

Чл.-кор. проф. д-р инж. ГЕОРГИ МИЛЕВ
Поч. проф. д-р инж. ИВО МИЛЕВ

ПРИЛОЖНА ГЕОДЕЗИЯ
Част 1
ИНЖЕНЕРНА ГЕОДЕЗИЯ

«Наука требует от человека всей его жизни. И если бы у вас было бы две жизни, то их бы не хватило вам. Большого напряжения и великой страсти требует наука от человека»

Акад. Иван Петрович Павлов (1849-1936),
лауреат на Нобелова награда
<https://psychov.net/pavlov-ivan-petrovich/>

Книга 3(3.2)
ИЗГРАЖДАНЕ НА ЛИНЕЙНИ ОБЕКТИ,
СГРАДИ, СЪОРЪЖЕНИЯ И МОНТАЖ НА
ТЕХНОЛОГИЧНО ОБОРУВАНЕ. ПЛАНОВЕ
НА ИЗГРАДЕНИТЕ КОМПЛЕКСНИ ОБЕКТИ

Съюз на геодезистите и земеустроителите в България
София, 2022 г.

Анотация

В книги 3, на част 1. Инженерна геодезия от Приложна геодезия, са разгледани същността, задачите и ролята на Инженерната геодезия при **проектирането, трасирането, изграждането и експлоатацията на конкретни типове инженерни обекти** – линейни обекти, сгради, съоръжения, и монтаж на технологично оборудване, планове, модели и информационни системи на изградените комплексни обекти и др.

Поради многостранността на третираните проблеми и големия обем на изложената материя, надхвърлящи 1500 компютърни страници, книга 3 е разделена на три книги – 3(3.1), 3(3.2) и 3(3.3).

В книга 3(3.1) са изложени проектирането, строителството, експлоатацията и реконструкция на линейни обекти и особеностите в геодезическите работи при – железопътни линии, пътища, обекти на енергоснабдяването, съобщенията, водоснабдяване и канализация, въжени линии, както и на тунели и метрополитени.

В книга 3(3.2) са включени проблемите, свързани с проектирането, строителството и монтажа на съоръжения по други линейни обекти, напр. мостове, а също геодезическите методи и технологии, за трасирането и контролните измервания и изследването на деформациите им. Представени са още тези проблеми при, хидротехнически обекти, изградени самостоятелно или в комплекси от инженерни такива – язовири, каскади и др., както и хидромелиоративни обекти, корекции на реки, наводнения и засушавания, пристанища и речен транспорт.

В книга 3(3.3) е представено проучването, проектирането, трасирането и контролирането и изследване на деформациите при строителството, монтажа и експлоатацията на сгради, промишлени съоръжения и технологично оборудване, монтаж на машини с различно предназначение, също и обекти с гражданско предназначение – летища, спортни, високи съоръжения и др. По-нататък е представено съставянето на плановете и моделирането на изградените обекти – ВМ и кадастъра на комуникациите на комплекси от инженерни обекти и съответните информационни системи, респективно – Специализирани данни (модел) на подземните комуникации, както и други инженерни аспекти на приложение.

За **различните обекти**, в изложението 3(3.1), 3(3.2) и 3(3.3), най-напред се дава кратка, **специфична информация за тяхната същност, изграждане, изисквания, нормативна база и особености**. Така, наред с другото се използва **актуалната инженерна информация** и терминология и специалистите говорят на един език помежду си, още повече, че разглежданите проблеми са **интердисциплинарни**.

Структурата на книгите е оригинална. Изложението е в съответствие с възприетия начин на изложение в книги 1 и 2 на авторите, с действащата нормативна база и с възможностите, които предлагат съвременните дигитални апарати, инструменти, системи и технологии. Тя **отразява** в голяма степен вижданията, дългогодишните изследвания, преподавателски опит, участие в изграждането и изследването на деформациите на инженерни обекти, включително и на такива с оригинални пространствени конструктивни решения, реализирани с участие на авторите.

Книги (3.1), 3(3.2), 3(3.3) са предназначени за специалистите, работещи по изграждането (проучване, проектиране, строителство, монтаж) и експлоатацията на различни инженерни обекти и комплекси от тях. Също така и за преподавателите, докторантите, студентите от направление „Архитектура, строителство и геодезия“ и др. и за практикуващите специалисти в областта на строителството и инженерната геодезия, препоръчително заедно с книги 1 и 2.

Посвещаваме на Наталия Иванова Милева: – съпруга и майка.

Цялото издание от 5 книги {1, 2, и 3(3.1), 3(3.2), 3(3.3)} на Инженерна геодезия посвещаваме и на 150 годишнината на БАН.

Авторите

Рецензенти:

1. Чл.-кор. проф. д. а. н. д-р арх. Атанас Ковачев,
доц. д-р инж. Венета Коцева
2. Доц. д-р инж. Тодор Костадинов
3. Доц. д-р инж. Лъчезар Хрисчев
4. Д-р инж. Иван Калчев Иванов.

ISBN 978-619-90732-6-1 (твърда подвързия)

ISBN 978-619-90732-8-5 (pdf)

Предговор

Книга 3 „Изграждане на линейни обекти, сгради, съоръжения и монтаж на технологично оборудване. Планове на изградените комплексни обекти“, както вече се спомена, е оформена, като три отделни книги – 3(3.1), 3(3.2), 3(3.3).

Те са част от проекта „Приложна геодезия“ на авторите, състоящ се от три части **1. Инженерна геодезия, 2. Природонаучен аспект на приложение на геодезията, 3. Други приложения на геодезията.** Трите заедно разглеждат всеотрасловото приложение на геодезията.

Част 1. **Инженерна геодезия**, която се издава под формата на книга 1 „**Основи, системи и технологии в Инженерната геодезия**“ – 498 стр., и книга 2 „**Проектиране и приложение на устройствените и на генералните планове**“ – 330 стр., които заедно с книга 3(3.1) „Изграждане на линейни обекти, сгради, съоръжения и монтаж на технологично оборудване. Планове на изградените комплексни обекти“ – 524 стр., вече в дигитален вид се разпространяват от електронната книжарница [<http://Billio.bg>] и в аналогов вид в книжарниците на УАСГ, МГУ, строителната книжарница СЕК и др. Всъщност отпечатани са в издателство „Авангард“. **Издания са на Съюза на геодезистите и земеустроителите в България (Изд. № 978-619-90732), подкрепени от БАН и ИКИТ.** Там ще бъдат разпространявани и Книга 3(3.2) – 530 стр. и Книга 3(3.3) – 466 стр., носещи същото заглавие, както книга 3.1.

Основанието за обособяването на част от проблемите на Инженерната геодезия като книги 3(3.1), 3(3.2), 3(3.3), както вече се отбеляза, от една страна е: **големият обем** на материята по Инженерна геодезия; от друга **специфичността** и тематичното обособяване на проблематиката; направеното за първи път **обособяване, систематизиране, обобщаване и представяне** на съвременните постижения в тази област във вид на **системи, методи и технологии** (основен, неотменен елемент и предпоставка - теоретична и практическа, за по-нататъшното реализиране и при отделните конкретни инженерни обекти или комплекс от тях); **необходимостта** от по-обширно излагане на проблемите по проучването, проектирането, строителството, контрола и изследването на деформациите на конкретни обекти или комплекси от тях, налагаща се поради факта, че при тях възникват и трябва да бъдат решени от геодезистите много комплексни специфични проблеми. Примери и подробни обобщения за това, за съжаление, липсват или са малко в литературата. Информацията и опита за това, обаче според авторите, е много необходимо да бъдат систематизирани, обобщени и представени на геодезистите, тъй като опитът в инженерната геодезия е от изключително значение за решаването на проблемите; **големият кръг от специалисти**, работещи конкретно и то само в тази област. Не на последно място, с отделното ѝ издаване тя ще бъде **много по-бързо достъпна и удобна** за ползване. За това благоприятства и реализирането ѝ чрез съвременните възможности за **дигитално издаване и ползване**, включително и на мобилни устройства.

