

STRUCTURAL ENGINEERING

INFORMATION BOOKLET 2019-2020

UBASE

The official course and examination regulations are always decisive: Teaching and Examination Regulations (TER), the annex to the TER named Implementation Regulations, and Rules and guidelines Board of Examiners MSc CE and AES (BoE MSc). These can be found on the TU Delft website at Regulations: TER, Rules and Guidelines.

PREFACE

This booklet is published by the United Building and Structural Engineering Student Association of the faculty of Civil Engineering of the Delft University of Technology. The booklet is meant as a guiding document for (future) Master students Structural Engineering at this faculty.

With this guiding document an overview is given of the possibilities within the Master Track. At the same time it helps the student to choose courses and make a planning for the Master's phase. In addition to this information booklet it is advised to visit the website of Structural Engineering, <https://www.tudelft.nl/onderwijs/opleidingen/masters/ce/msc-civil-engineering/msc-programme/track-structural-engineering/> (or google "TU Delft MSc Track Structural Engineering") Here you can find more information about the courses, specializations and so on.

Furthermore have a look at <https://studiegids.tudelft.nl>. Here you can find more detailed information about the courses. Course evaluations from previous years are available in the Brightspace Course "Evaluations TUD". We recommend you to enroll and check on your preferred courses to plan your study load accordingly.



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1. INTRODUCTION

Structures such as bridges, high-rise buildings, tunnels and storm surge barriers clearly may not collapse or fall over. They may not deflect or vibrate in excess. Moreover, often they need to last for more than 100 years without much maintenance. In the MSc Structural Engineering track you will learn to calculate and design whether a structure is safe; whether it will buckle; whether its strength will be sufficient, between many other aspects relevant to the design of our built infrastructure.

Essential to this are physical models of structures, of materials and of loading. You will learn to formulate these models, to test them and to apply them. Simple models are used for hand calculations to quickly make decisions in meetings with owners, architects, contractors and local governments. Complicated models are used for computer simulations to accurately determine whether a structure will comply with the design specifications. Examples are the stresses that will occur in a concrete dam of an artificial lake or the damage that will occur in a high-rise building due to a strong earthquake.

This booklet is a guide for students interested or participating in the Structural Engineering master track.

Chapter 1 gives a short introduction into the background of Structural engineering and an overview of future possibilities. Chapter 2 is a practical chapter with relevant information about the curriculum of the Structural Engineering Track. The specializations within Structural engineering are discussed in Chapter 3, including curricular demands. Possibilities to compliment your MSc Program with specialized elective courses, annotations and the honours programme are included in Chapter 4. The practicalities surrounding the Master thesis, which concludes the Master's education, are found in Chapter 5. Chapter 6 give an insight on the transition arrangements due to changes of the program's schedule currently going on. Finally, Chapter 7 presents the student organization related to the Structural Engineering track at this faculty is introduced: U-BASE.



4th
in QS subject ranking
Civil Engineering



35%
International students



200
Students in total



98%
Job within 6 months



20%
Work abroad



70%
Graduation assignment
with external party

The Structural Engineering track provides students with in-depth knowledge of the fundamental behavior of civil engineering materials and structures. Used daily, the safe, sound and durable design, construction and maintenance of these structures is imperative for human well-being and society. Students learn to formulate and test physical models of loads, materials and structures. They test complex structure models for endurance under stresses that might occur. Additionally, students learn to test and apply hand calculations for quick decision-making and to use computer simulations to determine whether a structure will comply with design specifications. Research is fundamental to the educational program. Well-equipped laboratories enable testing from nanoscale materials to full-scale structures and their components.

Degree	Master of Science
Starts	September
Type	Full-time
Credits	120ECTS, 24 months
Language	English
Application Deadline	1st of April
Tuition Fee	€18.750 (non EU) €2.083 (EU)
Scholarships	scholarhips.tudelft.nl
International Student Ratio	35%



2. THE STRUCTURAL ENG. TRACK

GENERAL PROGRAMME CIVIL ENGINEERING MASTER

First Year	Second Year
Track Specific Courses (Total of 56 ECTS)	Special Subjects (choose one) <ul style="list-style-type: none">• Additional graduation Work, research project (10 ECTS)• Elective (10 ECTS)• Internship (10 ECTS)• Multidisciplinary Project, Civil Eng. Consultancy Project (10 ECTS)
Compulsory Ethics Course (Choose One) <ul style="list-style-type: none">• Climate Change: Science and Ethics (4 ECTS)• Philosophy, Technology Assessment and Ethics for Civil Engineers (4 ECTS)	Elective Courses (10 ECTS)
	Master thesis (40 ECTS)

Fig. 2.1. General Programme Civil Engineering MSc.

1 ECTS corresponds to 28 credit hours, according to the European Credit Transfer System. One academic year equals 60 ECTS. The total number of ECTS in the MSc Track Structural Engineering is 120 ECTS

The official documents on regulations for exams and graduation give a general scheme applicable for all Master tracks. This may be found summarized in the extract of Article 3 of the Implementation Regulations of the TER. This is presented in a convenient arrangement in Figure 2.3. The program overview can also be found on www.studyguide.tudelft.nl. In the scheme it is visible that all tracks of the Civil Engineering master program have one course in common. This is the course on Ethics (WM0312CIE), or its equivalent CIE4510. Then there is an obligatory part for all Structural engineering specializations, part b. Due to the large skill set every structural engineer needs this obligatory part consists of 32 ECTS of common courses to all Structural Engineering Tracks

In order to graduate on the specialization of your preference, students must follow the specialization-related courses before the end of their MSc programme. The reason for these specializations is to facilitate a transparent academic profile within all the possibilities. It gives an identity in relation with your graduation and future possibilities within the study program which aids the students as well as external professionals. The specifics of these specializations can be found in the Chapter 3 “Specializations”

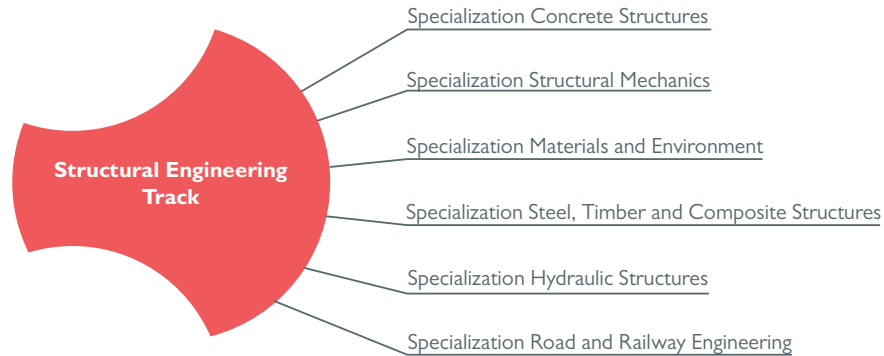


Fig. 2.2. The different Master Track Specializations in Structural Engineering

Several different possibilities are available to complete a personalized MSc Program. Aside from the core courses for each specialization within Structural Engineering, students may choose to realize an Annotation or a Honours Program, deepening into their technical knowledge or extending their reach towards a broader scope in Civil Engineering, Technology and Entrepreneurship. The possibility for electives allows the student to dive deeper into personal interest and development of higher technical knowledge.

