AF2023 Theory & Methodology of Science and Risk & Safety Analysis in Building Sciences 7,5 Hp, Autumn 2020

Version 1

ECTS Credits: 7,5
Level: D
Grade: A, B, C, D, E
Period: 2
Language: English
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Coordinator: Fredrik Johansson, fredrik.johansson@byv.kth.se

Prerequisite

1. 180 hp Bachelor's degree.
2. At least 30 hp of courses on advanced level within the Master of Science Program.
3. English B from Swedish high school or equivalent knowledge and skill from other courses or programs (e.g., TOEFL or IELTS).

Aim

The course provides an introduction to the theory and methodology of science and is intended for the Master student or beginning PhD student. One aim is to supply the basic concepts needed for placing the techniques and knowledge acquired in the student's other courses in the wider context of the technical sciences. Another aim is to provide the basic intellectual tools that allow for a reasoned and critical assessment of results and methods presented in research.

The course also provides basic knowledge about risk and safety in building and in construction work. After completing the course, students should have acquired good knowledge about the most important risk and safety issues in this field of technology. Students should also have acquired understanding of basic concepts in the analysis of risk and of basic principles for technical safety management. Students should also be able to apply these concepts and principles in analysis of actual buildings and other structures. Learning aims & grading criteria are given in Annexes A & B.

The course is built up by two parts: Theory & Methodology of Science (TaMoS) and Risk & Safety Analysis in Building Sciences (R&S).

TaMoS Part, 4,5 hp, is given by the Division of Philosophy: The part is built up by lectures and seminars.

R&S Part, 3 hp, is given by the Department of Civil & Architectural Engineering. This part consists of lectures and exercises.

Requirements

SEMA - Passed seminars (3 TaMoS seminars), 1 hp, grading: P, F

PROA - Passed project (Thesis preparation work), 1,5 hp (TaMoS 1,0 hp + R&S 0,5 hp), grading: P, F

TENA - Passed written exam on the TaMoS part, 2,5 hp, grading: A, B, C, D, E, FX, F

TENB - Passed written exam on the R&S part, 2,5 hp, grading: A, B, C, D, E, FX, F

Lectures, seminars, and exercise classes

Note that broadcasted live lectures on Zoom will not be recorded (due to GDPR regulations and administrative routines). If you cannot attend, you are referred to the PDF slides and the course book.
Students are not allowed to record lectures themselves.

Part	No	Subject	Time	Hall	Lecturer
TaMoS & R&S		Presentation of M.Sc. thesis subjects	Tue. Sept. 15, 15-17	Zoom	Johan Silfwerbrand et al.
TaMoS & R&S		Presentation of M.Sc. thesis subjects	Wed. Sept. 16, 15-17	Zoom	Johan Silfwerbrand et al.
R&S	Str 1	Introduction to Risk & safety: Loads, Failures & Damages. Summary of M.Sc. thesis subjects	Mon. Oct. 26, 9-12	Zoom	Johan Silfwerbrand
TaMoS	V1	Scientific Knowledge	Mon. Oct. 26, 13-15 (time & date are suggestions)	Video	Till Grüne-Yanoff
R&S	Geo 1	Safety Analysis in Geotechnical Engineering – Introduction	Wed. Oct. 28, 10-12	Zoom	Fredrik Johansson
R&S	Str, Ex 1	Safety Analysis for Structures, Exercise	Wed. Oct. 28, 14-17	B25, B26, Proj.h. + Zoom	Shicheng Li, Johan Silfwerbrand
R&S	Str 2	Safety Analysis for Structures	Fri. Oct. 30, 13-15	Zoom	Johan Silfwerbrand
TaMoS	V2	Scientific Inference	Fri. Oct. 30, 15-17 (time & date are suggestions)	Video	Till Grüne-Yanoff
R&S	Thesis	Scientific Writing	Mon. Nov. 2, 8-10	Zoom	Johan Silfwerbrand
R&S	Geo, Ex 1	Geotechnical Engineering, Ex 1	Mon. Nov. 2, 10-12	B25, Proj.h., B26 + Zoom	Fredrik Johansson Johan Spross
R&S	Geo, Ex 1, cont'd	Geotechnical Engineering, Ex 1, extra time	Mon. Nov. 2, 13-15	B25, B26, Proj.h. + Zoom	Fredrik Johansson Johan Spross
TaMoS	V3	Observations & Measurements	Mon. Nov. 2, 15-17 (time & date are suggestions)	Video	Till Grüne-Yanoff
TaMoS	V4	Experiments	Wed. Nov. 4, 14-16	Video	Till Grüne-Yanoff