Изтъкнати бяха аргументи книга 3 да бъде отпечатана като три книги – книга 3(3.1), 3(3.2), 3(3.3).

Заедно с това обаче съществува планирана, непосредствена и неизбежна връзка на тук разглежданата материя и конкретната ѝ реализация с останалите две книги на Част 1. Инженерна геодезия 1 и 2. Има се предвид приложението при изграждането – проектирането, трасирането и контролирането по време на строителството, монтажа и експлоатацията на различните типове конкретни инженерни обекти и комплекси от тях. Това означава, че петте книги са едно, обособено органично цяло – Инженерна геодезия. Поради това цялата номерация на заглавия, фигури, таблици и др. са неразделна част - елемент от 1. Инженерна геодезия. Това обуславя също и включването на тази книга по-нататък в едно обединено дигитално издание като 1. Инженерна геодезия. Всъщност тя,

както се отбеляза, по замисъл бе включена като неразделна част от нея. Нещо, което не е правено в тази област и в световната литература.

В литературата, посветена на Инженерната геодезия, практически има малко цялостни, специализирани трудове, посветени изцяло на Инженерната геодезия. Не са малко обаче тези, които са посветени на конкретни приложения на Инженерната геодезия. Те, до голяма степен, заедно със съвременната нормативна база, разбира се, са намерили отражение в предлагания труд.

В книги 3, както и във вече издадените две книги – 1 и 2, е използвана десетичната система на номерация. Поради големия брой и голямата многостепенност на заглавията, за по-голяма прегледност и тук е приложено едно оригинално опростяване, като е въведено последователно четиристепенно десетично номериране, както във вече споменатите наши книги 1 и 2. То се изразява във въвеждането на традиционното четиристепенно номериране, като там, където то се налага да бъде надвишено, се въвежда ново, допълнително едно или две четиристепенни номерирания.

При книги 3 обаче, поради обособеността на третираните проблеми, се наложи отделните раздели да се оформят самостоятелно по отношение на номерирането на литературата, фигурите, таблиците и формулите, поради сложността и многоцифреността, която се явява при непрекъснатата номерация. Такъв проблем всъщност се появява тук, както при цитиране на заглавията на текстове, макар и не много често. Така, освен при приетото правило за цитиране от книга в книга, при петте книги, тук има и нови моменти за цитиране и от един в друг раздел на книги 3. Приема се пред цитирания номер на фигура, таблица, формула, литература да се поставя и номерът на раздела. Например при необходимост от цитиране на фиг. 56 от раздел 3.6 – мостове, в някой друг раздел, цитатът в другия раздел има вида фиг. 3.6-56: съответно, табл. 3.6-5, форм. 3.6-35, литературен източник [3.6-25]. Така идентичността се осигурява.

Авторите изказват благодарност на Съюз на геодезистите и земеустройителите в България за издаването на книгата под негова егида, както и за съдействието и подкрепата, оказана им при подготовката и реализирането на книгата. Благодарим и на БАН и ИКИТ (книгите са качени на интернет страницата на Института) за подкрепата. Благодарност изказваме и на рецензентите: чл.-кор. проф. д. а. н. д-р арх. Атанас Ковачев и на сърецензента доц. д-р инж. Венета Коцева {на нея допълнително и за прегледа и подобрене на част от ръкописа на книги 3(3.2)}, на доц. д-р инж. Тодор Костадинов и на д-р инж. Иван Калчев {книги 3(3.1), 3(3.2), 3(3.3)} и доц. д-р инж. Лъчезар Хрисчев {инж. строител, книги 3(3.2), 3(3.3)} за положителните рецензии на книгите и на маг. икон. Илиян Панчев за ефективното съдействие при решаване на проблеми по компютърната подготовка на книгите и също на доц. д-р инж. Христо Николов, за съдействието в това отношение. Още благодарности са изказани в отделни раздели от книгите и на други колеги, спомогнали за реализирането им, включително и на специалисти от УАСГ. Специална благодарност изказваме на проф. д-р инж. Керанка Василева за цялостния сравнителен преглед и предложенията ѝ за подобрене на книги 3(3.2) и 3(3.3).

Особена благодарност дължим на безрезервното и активно съдействие на инж. Кристина Гълъбова за подготовката на таблици, формули и фигури за печат, за съставянето на индексите и др., както и на Светла Петрова и инж. Иванка Колева за изработването на корицата на книгата, на инж. Иванка Колева и за друга многостранна подкрепа, както и на инж. Катя Кръстева за превода на английски език на съответните части от книгите.

София, март, 2022 г.

Авторите

Annotation

Books 3 of Part 1, Engineering Surveying of Applied Geodesy, consider the nature, tasks and role of Engineering Surveying in the **design, tracing, construction and operation of specific types** of engineering objects – linear objects, buildings, facilities and installation of technological equipment, plans, models and information systems of built complex sites, etc.

Due to the versatility of the problems treated and the large volume of the matter discussed, exceeding 1500 computer pages, Book 3 is issued as three books – 3(3.1), 3(3.2) and 3(3.3).

Book 3(3.1) presents the design, construction, operation and reconstruction of linear objects and the specificities of geodetic works for railways, roads, objects of electric supply, communications, water supply and sewerage, cable-ways as well as tunnels and metro lines.

Book 3(3.2) includes the problems related to the design, construction and installation of facilities along other linear objects, e.g. bridges, as well as geodetic methods and technologies for tracing, control measurements and studies of their deformations. The same problems are also considered for hydrotechnical objects, built independently or in complexes of engineering ones – dams, cascades, etc., as well as hydro melioration objects, river corrections, floods and droughts and ports.

Book 3(3.3) presents the research, design, tracing and control and deformation studies during the construction, assembly and operation of buildings, industrial facilities and technological equipment, installation of machines for various purposes, as well as civil objects – airports, sport, high-rise objects, etc. Further on the composition of plans and modeling is shown for the built objects – BIM (Building Information Models) and the cadastre of communications of complexes of engineering objects and relevant information systems, respectively – Specialized Data (model) of underground communications, as well as other engineering aspects of application.

The exposition in 3(3.1), 3(3.2) and 3(3.3) provides first brief **specific information about the essence, construction, requirements, regulatory base and features of the various objects**. So, among other things, *up-to-date* engineering information and terminology are used and experts speak the same language, even more so that the problems addressed are *interdisciplinary* ones.

The book is with an original **structure**. The exposition is in conformity with the accepted way of presentation in Books 1 and 2 of the authors, with the current regulatory framework and the possibilities afforded by modern digital devices, instruments, systems and technologies. It **reflects** to a significant extent the views, years of research, teaching experience, involvement in the construction and study of deformations of engineering objects, including such with original spatial design solutions, implemented with the participation of the authors.