Students may choose a double track within one MSc-programme. Both Tracks are mentioned in the diploma. For both tracks all requirements set for both specialization-linked courses must be met. Additionally, 20ECTS should be added in the form of Electives. The subject of both tracks specialization must be addressed in the graduation work.

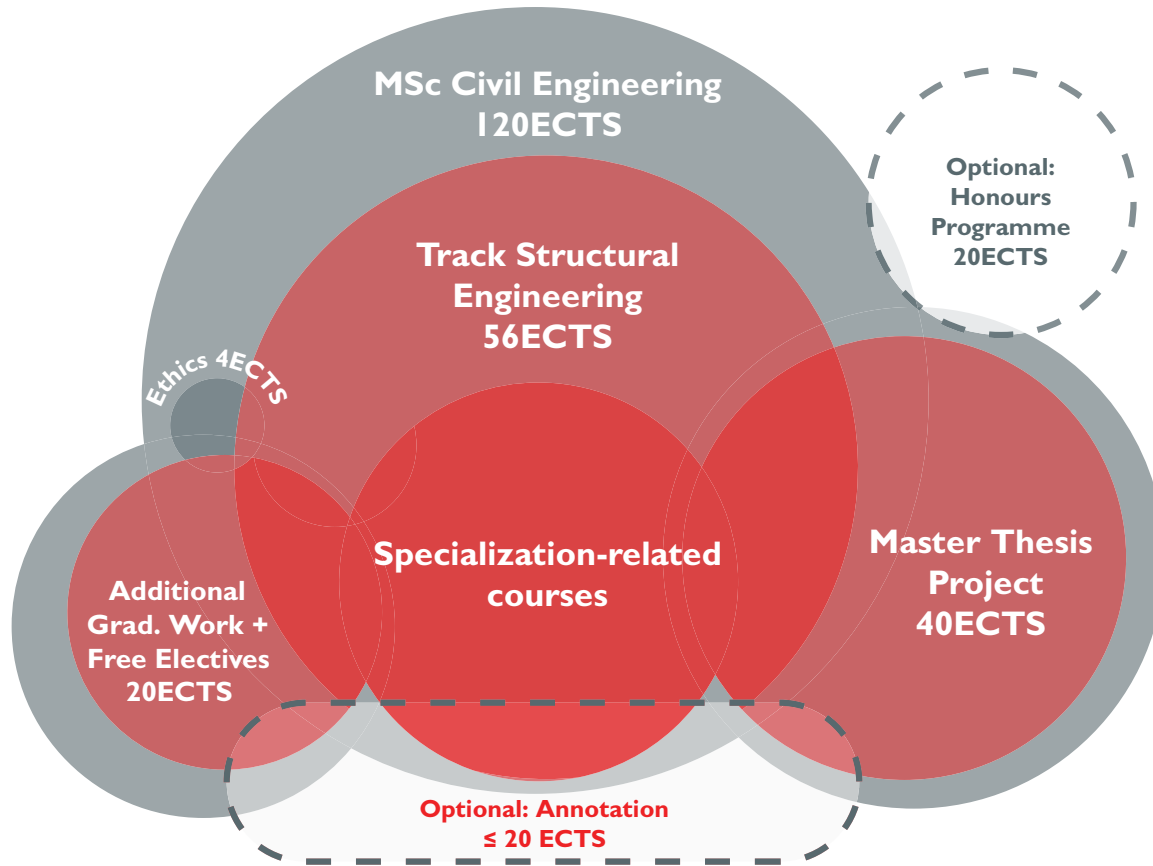


Fig. 2.3 The composition of the MSc Program in Civil Engineering and Relationship between graduation opportunities. An annotation may or may not require additional ECTS. Refer to Chapter 4 for further information.

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
a. At least 4 credits in one of the following courses (choose 1)		total: 4									
WM0312CIE	Philosophy, Tech. Assessment and Ethics for C.E.	4									
CIE4510	Climate Change: Science and Ethics	4									
b. 56 credits belonging to the chosen track		total: 56									
b.1. 32 credits belong to the compulsory block Structural Engineering											
CIE4100	Materials and Ecological Engineering	4									
CIE4110	Timber Structures and Wood Technology	4									
CIE4115	Steel Structures 2	4									
CIE4121	Steel Structures 3	4									
CIE4140	Structural Dynamics	4									
CIE4160	Prestressed Concrete	4									
CIE4180	Plates and Slabs	4									
CIE4190	Analysis of Slender Structures	4									
b2. 24 credits belonging to the chosen specialization											
...as described in the chapter 3 "Specializations"		24									

Fig. 2.4 The composition of the Structural Engineering MSc Track.

Article 3 - The composition

I. The study program tracks are compiled in the following way:

a. At least 4 credits (Choose 1 out of 5):

- Philosophy, Technology Assessment and Ethics for CT (WM0312CIE)
- Climate Change: Science & Ethics (CIE4510)
- Ethics of transportation (WMI302TU)
- Ethics of technological risk (WM0376TU)
- Water ethics (TPM003A)

b. 56 credits: track-linked subjects belonging to the chosen track.

The track-linked subjects may be subdivided into those that are general track-linked subjects (the common compulsory block) and those that belong to a specialization as stipulated in Articles 5 to 12 or a free specialization. Track-linked credits, exceeding 56 credits, will be considered as credits achieved for electives mentioned under c.

c. 20 ECTS as follows:

• Part 1: 10 credits. All subjects from the Civil Engineering MSc programme which may include only one of the following subjects:

- CIE5050-09 Additional Graduation Work, Research project
- CIE4040-09 Internship
- CIE4061-09 Multidisciplinary project, Civil Engineering Consultancy project

• Part 2, part 2: 10 credits electives from:

- Other subjects from all MSc programmes hosted by the faculty CEG with the exception of the three mentioned subjects above under part 1
- All subjects offered in conjunction with other MSc degree courses at a Dutch University or at an international university with an exchange contract with TUD
- The specialisation subjects included in the table 'Track linked BSc electives' ('keuzelijst specialisatievakken') as intended in Article 3 of the annex for the Bachelor's degree course in Civil Engineering at Delft University of Technology, as far as they are considered to be convergence subjects (CIE course codes, see list at end of annex)
- Interfaculty Master's-level electives at Delft University of Technology with a "WM-code" to a maximum of 6 credits, however language, skills subjects and MOOCs are not allowed within the examination programme. Language, skills subjects and MOOCs can only be part of the extracurricular paragraph of the diploma supplement,
- Deficiency subjects referred to in article 3, section 5.

[...]

Any deviations to this composition requires the approval of the Board of Examiners on forehand. For this a motivated request is needed.

d. 40 credits: a track-linked Master Thesis Project (CIE5060-09).

The Master Thesis Project consists of a final project, a thesis, a summary of the thesis and a final presentation. The project is subject to a strict planning and time table; specific dates and deadlines need to be set for the evaluation(s) and the final presentation of the project. The planning will be monitored by the graduation coordinator.

