibility of structural design services and the chance of the design offices to work for foreign markets. Some Bulgarian design offices converted significant part of their business for export. Unfortunately there is no official statistics for more exact investigation of that tendency.

The local software developers and dealers had to change their market orientation also. The first market task was to modify their member or connection design modules on the Eurocode basis. Having in mind the flexibility of the IT sector, that change happened quite quickly. Second aspect of the code changes was the entering in the market of already developed and well known European software products. Finally the available local software and the available European one made bigger market offering and increased the choice for finding the best balance between price and quality of the software. It would not be wrong to say that the introduction of Eurocode in the country improved the structural software supply in Bulgaria.

It is also very important to be analysed that the contemporary steel design fully rely on the 3D modelling or as it is more popular BIM design of steel structures. The authors see correlation between the Europeanization of the construction market, domination of EU steel products and the accelerated influence of the BIM software in Bulgaria. Introduction of BIM design improve the efficiency of engineering, fabrication and erection and moreover makes the steel construction sector well recognizable for international clients. The relation between CAD and CAM is well known. It started in Bulgaria about eight years ago and continues to step in the sector even more progressively. Base on it appeared nice and aesthetic steel structures (Figure 5).

![Figure 5. Example of aesthetic design of steel joints by BIM technology](image)

The steel fabrication sector is under big modernization. The requirements of EN 1090-2, which came with the introduction of Eurocode 3, demanded reorganization and modernization of the steel structures manufacturing process. The Companies invest money in new CNC machines or production lines, in improvement of welding process, production procedures and in training of the staff. The leading Bulgarian fabricators apply and obtain production certificates according to EN 1090-2 for execution classes 3 or 2. Following the new Eurocode requirements, the Bulgarian steel construction sector starts equalizing the quality standards with the European fabricators and starts offering similar quality on better price. Naturally, some of them became preferred partners for EU contractors. The last circumstances increased the export of Bulgarian steel structures worldwide (Figure 6). We believe that one of the main reasons for that progress is based on the Eurocode implementation in the sector.
The normative regulations for fabrication of steel structures are still in a transition stage. If it is not definitely stated in the design documentation, fabricator may follow the national regulations. As a response of that dual status, Bulgarian Association for Steel Structures aiming at uniting and protecting the interest of the steelwork fabricators was established. It starts driving policy in direction of constituting EN 1090-2 as the only guiding standard for steelwork fabrication. Some internal disputes about the need of establishing a National Metal Society are carried out. The role of a leader in that modernisation process is assigned to the Department of Steel Structures of the Faculty of Structural Engineering at UACEG, Sofia.

7. SOME CONSTRUCTION SITES DESIGNED ACCORDING TO EUROCODE 3

The Implementation of Eurocodes is not only theory but it is also practice of application. There are many of nice examples of construction sites with steel structures in Bulgaria, realised according to EN 1993 and EN 1090-2 as well EN 1998, EN 1997 (Figures 7 to 12). The main generators of implementation of Eurocodes may be classified into three main categories:

- Public projects, financed with national or EU funds;
- Industrial construction sites of highest category of importance;
- Private foreign or domestic investors, trusting more in the Eurocode.

Practically the public projects are tendered according to Public Procurement Law. According to the legislation in force in Bulgaria, such projects shall be designed according to Eurocode. That requirement emphasizes the importance of the capability of the structural engineers, design offices and supervisors to work according to Eurocode, since the most prestigious sites belong to that category.
Good examples of that group of projects are the Sofia Sport Hall ‘Arena Armeec’ (Figure 7) and the reconstruction and modernization of Sofia Central Railway Station (Figure 8).

Figure 8. Reconstruction of Central Railway Station in Sofia; General Architectural view - left, the building during the reconstruction– right.

Industrial construction sites of big plants in the Oil& Gas, Mining & Metallurgy and Processing or Energy sectors of the industry are traditional field for large use of steel structures. In the last five years they became also a field for design and construction according to Eurocode. One of the main reasons is that they usually belong to construction category I or II, and according to the legislation in force in Bulgaria, such projects shall be designed according to Eurocode. Second independent reason, but with equal importance is the fact that such projects are realized with participations of many international engineering suppliers of technology, equipment and vessels from Europe, North America, Asia or Australia. Since the Eurocode is highly international recognized code, the owners prefer to choose it for design code. It enables them to hire experts from abroad for doing independent control or review, create more trust for the investing banks and provide engineering comfort of the wide range of
suppliers. Last but not least, designing and building according to Eurocode enables the Owners to obtain better insurance conditions and provides more safety, durability and robustness for protecting the public interest. Figures 9 and 10 present some new realizations in the Metallurgy, Mining and Cement production sectors of the industry.

The third group of construction sites are those sites, which owners trust more Eurocode or achieve more economical design by Eurocode. The variety of the type of construction belonging to this group is high. It might include warehouses, specialised storages, car services, offices or even residential buildings. It also happened that some types of structures are not covered by the national codes so the designers have to use Eurocode (Figures 11, 12). Such as lattice structures with members and joints with hollow sections (Figure 11) or towers and masts, tank structures, bunkers, silos and other plated structures.

![Lattice structures made of hollow sections can be designed only according to Eurocode.](image1)

![Tanks and plate structures can be designed only according to Eurocode.](image2)

8. CONCLUSIONS

The introduction of the Eurocodes is the most significant change that was faced in front of the nowadays structural engineers and technical officials in Bulgaria. It is a complex and multidirectional process with significant technical, social and economic effects on the construction sector.

The Bulgarian experience in Eurocode introduction has its good sides, but also shows some weak ones. It would be better if the starting of the administration preparation and the debate between engineers had commenced at the same time. It appeared that the administration maturity came ahead of the readiness of the practicing engineers to adopt Eurocode that is why major part of them started to resist against its use.
It would be better if the Bulgarian State had recognized the potential difficulties for the engineering community for adaptation of Eurocode in everyday work and would find the way to support them.

The authors consider the process of introduction of Eurocodes not only in terms of their difficulty but also as a source of development that would help the Bulgarian engineering community to achieve convertibility and to increase the design works for export. Nowadays more and more engineers overcome the difficulties for study and implement Eurocodes and discover the advantages of using them.

REFERENCES


[5] Венков Л., Белев Б., Пенелов Ч. (2009), „Ръководство за проектиране на стоманени конструкции на сгради по Еврокод 3“, КИИП, София


[7] Цачев Ст. (2011), „Етажни сгради със стоманена носеща конструкция. Проектиране съгласно Еврокодове 1, 3 и 8“, КИИП, София


[9] Венков Л. (2012), „Ръководство за проектиране на стоманени подкранови греди в сгради по Еврокод 3“, КИИП, София