Books 3(3.1), 3(3.2) and 3(3.3) are intended for specialists working on construction (research, design, construction, installation) and operation of various engineering objects and complexes of them, as well as for lecturers, PhD students, students in the area of Architecture, Civil Engineering and Geodesy, etc., and for practitioners in the field of construction and engineering surveying, recommendably with books 1 and 2.

We dedicate to: Natalia Ivanova Mileva – wife and mother.

The entire edition of 5 books {1, 2 and 3(3.1), 3(3.2), 3(3.3)} of Engineering Surveying we also dedicate to the 150th Anniversary of the Bulgarian Academy of Sciences.

The authors

Reviewers:

1. Corr. Member Prof. D.Sc. Dr Arch. Atanas Kovachev,
Assoc. Prof. Dr Eng. Veneta Kotseva
1. Assoc. Prof. Dr Eng. Todor Kostadinov
2. Assoc. Prof. Dr Eng. Lachezar Hrishev
3. Dr Eng. Ivan Kalchev Ivanov

ISBN 978-619-90732-6-1 (твърда подвързия)

ISBN 978-619-90732-8-5 (pdf)

Preface

Book 3 “**Construction of linear objects, buildings, facilities and installation of technological equipment. Plans of the built complex objects**” is issued, as already mentioned, in three separate books – **3(3.1), 3(3.2) and 3(3.3)**.

They are part of the **Applied Geodesy** project of the authors, consisting of three parts: **1. Engineering Surveying, 2. Natural scientific aspect of Geodesy application, 3. Other applications of Geodesy**. The three together treat the versatile application of geodesy.

Part 1. **Engineering Surveying** is issued in the form of Book 1 **Basics, systems and technologies in Engineering Surveying** – 498 p., and Book 2 **Design and implementation of development and master (physical) plans** – 330 p., which together with **Book 3(3.1) Construction of linear objects, buildings, facilities and installation of technological equipment. Plans of the built complex objects** – 524 p., are already in digital form and are distributed by the electronic bookstore [<http://Biblio.bg>] and in an analog form by the bookstores of UACEG, UMG, SEK bookstore for building literature and others. They are issued by the Avangard Publishing House and are **editions** of the **Union of Surveyors and Land Managers in Bulgaria** (Ed. No 978-619-90732), supported by BAS and SRTI. Book 3 (3.2) - 530 pages and Book 3 (3.3) - 466 pages, bearing the same title as Book 3.1, will also be distributed there.

The reason for the separate publication of part of the problems of Engineering Surveying in books 3(3.1), 3(3.2), 3(3.3), as already mentioned, is on the one hand: the **large volume** of the materials on Engineering Surveying; and on the other hand the **specifics** and thematic distinguishing of the topics; the realized for the first time **differentiation, systematization, generalization and representation** of the modern achievements in this area in the form of **systems, methods and technologies** (a basic, indivisible element and a prerequisite – theoretical and practical, for the subsequent realization also of individual specific engineering objects or a complex of them); the **necessity** of broader presentation of the issues of research, design, construction, control and studies of the deformations of particular objects or complexes of them, due to the fact that many complex specific problems emerge and have to be solved by the surveyors. Unfortunately, there are a few or no examples and detailed generalizations for this in reference literature. However the authors consider that it is very useful to summarize the information and experience in this context and to present it to the surveyors, since the experience in engineering surveying is of extreme importance for solving the problems; and to the **broad circle of specialists**, working particularly only in this area. Last but not least, its separate publication will make it **much easier accessible** and **convenient** for use. This is also enhanced by its realization with the modern possibilities of **digital publication and use**, including with mobile devices.

Arguments have been pointed out for the publication of Book 3 as three books – books 3(3.1), 3(3.2), 3(3.3).

At the same time there is planned, immediate and inevitable connection between the matter treated here and its specific implementation and the other two books of Part 1. Engineering Surveying 1 and 2. The application during construction is implied – the design, tracing and control in the course of the building process, installation and operation of the different types of specific engineering objects and complexes of them. This means that the five books represent a whole, an integral organic entity – Engineering Surveying. Therefore the whole numbering of titles, figures and tables, etc., is an indivisible part – an element of 1. Engineering Surveying. This also determines the inclusion of this book further on in a unified digital edition as 1. Engineering Surveying. In fact, as already noted, it was intended to be included as an indivisible part of it. Something that has not been done so far in the world literature in this area.

In the literature devoted to Engineering Surveying there are actually a few comprehensive specialized works, dedicated entirely to Engineering Surveying. However, there are a lot of those dedicated to specific applications of Engineering Surveying. They have found to a large extent their place in the offered work, of course together with the modern regulatory base.

In Books 3, as well as in the already issued two books – 1 and 2, the **decimal numbering system** is used. Due to the large number of titles and their multiple stages, for the sake of clarity, an original simplification has been made here by introducing sequentially a four-stage numbering as in our previously mentioned Books 1 and 2. It consists in introducing the conventional four-stage numbering, applying if necessary, new additional one or two four-stage numbering in the cases, when it has to be exceeded.

In books 3 however, **the individual sections had to be formatted independently** in terms of **numbering** of reference literature, figures, tables and formulas due to the complexity and multifarious nature of continuous numbering. Such a problem actually arises here as with quoting text titles, although not quite often. So, except for the accepted rule for citing from one book to another, for the five books, new moments of citing appear here for quoting from one section to another in books 3. It is accepted to place the number of the section before the cited number of a figure, table, formula, reference literature. For example, if it is necessary to cite Fig. 56 of section 3.6 – bridges, in some other section, citing in the other section has the form Fig. 3.6-56, respectively Table 3.6-5, formula 3.6-35, reference literature source [3.6-25]). In this way the identity is ensured.

The authors acknowledge their gratitude to the **Union of Surveyors and Land Managers in Bulgaria** for issuing the book under its auspices, as well as for the assistance and support rendered for the preparation and realization of the book. We also thank **BAS and SRTI (the books are placed in the internet page of the institute) for their support**. We acknowledge our gratitude to the **reviewers** Corr. Mem. Prof. D.Sc. Dr Arch. Atanas Kovachev and the co-reviewer Assoc. Prof. Dr Eng. Veneta Kotseva {and in addition for her review and improvement of part of the manuscript of book 3(3.2)}, to Assoc. Prof. Dr Eng. Todor Kostadinov and Dr Eng. Ivan Kalchev {books 3(3.1), 3(3.2), 3(3.3)} for the positive reviews of the book and to M.Sc. Econ. Ilian Panchev for the efficient collaboration in solving problems with the computer preparation of the books. Our gratitude is also expressed in some sections to other colleagues with contribution to the realization of the topics. Special thanks to Prof. Dr Eng. Keranka Vasileva for the comprehensive comparative review and her suggestions for improving books 3(3.2) and 3(3.3).

We owe special gratitude to Eng. Kristina Galabova for the unreserved and active cooperation in preparing the tables, formulas and most of the figures for press, compiling the indices, etc., as well as to Svetla Petrova and Eng. Ivanka Koleva for elaborating the title page of the book and to Eng. Ekaterina Krusteva for translating parts of the book to English.