In article 21, as well as in the Rules and Guidelines laid down by the board of examiners, further stipulations have been laid down in relation to the Internship, the Multidisciplinary Project, Civil Engineering Consultancy project, the Additional Graduation Work and the Master Thesis Project.

SPECIAL SUBJECTS: INTERNSHIPS

One of the optional subjects in the MSc programme is the internship. The internship lasts for at least 8 weeks and is awarded 10 ECTS as standard. The aim is that in the course of your internship you become familiar with the technical, social and organizational aspects of civil engineering as a practical profession. All information can be found at the internship office at room 2.73 of Civil Engineering or at www.citg.tudelft.nl/stagebureau.

SPECIAL SUBJECTS: THE MULTIDISCIPLINARY PROJECT

Solve an actual and recent civil engineering problem in a multidisciplinary team. Integrate several studies and designs into a coherent entity, based on knowledge, understanding and skills acquired in the preceding years. Attention will be on quality control and the evaluation of the design process. Knowledge and skills obtained during the BSc projects will be used in this project. The course is divided into three phases: phase 1: inception plan; phase 2: preliminary design and studies; phase 3: process evaluation with respect to interdisciplinary aspects; final report.

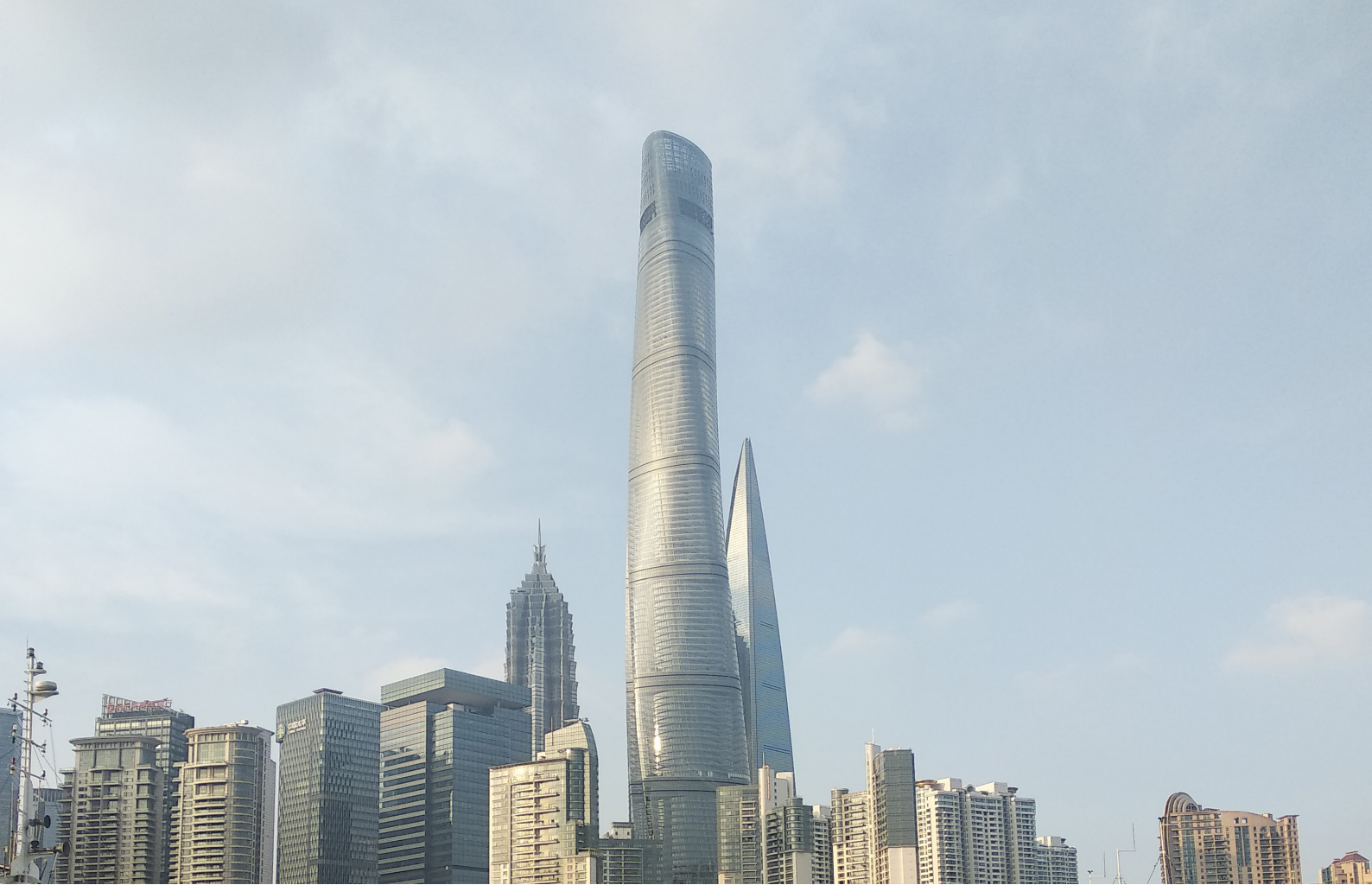
For more information regarding the Multi-disciplinary project visit <https://studiegids.tudelft.nl/> under course code CIE4061-09

SPECIAL SUBJECTS: ADDITIONAL GRADUATION WORK

The additional graduation work lasts for at least 8 weeks and is awarded 10 ECTS as standard. The additional graduation may or may not be linked to the MSc Thesis (CIE5060-09) and can be done after completion. For more information please visit <https://studiegids.tudelft.nl/> and look for the course code CIE5050-09.

THE FREE STUDY PROGRAM

Students are free to compile examination programmes that are rounded off with a final exam. Such a programme needs prior approval by the board of examiners and it must consist entirely or mainly of subjects given in conjunction with the degree course but it can be complemented with subjects provided by or given in other courses. For more information, reach out to the graduation coordinator.



3. SPECIALIZATIONS

On this chapter the different requirements are discussed for each one of the specializations that conform the Structural Engineering track. As shown previously in Fig. 2, all Structural Engineering students have the possibility to carry out 24ECTS on courses related to their specialization.

b. 56 credits belonging to the chosen track

total: 56

b2. 24 credits belonging to the chosen specialization

...as described in the chapter 3 “Specializations”

24

Extract from Figure 2. Space allocated for Specialization-Related Courses.

As said before, 6 specializations conform the Structural Engineering track; these include: (1) Structural Mechanics, (2) Concrete Structures (3) Steel, Timber and Composite Structures, (4) Materials and Environment (5) Hydraulic Structures and (6) Road and Railway Engineering. These specializations will be discussed in this chapter. For each specialization a short description is given and following that an overview of the specialization linked courses is given.

The specializations Structural Mechanics, Hydraulic Structures and Railway Engineering offer a comprehensive list of suggested electives that may more adequately address the specialization possibilities in these three tracks. These recommended electives may be found in the chapter “Recommended Electives, Annotations and Honours”. Be aware that some of the courses covered in the Specialization may have already be covered in the BSc phase. In such case an exception may be granted with the approval of the teaching faculty and the graduation coordinator to be changed for any of recommended electives.