			(time & date are suggestions)		
TaMoS	V5	Models	Fri. Nov. 6, 13-15 (time & date are suggestions)	Video	Till Grüne-Yanoff
R&S	Geo 2	Safety Analysis in Geotechnical Engineering	Mon. Nov. 9, 9-11	Zoom	Fredrik Johansson
R&S	Geo, Ex 2	Correlation and MCS in Reliability Analysis, Exercise	Mon. Nov. 9, 13-16	B25, B26, Proj.h. + Zoom	Fredrik Johansson, Johan Spross
TaMoS	V6	Statistics	Wed. Nov. 11, 8-10 (time & date are suggestions)	Video	Till Grüne-Yanoff
R&S	Geo 3	Geotechnical Risk Management	Wed. Nov. 11, 10-12	Zoom	Johan Spross
TaMoS	Sem 1	Seminar 1: Definitions, operationalizations and hypotheses	Wed. Nov. 11, 13-15 & 15-17	Q11, Q13, Q24	
R&S	Str 3	Partial Safety Factors, Safety of Systems	Mon., Nov. 16, 8-10	Zoom	Johan Silfwerbrand
R&S	Str, Ex 2	Safety Analysis for Structures, Exercise	Mon. Nov. 16, 13-15	B24, B25, Proj.h. + Zoom	Shicheng Li, Johan Silfwerbrand
TaMoS	V7	Explanations & Causes	Wed. Nov. 18, 8-10 (time & date are suggestions)	Video	Till Grüne-Yanoff
TaMoS	Sem 2	Seminar 2: Designing an experiment	Wed. Nov. 18, 13-15 & 15-17	Zoom	
TaMoS	V8	Engineering Design	Mon. Nov. 23, 13-15 (time & date are suggestions)	Video	Till Grüne-Yanoff
TaMoS	V9	Risk	Wed. Nov. 25, 8-10 (time & date are suggestions)	Video	Till Grüne-Yanoff
TaMoS	Sem 3	Seminar 3: Interpretation, Evidence & Analysis	Wed. Nov. 25, 13-15 & 15-17	Zoom	
TaMoS	V10	Qualitative Methods	Fri. Nov. 27, 13-15 (time & date are suggestions)	Video	Till Grüne-Yanoff
TaMoS	V11	Research Ethics	Mon. Nov. 30, 13-15 (time & date are suggestions)	Video	Till Grüne-Yanoff

R&S	Geo & Str, Ex	Workshop for questions and finalization of exercises	Wed. Dec. 9, 8-10	Zoom	Fredrik Johansson Johan Spross Shicheng Li
R&S	Str 4	Risk & Safety of Structures, Repetition & Examples	Wed. Dec. 9, 10-12	Zoom	Johan Silfwerbrand
TaMoS +R&S	Sem	M.Sc. Thesis Presentations	Wed. Dec. 9, 13-17	Zoom	3 parallel meetings + 3 parallel meetings
TaMoS +R&S	Sem	M.Sc. Thesis Presentations	Mon. Dec. 14, 10-12	Zoom	3 parallel meetings + 3 parallel meetings
TaMoS +R&S	Sem	M.Sc. Thesis Presentations	Mon. Dec. 14, 13-15	Zoom	3 parallel meetings + 3 parallel meetings
TaMoS +R&S	Sem	M.Sc. Thesis Presentations	Wed. Dec. 16, 10-12	Zoom	3 parallel meetings + 3 parallel meetings
TaMoS +R&S	Sem	M.Sc. Thesis Presentations	Wed. Dec. 16, 13-15	Zoom	3 parallel meetings + 3 parallel meetings
TaMoS	Exam		Wed. Jan. 13, 8-12	Canvas	
R&S	Exam		Fre. Jan. 15, 8-10.30	B22, D42, L31, L42, Q1	

Syllabus, TaMoS Part. This part of the course has two sections, the first detailing issues in the philosophy of science, the second part (in cooperation with R&S) aiming to help students prepare for writing their thesis. The first section will be focusing on questions about how scientific knowledge is achieved. Questions such as what one can conclude from data, what it means to test a hypothesis, what separates science from other knowledge gathering activities, what it means for a theory to be true and what it means for a hypothesis to be falsified will be treated. The course will bring up some issues from ethics, specifically the question of what constitutes good scientific conduct and what the relationship between science and ethics is. After this part of the course the student should have a good overarching grasp of the philosophical questions and perspectives regarding scientific knowledge and practice.

The second section – **the essay** – is aimed at aiding the student in writing their final degree project/master thesis. The student will be expected to write a brief paper (approx. 2000 words) (1) giving the background, (2) stating the hypothesis or research question, (3) outlining the method, and (4) discussing how suitable the method is for testing the hypothesis or answering the research question. At the end of the course students will be required to present the finished essay at a meeting using PowerPoint slides.

The TaMoS part of the course is built up by eleven video lectures, three mandatory seminars, and one mandatory meeting. As a part of the continuous examination here are non-mandatory

quizzes in connection to these lectures which can earn bonus points, valid for the exam and the re-exam of the period.

Lecture notes and literature are available at the "AF2023: Theory and methodology of science and risk and safety analysis in building sciences HT19" event on Canvas, in the Part I: Reading and lecture notes section. The main book is Sven Ove Hansson's *The Art of Doing Science,* available online.