Sofia, March, 2022

The authors

CONTENTS of Book 3(3.2)

3.6. DESIGN, TRACING AND CONTROL IN BRIDGE CONSTRUCTION	20
3.6.1. Bridges and their construction	20
3.6.1.1. General data and characteristics of bridges and related problems	20
3.6.1.2. Types of bridges	22
3.6.1.3. Design of bridges	27
3.6.1.4. Technologies for construction and assembly of bridges	30
1. Technologies for monolithic construction of bridges	30
1.1. General	31
1.2. Cantilever concreting	31
1.3. Movable formwork	32
2. Technologies for bridge assembly	32
2.1. General statements	32
2.2. Assembly by crane on the terrain	32
2.3. Cantilever assembly by crane	33
2.4. Longitudinal launching	35
2.5. Span-by-span assembly	35
2.6. Assembly with prefabricated auxiliary systems	35
3. Modular systems	35
4. Additional applications of cantilever bridge construction	36
5. Sequence of cantilever construction	37
3.6.2. Regulatory base and main requirements for bridge construction	39
3.6.3. TYPE AND SCOPE OF GEODETIC WORKS IN BRIDGE CONSTRUCTION	41
3.6.3.1. General on geodetic works	41
3.6.3.2. Geodetic and topographic works related to preliminary studies and design of bridges and other relevant studies	42
1. Topographic and geodetic base for bridge design	42
1.1. Principle statements	42
1.2. Type of the geodetic reference networks	43
1.3. Specific geodetic part in bridge design	44
2. Other studies	46
3. Specific solutions in the feasibility studies and design of large bridges in Bulgaria	47
3.1. Solutions for Danube Bridge 2, Vidin – Calafat	47
3.1.1. General data about Danube Bridge 2 and the related geodetic works	47
3.1.1.1. Danube Bridge 2	47
3.1.1.2. General on the geodetic works related to this stage of bridge construction	49
3.1.2. Preliminary studies and provision of geodetic and cartographic information, information about the natural, infrastructural and other conditions for bridge design	52
3.1.2.1. General statements	52
3.1.2.2. Geodetic reference networks for collecting information, design and construction, assembly and operation of Danube Bridge 2 and their evaluation	54
3.1.2.3. Analysis of the initial geodetic surfaces, coordinate and height systems. Problems and solutions	54
1. Preliminary information	54
2. Connecting, integrated GNSS and angular distance networks, respectively height networks, on the Bulgarian and Romanian banks	55
2.1. DGPS measurements. Methodology	55

2.2. Connecting measurements on the Bulgarian side	56
2.3. Connecting measurements on the Romanian side	58
2.4. DGPS measurements across the river	59
2.5. Height connection across the river	60
2.5.1. Measurements and processing	60
2.5.2. Height difference between Vidin and Calafat	62
2.6. Heights in digital projects of the electronic database	63
2.7. Coordinates	64
3.1.2.4. Providing geodetic, topographic, cadastral, infrastructural, legal (expropriation) and other information – basis for bridge design	66
1. Available geodetic and topographic basis in the region for design of Danube Bridge 2	66
1.1. State and regional network for local purposes in the area of the bridge to ensure the collection of topographic and other versatile information	67
1.1.1. Updating the type and measurement of networks	67
1.1.1.1. Reference geodetic network to provide topographic survey in scale 1:1000 of an area of about 700 ha	67
2. Elaboration of an up-to-date numerical topographic map in scale 1:5000	68
3. Combining the numerical model of the topographic map with models from the land subdivision plans in force	69
4. Exploring the location of underground conduits and facilities in the construction area of the bridge and the railway equipment and their designation in a copy of the topographic map in scale 1:5000	70
4.1. Feasibility studies	70
4.2. Plan of underground conduits	70
5. Elaboration of a numerical cadastral plan in scale 1:1000 for the area of Danube Bridge 2 Vidin – Calafat	72
6. Designation of the design solutions for the location of Danube Bridge 2 and the accompanying infrastructure in the numerical model of the topographic map in scale 1:5000	74
7. Reference geodetic network to ensure the design of the adjacent Infrastructure	75
8. Plot problems and expropriation	78
9. Hydrographic measurements and investigations and depiction of underwater relief	79
9.1. General statements	79
9.1.1. Analysis of the initial information	79
9.1.2. Organization of work and equipment	80
9.1.3. Methodology and technology of work and normative regulations	80
9.2. Geodetic base	81
9.2.1. Work geodetic base	81
9.2.2. Data processing	81
9.2.3. Accuracy assessment	82
9.3. Topographic survey	82
9.4. Hydrographic survey	82
9.4.1. Technology and organization	82
9.4.2. Echo sounder measurements	83
9.4.3. Measurement processing	84
9.4.4. Accuracy assessment	84

9.5. Three-dimensional model of the underwater relief	85
9.5.1. Preparatory works	85
9.5.2. Modeling method	85
9.5.3. Development of an integrated numerical model	86
9.5.4. Results	87
9.6. Magnetometric measurements and research	88
9.6.1. General on the problem	88
9.6.2. Equipment	88
9.6.3. Methodology and technologies	88
9.6.4. Measurement and results	89
9.6.5. Conclusions, recommendations, activities and results of the survey	91
3.2. Solutions at the Bridge Overpass in Varna City	91
3.2.1. General data for the Bridge Overpass in Varna City – Asparuhov Bridge	91
3.2.2. Geodetic reference networks of the Bridge Overpass	93
3.2.2.1. Precise angular network	93
1. Stabilization	94
2. Measurement and processing	94
3.2.2.2. Precise leveling network	95
3.2.3. Determining the exact bridge length of the Bridge Overpass in Varna City	97
3.2.4. Conclusion	97
3.6.3.3. TRACING AND CONTROL OF BRIDGES	98
1. Projects for tracing and control	98
2. Preparation and tracing of a bridge axis in a straight and curved section	98
3. Detailed tracing of the bridge	100
3.1. Tracing and control of abutments, foundations and columns – plumbing	100
3.2. Tracing of bridge axis and columns with different obstacles	101
4. Tracing and control in building the bridge superstructure	101
4.1. Tracing and control in cantilever construction – concreting or assembly of the bridge superstructure	101
4.1.1. Essence of the system	101
4.1.2. Geodetic base, tracing and control in cantilever concreting	103
4.1.3. Automated system of geodetic control in cantilever construction	106
4.1.3.1. Essence and requirements for the system	106
4.1.3.2. Functional flow-chart of the Geodetic Control System	107
4.1.3.3. Equipment	107
1. Measurement module (monitoring station)	107
2. Assembly module (assembly station)	107
4.1.3.4. Model of system operation in cantilever concreting	108
4.1.3.5. System preparation	109
4.1.3.6. Model of system operation in cantilever construction	109
4.1.3.7. Conclusion	111
4.2. Tracing and control in the construction of other bridge types	111
5. Specific solutions for tracing and control during the construction and assembly of large bridges in Bulgaria	113
5.1. TRACING AND CONTROL DURING THE CONSTRUCTION OF THE BEBRESH VIADUCT	113
5.1.1. General data for the viaduct	113
5.1.2. Data for the geodetic network, tracing of the bridge axis and bridge column Axes	115
5.1.3. Tracing during bridge column construction by climbing formwork	117