STRUCTURAL MECHANICS

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
b2. Specialization-related courses			total: 24								
CIE4130	Probabilistic Design and Risk Management	4		■					■		
CIE4143	Shell Analysis, Theory and Application	4				■					■
CIE4150	Plastic analysis of Structures	4		+	!					■	
CIE5123	Introduction to the Finite Element Method	4			■					■	
CIE5145	Random Vibrations	4	+				!				■
CIE5148	Computational Modeling of Structures	4	■					■			

Add. available education period
 Recommended period

Fig. 3.1. Structural Mechanics specialization courses

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

The basis of every structural analysis is applied mechanics. This is used to calculate structures ever since the formulation of the Newtonian Laws of Physics 300 years ago, and complimented by the Rational Mechanics of Flexible Elastic Bodies, as Loehnard Euler once mathematically described to his epistolar partner Daniel Bernoulli. Now, the formulation of ever-more complex problems is complimented by the formulation of the Finite Element Method to discretize the physical world into a numerical model.

In the graduation project you will develop tools for other engineers to design structures, for example computational calculation methods, rules of thumb or design charts. In your carrier you can develop yourself further as the one who solves structural problems for which others do not know a solution.

CONCRETE STRUCTURES

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
b2. Specialization-related courses			total: 24								
CIE4170	Construction Technology of Civil Engineering Structures	4									
CIE4281	Building Structures 2	4									
CIE5110	Concrete - Science and Technology	4									
CIE5127	Concrete Bridges	4	!		+						
CIE5130	Capita Selecta Concrete Structures	4		!		+					
CIE5148	Computational Modeling of Structures	4									

Fig. 3.2. Concrete Structures specialization courses

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

Reinforced Concrete is the most use construction material. Architects and contractors appreciate this material because of the freedom in design, the low costs, the strength and the durability. However, designing a reinforced concrete structure is a specialization in itself. For example every reinforced structure has small cracks that cannot be seen by the naked eye. These cracks are necessary for activating the reinforcement but when they become too large the concrete is no longer water proof and the reinforcement will corrode.

In the Concrete Structures specialization you learn to make the right decisions for obtaining an optimal design. Despite that the material is being used for over 100 years, in the last years many innovations occurred in material, construction and applications to which this specialization gives much attention.

STEEL, TIMBER AND COMPOSITE STRUCTURES

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
b2. Specialization-related courses			total: 24								
CIE4125	Structural Design - Case Study Steel, Timber or FRP	3									
CIE5122	Capita Selecta Steel and Aluminum Structures	4									
CIE5124	Biobased Structures and Materials	4									
CIE5125	Steel Bridges	4									
CIE5126	Fatigue	3									
CIE5128	Fiber-Reinforced Polymer (FRP) Structures	3									
CIE5131	Fire Safety Design	3									

Fig. 3.3. Steel, Timber and Composite Structures specialization courses

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

You encounter structures made of steel, wood, aluminium and fibre-reinforced plastic everywhere you go. Think for example of applications in high-rise and low-rise buildings, in factory buildings, towers, masts, locks, weirs, bridges and viaducts. You will find out how to design and execute these constructions, as well as carry out the necessary calculations, within the Steel and Timber Structures specialization.

MATERIALS & ENVIRONMENT

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
b2. Specialization-related courses		total: 24									
CIE4030	Methodology of Scientific Research	3									
CIE4240-19 ^a	Forensic Structural Engineering	3									
CIE5100	Repair and Maintenance of Construction Materials	4		+	!						
CIE5102	Forensic Building Materials Engineering	3			!	!					
CIE5110	Concrete - Science and Technology	4									
CIE5130	Capita Selecta Concrete Structures	4		!							
CIE5146	Micromechanics and Computational Modeling of Materials	3	!		+						

Fig. 3.4. Materials and Environment specialization courses

^a Students who started their MSc program in 2018-2019 must take the course CIE5126 Fatigue instead of CIE4240-19

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

If you aim to design constructions, you have to be very much aware of the properties of the materials you plan to use. For example, what is the load bearing capacity of a prefab concrete driven pile? When does metal fatigue occur in aluminium? How can you make strong joints with wood? What is the minimum life span of the various building materials? You will learn the answers to these and other questions within the Materials Science specialization.

HYDRAULIC STRUCTURES

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
b2. Specialization-related courses			total: 24								
CIE3310-09	Open Channel Flow	4			■					■	
CIE3330	Hydraulic Structures I	4			■					■	
CIE4130	Probabilistic Design and Risk Management	4		■					■		
CIE4170	Construction Technology of Civil Engineering Structures	4				■					■
CIE4310	Bed, Bank and Shore Protection	4		■					■		
CIE4345	River Dynamics I	4	■					■			

Fig. 3.5. Hydraulic Structures specialization courses
CIE3310, CIE3330 or CIE3345 may be changed for further elective space as suggested in the “Recommended Electives” chapter if these courses or their equivalent had already been taken in the Bachelor’s Phase.

Hydraulic structures are always part of larger systems, such as flood defense systems or navigation systems, that play an important role in providing safety and prosperity to vulnerable delta regions. Hydraulic structures therefore have to be designed, built and maintained in an integral way. The group’s research and education is concerned with various types of hydraulic structures and systems, such as tunnels, quay walls, locks, dikes and storm surge barriers. To understand the behavior of these structures it is important that hydraulic, geotechnical and structural aspects are addressed in coherence.

ROAD AND RAILWAY ENGINEERING

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
b2. Specialization-related courses		total: 24									
CIE4860	Structural Pavement Design	6			+	!					
CIE4870	Structural Design of Railway Track	4									
CIE4880	Road Paving Materials, Laboratory Experiment included	7	+	+	!						
CIE5850	Road Construction	3									
CIE5871	Capita Selecta Railway and Road Structures	4		!		!					

Fig. 3.6. Road and Railway Engineering specialization courses; CIE4880 takes place in Q1+Q2 (+) and Q2+Q3 (!) in the year 2019-2020.

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

Note: for those interested in Railway Engineering there is a possibility to replace the above-mentioned courses by the Recommended Electives of the Chair of Railway Engineering (Chapter 5, page 29).

Infrastructural facilities such as roads, airfields, port areas, railways and tramways are essential for the proper functioning of our modern society. The structures required for these facilities are complex because they consist of multiple layers or components which together – over a long period – need to withstand increasingly heavy traffic loads. In the case of roads, airfields and port areas this involves asphalt, concrete or small elements, a solid foundation and a sand foundation. In the case of railways the basic structure is, in principle, rails connected by sleepers (or ties), a ballast foundation and a sand foundation, while tramways are mostly embedded in a road structure. The structures are built on the natural soil; in large parts of the Netherlands this is extremely weak, thus leading to a range of complications. In the Road and Railway Engineering specialisation you learn to design and maintain such structures.



4. RECOMMENDED ELECTIVES, ANNOTATIONS AND HONOURS

RECOMMENDED ELECTIVES FROM THE CHAIR OF INTEGRAL DESIGN MANAGEMENT

IDM focuses on integrated design and project management of major infrastructural projects from the viewpoint that a comprehensive review of the life cycle of a structure should generate maximum benefit for all the stakeholders concerned at the minimum price (including to society). The chair of integral Design Management has recommended the following courses as electives to compliment the study course of Structural Engineering with comprehensive technical and analytical techniques for the management of the built infrastructure.

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
CIE438I	Engineering Asset Management	4	■				■				
CIE4120	Information Systems for Construction	4	■				■				
CIE439I	Quantitative Asset Modeling	4	■				■				
CIE4170	Construction Technology for Civil Engineering Structures	4				■					■

Add. available education period
 Recommended period

Fig. 4.1. Recommended Electives IDM

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

RECOMMENDED ELECTIVES FROM THE CHAIR OF HYDRAULIC ENGINEERING

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
CIE4305	Coastal Dynamics I	6			█					█	
CIE4325	Ocean Waves	6					█				█
CIE5304	Waterpower Engineering	3				█				█	
CIE5310	Probabilistic Design in Hydraulic Engineering	3				█				█	
CIE5313-18	Hydraulic Structures 2	4				█				█	
CIE5314-19	Flood Defenses	4				█				█	

Fig. 4.2 Recommended Electives Hydraulic Eng.

The Hydraulic Engineering group focuses on research and education related to hydraulic engineering systems, such as flood defenses, storm surges, barriers, tunnels and locks. In the specific case of the hydraulic structures specialization, the following courses may be undertaken as electives instead of courses that have been previously accredited by the student during their BSc phase.

RECOMMENDED ELECTIVES FROM THE CHAIR OF STRUCTURAL MECHANICS

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
CIE5144	Stability of Structures	3				█					█
CIE5142	Computational Methods in Non-Linear Solid Mechanics	3	█				█				
CIE5260	Structural Response to Earthquakes	4	█				█				
CIE4353	Continuum Mechanics	3	█	█			█	█			

Fig. 4.3 Recommended Electives Structural Mechanics; CIE4353 takes place in Q1+Q2

The chair of Structural Mechanics focuses on modeling of civil and building engineering structures, comprising the generation and evaluation of FEM models. The challenge is to confront the behavior of lab tests and real world structures through a thorough understanding of the finite element analysis. As compliment to the specialization of Structural Mechanics and as an offer for all SE specializations, the chair of Structural Mechanics offers the courses mentioned above

RECOMMENDED ELECTIVES FROM THE CHAIR OF RAILWAY ENGINEERING

Railways are complex systems that include rolling stock, infrastructure and operations. The chair of Railway Engineering recommends the following courses as electives to compliment any chosen specialization:

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
CIE4874	Elements of Railway Engineering	4		■				■			
CIE5826	Railway operations and Control	4			■				■		
CIE4873	Wheel-Rail Interface	4				■					■
CIE4871	Design and Maintenance of Railway Vehicles	4				■					■
CIE5875	Railway Asset Management	4	■				■				

Figure 4.4. Recommended electives Railway Engineering.

Keeping in mind that the grand total of ECTS for the specialization-related courses should be at least 24 ECTS, any compulsory course of the Road and Railway Engineering Specialization may be replaced by the above-mentioned courses with the approval of the graduation coordinator. These courses are also included in the Annotation Railway Systems.

ANNOTATION TECHNOLOGY IN SUSTAINABLE DEVELOPMENT (TIDO)

This is an annotation open to all TU Delft students. The graduation covers both a broader and deeper knowledge regarding Sustainable Development and Technology. To receive this annotation, students must complete the colloquium “Engineering for Sustainable Development” and a total of 10ECTS from the clusters “Design, Analysis and Tools” or

“Organization and Society”. At least 3ECTS must be carried out from one of each cluster. Additionally, the Master Thesis project must partially focus on the topic of sustainable development.

More information on the annotation, further requirements and available electives may be found on: <https://www.tudelft.nl/tbm/over-de-faculteit/afdelingen/values-technology-and-innovation/sections/economics-of-technology-and-innovation/education/annotation-tido/>. Prior approval by the Board of Examiners is required to enroll in this annotation. Students who complete will receive an annotation for Technology in Sustainable Development on their certificate.

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
a. Sustainable development colloquium		total: 5									
WM0939TU	Engineering for Sustainable Development	5									
b. Subjects belonging to the two TiDO clusters		total: 10									
	electives on the cluster Design, Analysis and Tools	min. 3									
	electives on the cluster Organization and Society	min. 3									

Fig. 4.5. Annotation TIDO

ANNOTATION ENTREPRENEURSHIP

This is an annotation open to all TU Delft MSc students. This can be achieved within the space for electives on the MSc specialization (5 ECTS) and 10 ECTS as extracurricular electives. The Master Thesis project must also be partially focused on Entrepreneurship. The list of electives that may be chosen and further information on the annotation may be found on the Brightspace course “Annotation Entrepreneurship”. Prior approval by the Board of Examiners is required to enroll in this annotation. Students who complete will receive an annotation for Entrepreneurship on their certificate.

Course Code	Course Name	ECTS	1st Year				2nd Year			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
a. Elective courses related to the Entrepreneurship Track			<u>total: 15</u>							
MOT9610	Entrepreneurship Basic Course	5								
MOT9612	Business Development Lab (short)	5								
	Annotation-related electives	min. 5								

Fig. 4..6. Annotation Entrepreneurship

ANNOTATION URBAN PLANNING ENGINEERING

This annotation is offered to Civil Engineering Students who would like to specialize in Urban Planning and Engineering. The annotation requires 20 credits which may be entirely part of the elective space in the MSc program, or complimentary as extracurricular credits. The courses must relate to one or more of the following fields: (1) Urban and Regional Planning, (2) Infrastructure Planning, (3) Real State, (4) Land Clearing, or (5) Urban Civil Engineering. Moreover, the thesis must focus on one or more of the topics mentioned before. Prior approval by the Board of Examiners is required to enroll in this annotation. More information through the graduation coordinator.

Course Code	Course Name	ECTS	1st Year				2nd Year			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
a. Elective courses related to on of the fields of Urban Planning Engineering			<u>total: 20</u>							
	Annotation-related electives	20								

Fig. 4.7. Annotation Urban Planning and Engineering

ANNOTATION RAILWAY SYSTEMS

This is an annotation open to MSc Transport and Planning, MSc Civil Engineering and the MSc Transport, Infrastructure and Logistics students. The railway sector needs scientifically educated engineers with integrated knowledge of railway systems. The railway annotation integrates railway engineering and operations to become a railway expert. The annotation consists of two compulsory courses amounting to 8 ECTS and a set of 14 ECTS of annotation-related electives. For more information visit: <https://www.tudelft.nl/studenten/faculteiten/citg-studentenportal/onderwijs/master/annotaties/railway-systems-annotation/>. The Master Thesis project must be partially focused in Railway Systems. Prior approval by the Board of Examiners is required to enroll in this annotation. Students who complete will receive an annotation for Railway Systems on their certificate.