5.2. TRACING AND CONTROL DURING THE CONSTRUCTION OF THE ABUTMENTS, COLUMNS AND SUPERSTRUCTURE OF DANUBE BRIDGE 2	118
5.2.1. General description of the structure, technology and requirements for the production, construction and assembly	118
5.2.1.1. Brief description of the bridge	118
5.2.1.2. Railway approach to the main bridge	120
5.2.1.3. Combined bridge in the non-navigable part	121
5.2.1.4. Combined bridge in the navigable part	122
5.2.2. Reference network for direct tracing and control during the construction and assembly works of the bridge	124
5.2.3. Production of the precast elements of the superstructure	129
5.3.3.1. Geometric control in the production of segments	129
1. General data	129
2. Geometric control in the production of segments	130
5.3.3.2. Production geometry	132
5.3.3.3. Theoretical geometry	135
5.2.4. Tracing and control during the construction of the abutments and column foundations of the bridge	135
5.2.4.1. General requirements for the tracing and control	135
5.2.4.2. Tracing of permanent piles	136
5.2.4.3. Pile head beams and abutments	137
5.2.4.4. Control of piers and pylons of the main bridge	138
5.2.4.5. Tracing of columns and abutments outside the water section	139
5.2.5. Tracing and control during the construction of the bridge superstructure	141
5.2.6. Tests of the Danube Bridge 2 structure prior to bridge commissioning	141
3.6.3.4. EXAMINATION OF BRIDGES AND STUDY OF THEIR DEFORMATIONS	146
1. General on bridge examination and deformation studies and application of geodetic methods	146
2. Specific deformation studies of large bridges in Bulgaria	149
2.1. Deformation studies of Danube Bridge 2, Vidin – Calafat	149
2.1.1. General data	149
2.1.2. Study of horizontal deformations	150
2.1.2.1. Reference network and control points	150
1. GNSS network	150
2. Angular distance network	152
2.1.2.2. Stabilization and signalization	154
2.1.2.3. Measurements	155
2.1.2.4. Processing	154
2.1.3. Study of vertical deformations	157
2.1.3.1. Reference leveling network	157
2.1.3.2. Control leveling benchmarks	158
2.1.3.3. Measurement	158
2.1.3.4. Processing	159
2.1.3.5. Result discussion	160
2.1.3.6. Conclusion	161
2.1.4. General conclusion	161

2.1.4.1. Horizontal deformations and deviation from the vertical	161
2.1.4.2. Vertical deformations	161
2.1.4.3. Proposals of the contractor of geodetic measurements and investigations after the 5 th period of measurement	162
2.1.4.4. Ascertainments and opinions	162
2.2. Studies of the deformations of Danube Bridge 1, Ruse – Giurgiu	164
2.2.1. General data for the bridge	164
2.2.2. Structural data for the bridge	165
2.2.3. Geological characteristics of the ground base in the area	166
2.2.4. Geodetic measurements and investigations of Danube Bridge 1	166
2.2.4.1. Measurements and studies for the period 1992-1999	166
2.2.4.2. Further geodetic measurements and studies	166
1. Reference network and control points to determine the horizontal Displacements	166
1.1. Angular distance network	167
1.2. GNSS network in the region of Ruse	168
1.3. Reference network of deep initial leveling benchmarks	169
2. Study of individual structures of the bridge	173
2.1. Study of the horizontal deformations of supports from 18 to 25	174
2.2. Study of the vertical deformations of supports from 19 to 25	176
2.3. Study of the deflection of load bearing beams under the road and railway part of supports 25 to 37	180
2.4. Leveling of the bearing platforms of the supports under the continuous beams from support 19 to 25	184
2.5. Examination of the underwater part of supports 19, 20, 21, 22, 23 and 24 of Danube Bridge 1	185
2.6. Monitoring and control of the cracks in the chambers of support 37	187
2.2.5. Direct assessment of the general condition of the bridge based on geodetic surveys and conclusion	188
3.6.4. REFERENCES to 3.6.	188
3.7. GEODETIC WORKS RELATED TO THE CONSTRUCTION AND OPERATION OF HYDROTECHNICAL OBJECTS	192
3.7.1. Design, tracing and control of hydrotechnical facilities and complexes	192
3.7.1.1. General information and data about the hydrotechnical facilities	193
3.7.1.2. Brief characteristics of hydrotechnical facilities	193
1. Water-power systems	193
2. Cascades	194
3. Dams	195
3.1. General	
3.2. Classification of dam walls and related facilities	196
3.3. Characteristics and illustration of different types of dam walls	197
3.4. Hydropower plants	202
3.5. Construction of dam walls	202
4. Construction and operation of hydrotechnical facilities	203
5. Basic concepts and technical characteristics of dam water areas	205
5.1. Basic concepts and designations	205
5.2. Topographic (key) curves	205
5.3. Support curve	206
5.4. Assessment of the water resources in water reservoirs	207

3.7.2. Geodetic measurements related to the exploration of natural conditions	207
3.7.2.1. General	207
3.7.2.2. Hydrological explorations	208
1. Traditional methods	208
1.1. Brief characteristics	208
1.2. Geodetic measurements	209
1.3. Hydrometric network in the Kamchia River valley	212
2. Automated radio-controlled portable hydrographic system	213
2.1. General statements and characteristics of the system	213
2.2. Basic elements of the system	214
2.3. Basic technical characteristics of the equipment	215
2.4. Preparation of the system	217
2.5. Selection and activation of a surveying route, start of measurements	217
2.6. Processing of measurements	218
3.7.2.3. Geodetic works in geological, hydrogeological and geophysical explorations	218
3.7.3. Design and tracing of water-power systems and dam walls	220
3.7.3.1. General statements	220
3.7.3.2. Geodetic works in the design of cascades and water-power systems	220
1. Geodetic base for the design	220
2. Special local networks for design, tracing and control of dam walls	222
3. Height systems	226
3.7.3.3. Tracing of dam walls	227
1. General on tracing of dam walls	227
2. Project for tracing straight dam walls	227
3. Projects for tracing arch dam walls	231
3.1. General statements	231
3.2. Mathematical definition of the wall and determination of point coordinates on the water and air side of the wall	233
3.2.1. Arch variant of the Antonivanovtsi dam	233
3.2.2. Tsankov Kamak dam	236
3.2.3. Tracing project	238
3.3. Tracing of arch dam walls	240
3.3.1. General statements	240
3.3.2. Methods and tracing of arch dam walls	241
3.3.2.1. Section forward	241
3.3.2.2. Resection (section backward)	241
3.3.2.3. Profile lines	243
3.3.2.4. Combined methods	244
3.3.2.5. Method of permanent points	244
3.3.2.6. Spatial tracing with an electronic tachymeter. Other methods	245
3.3.3. Direct tracing of the shuttering panels	246
3.7.3.4. Tracing and control during the construction and assembly of a hydro-power plant (HPP) and the other facilities of the dam wall and HPP	248
3.7.3.5. Establishing and delineating the contours of the dam lake, determining the f Loaded area and backwater volume	251
3.7.3.6. Determination of the water resources of water reservoirs	253
3.7.4. Study of deformations of dam walls and other hydrotechnical facilities	257
3.7.4.1. General statements	257
3.7.4.2. Principle statements in the study of different types of hydrotechnical facilities	
1. Earth-fill and earth-rockfill dam walls	259

2. Concrete and reinforced concrete dam walls	260
3. Hydro-electric power plants, derivation facilities (syphons, aqueducts, tunnels and other underground facilities), pressure pools, compensating water towers, etc	260
4. General and specific statements and solutions in geodetic surveys of major hydrotechnical objects	260
3.7.5. Measurement and calculation of depositions in dams	268
3.7.6. A summarized example of deformation studies of the Tsankov Kamak dam	272
3.7.6.1. Data for the dam and the wall	272
3.7.6.2. Project of the system for dam measurement and geodetic works	273
1. Project for deformation studies	273
2. Drawings (illustrations) and explanations	274
3. Preliminary investigations on the expected accuracy of the geodetic reference network for the study of displacements and deformations of the Tsankov Kamak dam	278
3.7.7. REFERENCES to 3.7	280
3.8. CONSTRUCTION AND CONTROL OF PORTS AND RIVER TRANSPORT	283
3.8.1. General statements	283
3.8.2. General data for ports and port facilities. Regulatory base and port design	284
3.8.2.1. Ports and port facilities	284
3.8.2.2. Regulatory base	288
3.8.2.3. Port design	289
1. Master (physical) plan	289
3.8.3. Geodetic activities in exploring and documenting ports	293
3.8.3.1. Overview	293
3.8.3.2. Geodetic and hydrological survey of the port region and the bottom of the water area	294
1. Methods and technologies for the survey	294
2. Water level	295
3. Essence and application of the different methods and technologies	297
3.1. Classical methods	297
3.2. Aerial laser bathymetry for precise survey and study of port water areas, riverbeds and their affiliated territories	298
3.3. Unmanned aerial photogrammetric survey of riverside areas and underwater relief of shallow-water zones	299
3.3.1. General statements	299
3.3.2. Unmanned aerial photogrammetric survey of the Black Sea coast and shallow-water zones of underwater relief	301
3.3.2.1. General on the activity	301
3.3.2.2. Stages of the Unmanned aerial photogrammetric survey and results	302
3.3.2.3. Specific applications of the Unmanned aerial survey (UAS)	304
1. Byala port	305
2. Balchik Tuzla – Ikantalaka cape	306
3. Other surveyed and studied sites along the Black Sea coast	308
4. Accuracy assessment for UAS	310
4.1. UAS accuracy for the Byala port	310
4.2. UAS accuracy for the Ikantalaka cape	310
3.4. Sonar systems	311
3.4.1. General on the systems and technology	311

3.4.2. Multi-beam sonar systems and complexes	313
3.4.3. Accuracy of hydrographic measurements	321
3.4.4. Development of a numerical model of bottom relief	324
3.4.5. Application of multi-beam sonar systems	325
3.4.5.1. General data	325
3.4.5.2. Development of a numerical model of the bottom	325
3.4.5.3. Sonar mosaic of the bottom	326
3.4.5.4. Results and interpretation	327
3.5. Unmanned aerial photogrammetric and laser survey combined with single-beam and multi-beam echo sounder	329
3.6. Using GNSS to precisely determine the location of points in the survey of underwater relief	329
3.7. Application of satellite radar interferometry in surveying and imaging underwater relief	329
3.8. Summary of the port survey problem	331
3.8.4. GEODETIC AND HYDROGRAPHIC MEASUREMENTS TO ENSURE RIVER TRANSPORT	332
3.8.4.1. General statements	332
3.8.4.2. GNSS reference geodetic network of the Bulgarian bank of the Danube River	333
3.8.4.3. Project for complex measurements and investigations of the Danube River	334
1. General data about the project	334
2. LiDAR survey of the river	336
3.8.4.4. Catamaran and hydrographic studies of the Danube River	339
3.8.5. Modern methods of tracing and control in port and related riparian Construction	341
3.8.6. Permissible differences in the control and acceptance of port facilities	346
3.8.7. Geodetic works in the operation of ports and the studies of their deformations	347
3.8.8. REFERENCES to 3.8	349
3.9. GEODETIC WORKS RELATED TO HYDROMELIORATION OBJECTS, FLOODS, DROUGHTS AND RIVER CORRECTIONS	354
3.9.1. Principle statements	354
3.9.2. HYDROMELIORATION OBJECTS	354
3.9.2.1. Type and characteristics of the objects	354
1. General data	354
2. Irrigation	355
2.1. Ways of irrigation	355
2.2. Irrigation systems	355
2.2.1. Surface irrigation systems	357
2.2.2. Irrigation by inundation (flooding)	357
2.2.3. Boundary irrigation	357
2.2.4. Irrigation by furrows	357
2.2.5. Basin irrigation	358
2.3. Sprinkler systems	358
2.4. Drip irrigation	
2.5. Micro-irrigation systems	
3. Drainage	360
3.1. Essence	360
3.2. Drainage systems	361
3.2.1. Protection of the areas from surface water. Slope canals	361

3.2.2. Drainages	363
3.9.2.2. Regulatory framework and management	363
1. Water Act 1999	364
2. Law of Irrigation Associations 2001	364
3. Management of hydromelioration	365
4. Strategy	365
3.9.2.3. GEODETIC WORKS	365
1. Type, volume, accuracy and course of geodetic works. General data	365
2. Design and tracing of the objects of irrigation and drainage systems and other related objects	366
2.1. Principles of design and tracing	366
2.2. Illustration of the geodetic method application for design and tracing of irrigation systems and fields	367
2.3. Vertical planning	369
2.3.1. Principle statements	369
2.3.2. Requirements towards the terrain for the different methods of surface irrigation. Leveling of the terrain	370
2.3.2.1. Requirements towards the terrain	370
2.3.2.2. Leveling of the terrain	370
1. Advantages of leveling	370
2. Disadvantages of leveling	371
3. Types of terrain leveling	371
3.1. Basic	371
3.2. Current	371
3.3. Design of leveling	371
3.3.1. Methods	371
3.3.1.1. General solution	371
3.3.1.2. Square grid	372
3.3.1.3. Correction of horizontals	373
3. Tracing of irrigation and drainage systems and other related objects	374
4. Tracing and performing the leveling	375
5. Solutions for specific objects	376
3.9.2.4. Summary	378
3.9.3. FLOODS	379
3.9.3.1. Generally, on floods	379
1. General statements	379
2. Definitions	379
2.1. European Directives 2000/60/EC and Directive 2007/60/EU	379
2.2. Water Act in Bulgaria	381
3. Essence, methods and technologies and measures to prevent floods	381
3.9.3.2. Regulatory base	383
3.9.3.3. Flood risk assessment and management – maps and management plans	384
1. Problems and requirements	384
2. Preliminary flood risk assessment	384
2.1. Prescriptions in the regulatory base for the preliminary flood risk assessment	384
2.1.1. EU Directive	384
2.1.2. Water Act	385
2.1.3. Maps of the areas threatened by floods and maps of the areas at risk of flooding	385
3. Composing maps of flood-threatened areas and areas at risk of flooding	385