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
a. Compulsory courses of the Railway Systems Annotation		total: 8									
CIE4874	Elements of Railway Engineering	4		■				■			
CIE5826	Railway Operations and Control	4			■				■		
b. Elective courses of the Railway Systems Annotation		total: 14									
	Annotation-related electives	14									

Fig. 4.7. Annotation Railway Systems

ANNOTATION INTEGRAL DESIGN MANAGEMENT

The Integral Design Management annotation is meant for Civil Engineering Students, Transport Infrastructure and Logistics, and Construction Management and Engineering. Students must complete 8 ECTS of mandatory IDM courses and 6 ECTS elective courses from the IDM-elective list. The elective courses must be approved by the IDM coordinator. Additionally, the student must carry out a Multidisciplinary Project or the alternative courses listed in Fig. 4.6. More

information on the list of electives may be found on <https://www.tudelft.nl/en/student/faculties/ceg-student-portal/education/master/annotations/integral-design-and-management-idm-annotation/>. Finally, the Master Thesis project must be partially focused in Integral Design Management. Prior approval by the Board of Examiners is required to enroll in this annotation. Students who complete will receive an annotation for integral Design Management on their certificate.

Course Code	Course Name	ECTS	1st Year				2nd Year			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
a. Compulsory courses of the IDM annotation		total: 8								
CIE438I	Engineering Asset Management	4								
CIE4120	Information Systems in the Construction Industry	4								
b. Elective courses from the IDM-elective list		total: 6								
	Annotation-related electives	6								
c. Choose i, ii or iii		total: 10								
i. A Multidisciplinary Project with focus on IDM										
CIE406I-09	Multidisciplinary Project, Civil Engineering Consultancy Project	10								
ii. An Internship with focus on IDM										
CIE4040-09	Internship	10								
iii. Annotation-Specific courses										
CME1200	Collaborative Design	7								
CME2210	Open Design	3								

Fig. 4.8. Annotation IDM

ANNOTATION DYNAMICS OF STRUCTURES

This annotation is meant for MSc Civil Engineering Students. There is a significant increase in demand of graduates with an in-depth understanding of the dynamic behavior of structures. To complete the annotation, students must obtain at least 20 ECTS from the list of the annotation-related courses. Moreover, the Master Thesis project must be partially focused in Integral Design Management. Prior approval by the Board of Examiners is required to enroll in this annotation. Students who complete will receive an annotation for Dynamics of Structures on their certificate.

Course Code	Course Name	ECTS	1st Year				2nd Year				
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
a. Compulsory courses of the Dynamics of Structures Annotations			<u>min: 20</u>								
CIE4140	Dynamics of Structures	4			■					■	
CIE4260	Measurements and Analysis of Vibrations	4				■					■
CIE5145	Random Vibrations	4	+			!					■
CIE5260	Structural Response to Earthquakes	4	■				■				
CIE5340-18	Soil Dynamics	4				■					■
OE44055	Load Identification and Monitoring of Structures	4					■				

Fig. 4.9. Annotation Dynamics of Structures

The course OE44055 will not be taught during the academic year 2019-2020 due to schedule changes.

The courses marked with a + or ! are included in the transition arrangement 2019-2020. Please refer to chapter 6 for further information.

HONOURS PROGRAMME MASTER

Motivated Students who have proven good academic performance (above a 7.5 GPA in their BSc and average 7.5 GPA in their first semester of their MSc with no fails) may apply to the honors programme. The Honours Program includes 20 ECTS on top of the regular MSc track and a research proposal approved by a Scientific Staff Member and the Graduation Coordinator is presued. The research proposal must be sent to the Honours Coordinator .

The content of the Honors Program must be thematically consistent, complimented by the course “Critical Reflection on Technology”. The programme has to be completed during the course of the Student’s MSc programme. No results may be lower than 6.0. Students who have successfully completed the programme will receive a special certificate from the university.

Course Code	Course Name	ECTS	1st Year				2nd Year			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
a. Individual elective courses	free elective courses approved by the Honours Coordinator	15								
b. Collective interdepartmental course										
UD2010	Critical reflection on technology	5								

Fig. 4.10. Honours Programme MSc UD2010 takes place either in Q2+Q3 or Q3+Q4

JOINT INTERDISCIPLINARY PROJECT

The course is for the second year MSc students from the faculties of Aerospace Engineering; Civil Engineering and Geosciences; Mechanical, Maritime and Materials Engineering; Technology, Policy and Management. during the JIP you will work together with students of other faculties and with staff of a company. The full-time projects are focused on integrated design or research assignments in addition to value adding, societal acceptance and engineering ethics. For the MSc. Civil Engineering, 5ECTS are credited as elective space and 10ECTS are credited as extracurricular. Application is required for all interested students in the form of a Motivation Letter, CV and 1st year MSc transcript. More information in: www.jointinterdisciplinaryproject.nl.

Course Code	Course Name	ECTS	1st Year				2nd Year			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Joint Interdisciplinary Project	15								

Fig. 4.11. Joint interdisciplinary Project



5. GRADUATION

The Master's thesis finalizes the Master's study at the university. During the graduation period not only the graduation work itself is important, but also the organization of the graduation as whole.

The organization of the Master's thesis is considered an important part of the graduation and is the sole responsibility of the student.

This chapter tries to give an overview of all the steps that need to be taken within the graduation period. The buildup of the chapter is related to the graduation scheme shown in figure 5.1. In addition, students are advised to consult the CIE-0 form, which provides information on the graduation procedure (studenten.tudelft.nl).

CHAIRMAN GRADUATION COMMITTEE

For your graduation committee you will need a chair of your committee that has accredited the University Teaching Qualifications (UTQ's). For students Structural Engineering any (associate/assistant) professor of the CeG faculty will suffice,

START OF THE MASTER'S THESIS PROJECT

The first step in starting on the final project is to visit the graduation-coordinator. For Structural Engineering this is L.J.M. Houben. Together the official part of the graduation will be set-up, this is the left hand column in Figure 5.1. One can start the MSc thesis as soon as the BSc diploma and 65 ECTS in the MSc. are gained.

FINDING A SUBJECT

At the same time a graduation subject needs to be found. It is a good idea to discuss this with a number of teachers and professors, where own input is very much appreciated. The graduation subject needs to be approved in concordance with the graduation professor.

A graduation subject at Structural Engineering can be:

- Defined by the research interest of the student in collaboration with the faculty.
- Defined by the research interest of a third-party company.
- Defined by the research interest of the faculty in the Engineering Structures and 3MD chairs.

The department of Engineering Structures has made public a Master Thesis database as a Brightspace Course. This database showcases the currently available projects from the groups of Bio-based structures and Materials; Concrete Structures; Dynamics of Structures; Pavement Engineering; Railway Engineering; Resources and Recycling; and Steel and Composite Structures.

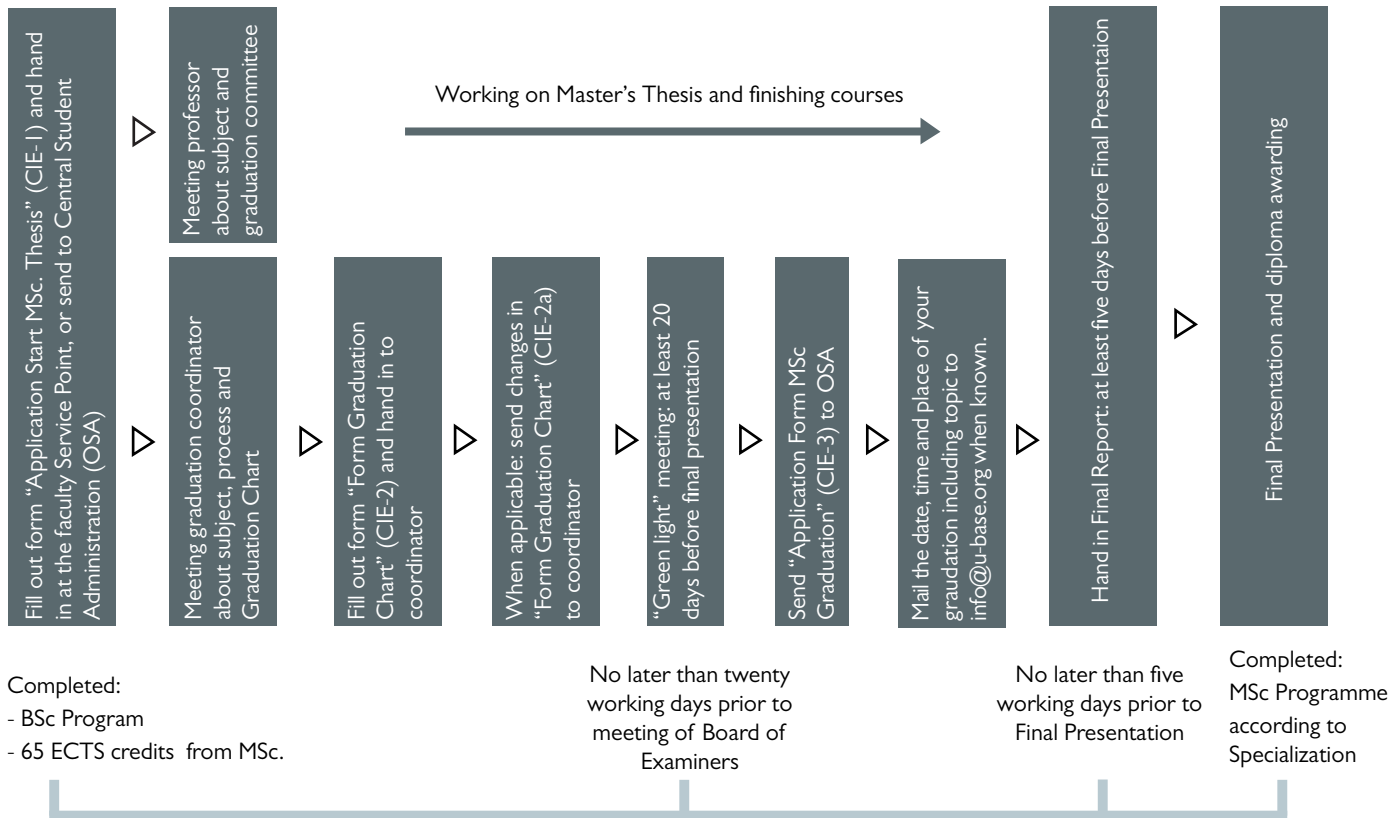
Thesis projects may be research oriented or design oriented. In reality a combination of the two is most common.

To help the student to find a graduation subject it is also advised to look at previous subjects. All the completed Master's theses of projects can be found on <https://repository.tudelft.nl/> (look for structural engineering subjects). Other important resources are PhD. students, fellow students and the permanent MSc thesis poster exposition on the first floor of the main building (facing lecture room G).

A discussion on all frequently asked questions and common pitfalls on the MSc master thesis was realized, recorded and transcribed by U-BASE in collaboration with the graduation coordinators Roel Schipper and Lambert Houben. This may be accessed through the U-BASE website or through YouTube under the title "U-BASE CCB - Let's talk about your Master Thesis Project".

GRADUATION PROJECT AT COMPANY

Companies also often have interesting challenges for graduating students. In these cases it is also normal to have a person from the company to take place in the graduation committee. This has to be approved by the graduation professor and the board of examination.



For information only. No rights may be inferred from this diagram. The official Course and Examinations Regulations and Board of Examiners Rules and Guidelines take precedence at all times.

Figure 5.1: Flow chart for graduation at structural Engineering

GRADUATION COMMITTEE

The chairman of the graduation committee is the graduation professor. The committee itself depends completely on the subject, but must consist of at least three persons from the Delft University, divided over at least two different sections of the Structural Engineering department. Furthermore. One or two members from outside the university can be added. The composition of the committee is a combined task of the graduation professor and the student. FORMS

All forms mentioned in Figure 4.1 can be found on the faculty website (studenten.tudelft.nl, go to CiTG, Forms). The following forms are available:

- “Application Start MSc. Thesis” (CIE-1) (Aanvraag Aanvang Afstudeerwerk)
- “Form Graduation Chart” (CIE-2) (‘Aanvraag Afstudeerkaart)
- “Form Changes Graduation Chart” (CIE-2a)
- “Application Form MSc Graduation” (CIE-3) (Aanvraag MSc Examen)

COURSE OF THE GRADUATION PROJECT

The **Kick-off Meeting** is the first official meeting of the complete graduation committee. At this meeting the student presents a detailed work plan for the entire project. The work plan is a result of preliminary research by the student into the chosen subject and is put down in concordance with the graduation professor.

Typically, the Start Meeting is followed by two **Interim Meetings** to monitor the progress of the project. The time between the meetings is approximately 2 to 3 months. Additional meetings can be set up when necessary. Obviously there is regular contact with the individual committee members between meetings.

At the **Green-Light Meeting** a green light is given to proceed to finishing the project. The date for the Final Presentation is set here as well. The **Judgement Meeting** takes place directly before the Final Presentation. At this meeting the student is absent and the committee will judge the project as a whole. After the **Final Presentation** the final mark is established, and the MSc-diploma is awarded.

A graduation project usually takes 9 months. Make a clear planning in advance and keep track of your progress!

FINALIZING THE MASTER'S THESIS

In order to graduate a number of aspects need to be taken into account. Firstly there is a number of deliverables and secondly the official judgement criteria that are used by the graduation committee.