3.1. General on the maps and their composition	385
3.2. Contents of the preliminary flood risk assessment	388
4. Development of flood risk management plans	389
5. Models and systems for identification and protection of areas at risk of flooding	389
5.1. General on the models	389
5.2. GraphoTech geo-based model	390
5.3. Flood risk assessment and management in Bulgaria	392
5.3.1. Assessment of future flood risk	392
5.3.2. Flood risk maps for the Danube region	392
5.3.2.1. Flood risk maps for the Danube River	392
5.3.2.2. Flood risk maps for regions with significant potential flood risk (RSPFR) of inland rivers in the Danube region	393
5.3.3. Maps and assessment of the other 3 basin directorates in Bulgaria	394
5.3.4. Management plans for the basin directorates	395
6. Role of GIS	396
3.9.3.4. GEODETIC MEASUREMENTS AND RESEARCH RELATED TO FLOODS	396
1. General on geodetic works and geodetic and topographic base for flood control	396
2. Methods and technologies for a geodetic set for collecting data about the land and underwater relief and composing numerical terrain models	397
2.1. General on the methods and technologies	397
2.2. Use of satellite images and technologies	398
2.3. Traditional updated geodetic methods	401
2.4. Transverse profiles and requirements	401
2.5. Aerial laser scanning	403
2.5.1. Modern possibilities and their use	403
2.5.2. Laser scanning of the underwater relief – bathymetry	404
2.5.2.1. General statements	404
2.5.2.2. Advantages	405
2.5.2.3. Expenses	405
2.6. Other methods and technologies	406
2.7. Numerical models of the surface, terrain and underwater relief – requirements	406
2.8. Report on geodetic measurements and studies	407
3. Essence and specifics in composing maps for flood hazard and flood risk	408
3.1. Thematic cartography. Electronic map	408
3.2. Types and composition of flood hazard and flood risk maps	410
3.3. Structural elements of maps	413
3.4. Thematic map design	414
3.5. Presentation of results	415
4. Examples of application of geodetic methods and technologies	416
4.1. DEVELOPMENT OF A NUMERICAL RELIEF MODEL BY AERIAL LASER SCANNING (LIDAR) OF THE AREAS WITH SIGNIFICANT POTENTIAL FLOOD RISK IN BULGARIA	416
4.1.1. General statements	416
4.1.2. Contents	416
4.1.3. Initial information	417
4.1.4. Subject of the terms of reference	417
4.1.5. General reference and aim of the project	417
4.1.6. Main purpose of the contract	418
4.1.7. Scope of activity	419
4.1.7.1. Territorial range	419

4.1.7.2. Description of activities	419
4.1.8. Requirements for the contractor	419
4.1.8.1. General requirements for the contractor	419
4.1.8.2. Requirements for the implementation contractor team	420
4.1.9. Requirements for the task performance	421
4.1.9.1. General requirements for the performance	421
4.1.9.2. Accuracy	422
4.1.10. Reference systems	422
4.1.11. Flight planning and survey	422
4.1.11.1. Equipment and technical means	422
4.1.11.2. Flight planning	422
4.1.11.3. Flight calibration and control. Systematic errors	423
4.1.11.4. Survey process	423
4.1.11.5. Requirements for data processing and final materials	423
1. Data processing	423
2. Quality assurance and control (QA/QC)	424
3. Content and format of the final materials – numerical data	425
3.1. LIDAR – cloud of relief points	425
3.2. Digital height model of relief (DTM) of the “bare” earth surface	425
3.3. Digital surface model (DSM)	425
3.4. Classified point cloud	426
3.5. IN – a model of the earth surface relief	426
3.6. River sections in the surveyed territory	426
3.7. Digital relief model	426
3.8. Scheme of separating data in blocks	426
4.1.11.6. Deadline for implementation	427
4.1.11.7. Presentation of results from the project implementation	427
4.1.11.8. Acceptance of the project implementation and payment	428
4.1.11.10. Work project	429
4.1.12. Rights of use	429
4.1.13. Premises and equipment	429
4.1.14. Additional information	430
4.2. LASER SCANNING IN SIMULATION OF HIGH WATER IN THE REGION OF PLOVDIV	430
4.2.1. Scope of the project	430
4.2.2. Aerial laser scanning. Orthophoto. Thermal survey	431
4.2.3. Geodetic measurements of transverse structures of the Maritsa River	431
4.2.4. Terrain model to determine high water	431
4.2.5. Hydrology	432
4.2.6. High water simulation	432
4.3. DEVELOPMENT OF A SYSTEM AND MEASURES AGAINST FLOODS OF PARTICULAR OBJECTS SITUATED ALONG THE VALLEYS AND TRIBUTARIES OF THE RUSENSKI LOM RIVER	433
4.3.1. General activities and measures related to floods	433
4.3.1.1. Data and information about the circumstances. Parameters of the runoff and facilities	433
4.3.1.2. Preliminary and preparatory works	434
4.3.1.3. Model investigations	434
4.3.1.4. Measures for improving safety in case of high water	434
4.3.1.5. Technical and work projects for reconstruction and new flood protection	

infrastructural objects	435
4.3.1.6. Composing maps of the hazardous regions and maps of the areas at flood risk	436
4.3. Geodetic activities	
4.4. Some geodetic technologies and activities in the East Aegean Basin Directorate for water management	436
4.4.1. Activities	436
4.4.2. General outlook of the flood hazard maps for probability of 5% and 1%	442
3.9.4. DROUGHTS	444
3.9.4.1. General statements	444
3.9.4.2. Data about the Studena dam	445
3.9.4.3. Numerical model of the Studena dam lake	446
1. Unmanned aerial survey of the dry part of the dam	446
2.1. Preliminary planning of flights for aerial photogrammetric survey	446
2.2. Flight plan	448
2.3. Reference photogrammetric points	449
1.4. Aerial photogrammetric survey	450
1.5. Processing of aerial photographs	451
1.6. Control on result processing	454
1.7. Results	455
1.8. Additional processing for terrain and situation modeling	458
2. Unmanned survey of the underwater relief of the Studena dam	458
2.1. Data about the conditions	458
2.2. Hydrographic survey	458
2.3. Numerical model of underwater relief	463
3. Combining the results of surveying the dry and underwater part of the dam	465
3.1. Transformation of coordinates into a uniform system	465
3.2. Combined model of both types of survey	466
3.9.4.4. Determination of water volumes and flooded areas	467
3.9.4.5. Additional information about the object	469
3.9.5. RIVER CORRECTIONS	470
3.9.5.1. General statements	470
1. Essence	470
2. Definitions	471
3.9.5.2. Methods and technologies for implementing river corrections	472
1. Categories of corrections	472
2. Widening of riverbeds	472
3. Dragging and removal of deposits	472
4. Riverbed stabilization	473
5. Riverbed maintenance	473
3.9.5.3. Regulatory base	474
3.9.5.4. Design of correction	475
1. Initial data and materials, requirements and principles	475
2. Design of the alignment axis in situation plan	476
3. Longitudinal profile	479
4. Transverse profiles	481
4.1. Requirements and types of transverse profiles	481
4.2. Design of the transverse profile	482
4.3. Hydraulic dimensioning	483

4.4. Types of corrections and their transverse profiles	484
5. Current modern requirements and correction solutions	485
5.1. Solution in a situation plan	485
5.2. Solution in a longitudinal profile	485
5.3. Solution in a transverse profile	486
3.9.5.5. Performance of corrections	486
3.9.5.6. Geodetic works	487
3. Geodetic part of the river investment project	487
2. Provision of information and design	489
2.1. Geodetic and topographic base	489
2.2. Design and coordination of the axis and objects of the correction alignment	491
2.3. Composing the longitudinal and transverse terrain profile of the river	492
3. Projects and correction tracing	492
4. Examples of application of geodetic measurements and technologies	493
4.1. Riverbed stabilization and socialization of the Maritsa River within the Plovdiv City	493
4.2. Road junction of the Struma Motorway – Drenovska River corrections	494
4.3. Correction of the Suhodolska River in the range of the Suhodol quarter, Ovcha Kupel region, Sub-project: First stage from Bregalnitsa St. to Trayan Tanev St., Sofia	496
4.4. Geodetic and hydrographic measurements to ensure river transport – the Danube River	496
3.9.5.7. Conclusion	496
3.9.6. REFERENCES to 3.9	496
INDEX	502
English presentation of the book	511
Annotation	513
Preface	515
CONTENTS	517
Autobiographies of the authors	530
Автобиографии на авторите.	–



Cor. Mem. Prof. Dr. Eng. Georgi Milev. Graduate of the University of Architecture, Civil Engineering and Geodesy (UACEG), Sofia (1956). In 1960 – Research Associate in the Bulgarian Academy of Sciences (BAS). In 1976 – Associate Professor, 1985 – Professor, 2008 – Cor. Mem. of BAS. Since 1988 – Cor. Mem. of the Bavarian Academy of Sciences, Germany. In 1973 – defended a PhD thesis in the Stuttgart University. Since 2001 – lectures to the students on Geodesy and Engineering Geodesy in UACEG, German lingual education.

The scope of his diverse and efficient activities is significant – scientific, applied research, scientific-organizational, educational, international, promotional, publishing, inventive, expert, scientific managerial and implementation. Basically, these activities were carried out in BAS, the Federation of Scientific Technical Unions in Bulgaria (FSTUB), the Union of Scientists in Bulgaria, UACEG and other institutions in Bulgaria and in international organizations and projects, mostly on an interdisciplinary ground.

The scientific activity of Prof. Milev covers both aspects of geodesy – natural and engineering. The number of his publications exceeds 580, of them 16 separate monographs, 9 studies, 5 books – each one of which is a system of monographs, 26 editing and publishing of scientific proceedings, 120 scientific papers, 243 scientific reports, etc. He was awarded by Stuttgart University for high scientific achievements of his thesis (1973).

Prof. Milev is honorary member of the International Federation of Surveyors (FIG), FSTUB and others. He had been a chairman of the Union of Surveyors and Land Managers in Bulgaria since 1990 for 24 years and later – its honorary chairman. He is Editor in chief of the Geodesy, Cartography and Land Management magazine since 1997. Member of BAS. Space research and Technologies Institute.



Honorary Prof. Dr. Eng. Ivo Milev graduated geodesy and mine surveying at the University of Mining and Geology, Sofia in 1991. He defended his PhD thesis in 2000 at the Technical University, Berlin – direction Construction and Geodesy.

He works in both aspects of geodesy – engineering and natural, but mainly in the area of Applied Geodesy – Engineering Surveying. This includes primarily the development of theory, software and application of adjustment – processing the results of geodetic measurements; GNSS – theory, software and application, alone and combined with data from other measurements; theory and software and application in the study of deformations of engineering objects – buildings and facilities, and the terrains for their situation; modern techniques of measurement – electronic tachometry, laser scanning and others, development, software and application. Special attention is paid to transport objects, particularly to railroad parameters. He has registered two patents associated with his name in implementing the system of the Leica Concern Geosystems.

He was: expert of UN – OOSA on reference systems; member of the Steering Committee of EUPOS (European Positioning Determination System); chairman of Working Group Private Services RTCM SC 104 (Radio Technical Commission for Maritime Services); guest professor at Beuth University of Applied Sciences in Berlin, East Kazakhstan Technical University, State Technical University of Kazakhstan and Siberian State Geodetic Academy.

Prof. Ivo Milev is a member of Working Group 4 Engineering Surveying of the Union of German Surveyors; Chairman of Commission 6 Engineering Geodesy of the International Federation of Surveyors for the period 2013-2017. He is an Executive Director of TechNet-rail GmbH. He is Honorary Prof. of the Siberian State Geodetic Academy, Russia and of the Technical University of Dresden, Germany.



Чл.-кор. проф. д-р инж. Георги Милев. Завършва Геодезия в Университета по архитектура, строителство и геодезия (УАСГ) през 1956 г, София. От 1960 г. е научен сътрудник в БАН. 1976 е доцент, 1985 – професор и 2008 – чл.-кор. на БАН, а 1988 е чл.-кор. на Баварската академия на науките, Германия. Защищава докторска дисертация в Щутгартския университет, през 1973 г. От 2001 г. до 2016 г. изнася лекции по Геодезия и Инженерна геодезия на студентите от УАСГ – немско езично обучение. Има значителна, разностранна и резултатна научна, научно-организационна, научно-приложна, педагогическа, международна, издателска, изобретателска, експертна, популяризаторска, научно-ръководна и внедрителска дейност.

Основно тя е извършвана в БАН, Федерация на научно-техническите съюзи (ФНТС), Съюз на учените в България, УАСГ и др. институции у нас и в международни организации и проекти, предимно на интердисциплинарна основа.

Научната му дейност покрива трите аспекта на Геодезията – природонаучен, инженерен, други. Има над 580 публикации, от които: монографии 16; система от монографии – 5 книги, студии – 9; учебници 5; редактиране и издаване на научни сборници – 27; научни статии – 120; научни доклади – 243 и др. Носител е на наградата на университет Щутгарт – за високи научни постижения в неговата дисертация (1973 г.). Награди на СУБ за монографии – 3.

Почетен член е на Международната федерация на геодезистите, на ФНТС и др. Председател е на Съюза на геодезистите и земеустроителите в България от 1990 г. в продължение на 24 г., след което е негов почетен председател. Главен редактор е на сп. “Геодезия, картография, земеустройство” от 1997 г. Член е на БАН, и е в Институт за космически изследвания и технологии.



Почетен проф. д-р инж. Иво Милев завършва Геодезия и Маркшайдерство в Минно геоложки университет, София, през 1991 г. Защищава дисертация през 2000 г. в Техническия университет Берлин – направление Строителство и геодезия.

Работи в двата основни аспекта на геодезията – инженерен и природонаучен, но предимно в Приложната геодезия – Инженерна геодезия. Основно това е развитие на теория, софтуер и приложение на изравнението – Обработка на резултатите от геодезическите измервания; GNSS – теория, софтуер и приложение, самостоятелно и комбинирано с данни от други измервания; теория и, софтуер и приложение при изследване на деформации на инженерни обекти – сгради, съоръжения и терените, в които те се разполагат; съвременна техника на измерване – електронна тахиметрия, лазерно сканиране, GNSS и др. – развитие, софтуер и приложение. Особено внимание е отделил на транспортните обекти и по-точно на параметрите на релсовия път. Има регистрирани два патента, свързан с неговото име при реализиране на системата от концерна Лайка Геосистемс.

Бил е: експерт на ООН – OOSA по референтните системи; член на ръководния комитет на EUPOS (EUropean Positioning Determination System); председател на работна група Private Services RTCM SC 104 (Radio Technical Commission for Maritime Services); гост проф. в Бойт Университета за приложни науки в Берлин; Източен Казахстански технически университет; Държавен технически университет на Казахстан, както и Сибирската държавна геодезическа Академия.

Член е на Работна група 4 „Инженерна геодезия“ на Съюз на германските геодезисти; Председател е на комисия 6 Инженерна геодезия на Международната федерация на геодезистите (International Federation of Surveyors) през периода 2013-2017 г. Изпълнителен директор е на technet-rail GmbH. Почетен професор е на Сибирската държавна геодезическа академия, Русия, и на Техническия университет в Дрезден, Германия.