Deliverables

The following deliverables are obligatory:

- Hard copy of the final report for each committee member
- Upload full report to repository in .doc or .pdf format

Judgement criteria

The Master's Thesis is judged on the following five aspects:

A. Scientific approach (25%)

- Theoretical profundity
- State of the art description and literature study
- Scientific argumentation (hypothesis testing)
- Quality of experimental work or design
- Creativity: new ideas

B. Quality of result/product (25%)

- Scientific reflection and judgment
- Utilization of result/product
- Extension/generation of method
- Quality of abstract
- Amount of work

C. Behavioral competencies (20%)

- Initiative and/or own contribution
- Responsibility
- Communicative skills
- Independency

D. Quality of written presentation (15%)

- Structure and consistency
- Acknowledgment of sources/quotations
- English proficiency

E. Quality of oral presentation and defense (15%)

- Speaker quality
- Clarity and structure of presentation
- Quality of presentation material
- Answering of questions



6. TRANSITION MEASURES

ACADEMIC YEAR 2019-2020

During the academic year 2019-2020, a transition measures will be implemented due to on-going optimization of the course schedule to improve the study progress of the students enrolled in the Structural Engineering track. Depending on each course, a somewhat different arrangement has been agreed upon, so don't hesitate on contacting the professors and graduation coordinators for further clarification when required. The following measures will apply only during the academic year 2019-2020:

Course Code	Course Name	ECTS	1st Year				
			Q1	Q2	Q3	Q4	
Courses in transition taught in person in the earlier academic period.						The ! marks the period when the course will be taught in person. The + marks the period when the course will be taught through self-study.	
CIE5127	Concrete Bridges	4	!		+		
CIE5130	Capita Selecta - Concrete Structures	4	!				+
CIE5146	Micromechanics and Computational Modeling of Construction Materials	3	!		+		
CIE5102	Forensic Building Material Engineering	3			!		!
CIE5871	Capita Selecta Road and Railway	4		!			!

Add. available education period
 Recommended period

Figure 6.1. Courses in transition taught in earlier academic period

The courses CIE5127, CIE5130 and CIE5146 will be taught and recorded through Collegerama in the earlier academic period (Q1 in all cases). CIE5127 and CIE5146 will be offered in the later academic period (Q3) in a basis of self-study and bi-weekly consultation sessions. In the case of CIE5130, the consultations sessions will occur on a weekly basis on the later academic period (Q4). The courses CIE5102 and CIE5871 will be offered as regular course sessions twice during the academic year. Examinations possibilities may be reduced during the academic year; contact the professor responsible for further information.

Course Code	Course Name	ECTS	1st Year				The ! marks the period when the course will be taught in person. The + marks the period when the course will be taught through self-study.
			Q1	Q2	Q3	Q4	
Courses in transition taught in person in the later academic period							
CIE5145	Random Vibrations	4	+			!	
CIE4150	Plastic Analysis of Structures	4		+	!		
CIE4860	Structural Design of Pavements	6			+	!	
CIE4880	Road and Paving Materials	7	+	+	!		
CIE5100	Repair and Maintenance of Construction Materials	4		+	!		
CIE5131	Fire Safety	3		+	!		

Fig. 3.6. Road and Railway Engineering specialization courses; CIE4880 takes place in Q1+Q2 (+) and Q2+Q3 (!) in the year 2019-2020.

Figure 6.2. Courses in transition taught in person in later academic period

The courses CIE5145, CIE4860, CIE5100 and CIE5131 will offer weekly consultation sessions in the earlier education period (Q1, Q3 and Q2 respectively). The course CIE4150 will offer bi-weekly consultation sessions in the earlier education period (Q2). The course CIE4880 will offer the laboratory sessions and consultation sessions in a weekly basis on the earlier education period (Q1+Q2).

For the courses CIE4150 and CIE5131 examinations possibilities may be reduced during the academic year; contact the professor responsible for further information.



7. U-BASE

U-BASE is the United Building and Structural Engineering Association for students at the Faculty of Civil Engineering and Geosciences at TU Delft.

The main objective of U-BASE is to stimulate relations between students, the university and the building industry by organizing several activities:

- Excursions to companies and interesting building projects
- One European and one overseas Study Tour per year. In the past years we have visited Moscow & St Petersburg, Shanghai, New York, Hong Kong, Chicago, Tokyo, Singapore, Macao, Shenzhen, Guangzhou, Osaka, Kyoto and Kuala Lumpur !
- Biennial Symposium with participation of professionally renowned architects and engineers such as Keith Boswell, Bart Leclercq, Eran Chen, Jacob van Rijs.
- Workshops, guest lectures, conference visits.
- Publication of the magazine U-Profiel
- Evaluations of courses in collaboration with the faculty staff for the improvement of the overall MSc programme.

For more information on U-BASE and their activities, come for a cup of coffee at room Stevin II, I.35 or visit www.U-BASE.org

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RELEVANT CONTACTS IN STRUCTURAL ENGINEERING

Contact		Telephone	E-mail	Room
Chair of Section Applied Mechanics	Prof. dr. ir. L.J (Bert) Sluijs	+31 15 278 2728	L.J.Sluijs@tudelft.nl	6.49
Chair of Section Materials and Environment	Prof. dr. ir. E. (Erik) Schlangen	+31 15 278 6535	Erik.Schlangen@tudelft.nl	6.21
Chair of Section IDM	Prof. dr. ir. M.J.C.M. (Marcel) Hertogh	+31 15 278 4921	M.J.C.M.Hertogh@tudelft.nl	3.38
Chair of Section Steel and Composite Structures	Prof. dr. M. (Milan) Veljkovic	+31 15 278 5816	M.Veljkovic@tudelft.nl	2.52
Chair of Section Biobased Structures and Mat.	Drs. W (Wolfgang) Gard	+31 15 278 9435	W.F.Gard@tudelft.nl	S2.2.57
Section Concrete Structures	Dr. ir. M. (Mladena) Luković / Dr. ir. Yuguang Yang	+31 15 278 2320/ +31 15 278 2277	M.lukovic@tudelft.nl/ Yuguang.Yang@tudelft.nl	S2.1.04/ S2.1.03
Chair of Section Dynamics of Structures	Prof. dr. A. (Andrei) Metrikine	+31 15 278 4749	A.Metrikine@tudelft.nl	3.38
Chair of Section Pavement Engineering	Prof. dr. ir. S.M.J.G. (Sandra) Erkens	+31 15 278 5949	S.M.J.G.Erkens@tudelft.nl	S2.2.25
Chair of Section Railway Engineering	Prof. dr. ir. R.P.B.J. (Rolf)Dollevoet	+31 15 278 2365	R.P.B.J.Dollevoet@tudelft.nl	S2.2.28
Chair of Section Resources and Recycling	Prof. dr. P. (Peter) Rem	+31 15 278 3617	P.C.Rem@tudelft.nl	S2.2.08
Graduation Coordinator Structural Engineering / Internship Coordinator BE and SE	ir. L.J.M. (Lambert) Houben	+31 15 278 4917	L.J.M.Houben@tudelft.nl	S2.2.27
Internship office	Dr. ir. J.H. (John) Baggen	+31 15 278 1174	stagebureau-citg@tudelft.nl	4.25
International Office	Maaike Kraeger-Holland and Nazli Ozdemir	+31 15 278 1174/4733	exchange-citg@tudelft.nl	2.73
Multidisciplinary Project	Yolanda de las Heras	+31 15 278 4800	studentoffice-esa-ceg@tudelft.nl	2.73
Education and Student Affairs		+31 15 278 8012	contactcentre-esa@tudelft.nl	Jaffalaan 9A
U-BASE		+31 15 278 3042	info@U-BASE.org	S2.1.35

Figure 5.3: Relevant contacts in Structural Engineering

UBASE