The seminars start on week 46 and end on week 48. The seminars will expand on and detail some of the concepts from the lectures. The seminars will be graded Pass/Fail.

There will be one seminar each week that you will have to attend. **When the course starts you will be assigned a seminar group**. The seminars will be held on times, given below, but at only one of those times each week will you have to attend:

TaMoS	Sem 1	Seminar 1: Definitions, operationalizations and hypotheses	Wed. Nov. 11, 13-15 & 15-17	Q11, Q13, Q24	
TaMoS	Sem 2	Seminar 2: Designing an experiment	Wed. Nov. 18, 13-15 & 15-17	Zoom	
TaMoS	Sem 3	Seminar 3: Interpretation, Evidence & Analysis	Wed. Nov. 25, 13-15 & 15-17	Zoom	

Before each seminar you will have to take an online quiz and score at least 14 of 15 points before the deadline. The deadline is 13:15 Wednesday each seminar week. No late submissions allowed – failing means forfeiting the seat.

In this course you will write an essay about the methodological issues in the area of your future master thesis work. The deadline for choosing a topic and finding a supervisor is **November 13th**, but you are encouraged to choose as quickly as possible. Deadline for submitting the essay is **December 4th**. On Canvas, you can read more about the essay, and find contact information if you have questions.

You find the deadlines collected here:

- Select a topic
- Find a supervisor
- Submit topic and supervisor here on Canvas – Deadline Nov. 13, 2020
- Submit the essay - Deadline Dec. 4, 2020
- Prepare the seminar
- Participate in the seminar – Dec. 9-16, 2020
- Revise & re-submit the essay (if required)
- Start the master thesis work – Jan. or Feb. 2020

Contact tamos.courses@abe.kth.se questions concerning this part of the course.

Syllabus, R&S Part. Part is given by the department of Civil & Architectural Engineering

The overall aim of this part of the course is to get a basic theoretical understanding on how the partial factors in the Eurocodes, which are used in the design of structural and geotechnical design, have been derived and are influenced from uncertainties and requirements of safety levels.

The course includes:

- Methods for safety analysis of buildings and structures
- Maintenance from a safety perspective
- Safety in bridges and structures
- Geotechnical uncertainties – above and below ground
- Tools for analyzing geotechnical safety and reliability
- Influence on safety and reliability from correlation.

Teachers in TaMoS Part:

Till Grüne-Yanoff – grune@kth.se

John Cantwell – cantwell@kth.se

Tor Sandqvist – tosa@kth.se

Seminar teachers in TaMoS Part:

Martin Rissler – martin.rissler@abe.kth.se

Johan Berg – jgberg@kth.se

Edvin Åström – edvina@kth.se

Henrik Lundvall – henrik12@kth.se

Course administration in TaMoS Part – tamos.courses@abe.kth.se

Teachers in R&S Part:

Structures

Johan Silfwerbrand, professor – jsilfwer@kth.se, course coordinator

Shicheng Li, PhD student, shicheng@kth.se

Geotechnical Engineering

Fredrik Johansson, assoc. professor – fredrik.johansson@byv.kth.se

Johan Spross, researcher – johan.spross@byv.kth.se

Course secretary (for registration issues, etc.):

student@byv.kth.se

Written exams

TaMoS exam (TENA)

The grading on TaMoS subpart: Exam consists of three subparts. Subpart I: 15 questions, multiple choice. Several options might be correct for each question. Subpart II: Two 5 point questions. Subpart III: Students choose between three questions.

During the course students can earn bonus points. Bonus points, 5 points in total, will be added to your score on part 1, up to the maximum limit of 15 points on part 1.

By completing only part 1 and part 2, a student can get the following grades: C, D, E, FX and F.

Part 3 will be graded A, B or C. This part will only be corrected if you have received the grade C from parts 1 and 2. This part will be graded according to the grading criteria (see below). This part will not be graded using points, and bonus points will therefore not be added to this part. More detailed exam information can be found on Canvas.

Grades are given as follows, all requirements needs to be fulfilled for each grade. A: Subpart I: 4, Subpart II: 3, Subpart III: 4, total: 20. B: subpart I: 4, Subpart II: 3, Subpart III: 3, total: 17. C: Subpart I: 4, Subpart II: 2, Subpart III: 3, total: 15. D: Subpart I: 4, Subpart II: 2, Subpart III: 2, total: 13. E: Subpart I: 4, Subpart II: 1, Subpart III: 1, total: 11. FX: Subpart I: 4, Subpart II: 1, Subpart III: 1, total: 9. F: Lower score than passing on any subpart, or lower total score than E.

Date: Wednesday, January 13, 2020, 8.00 – 12.00. **Halls:** W37, W38, W2, W43.

Risk & safety exam (TENB)

The grading on Risk & Safety exam (TENB) is based on the total number of points. The minimum points required for the grading are the following (total points = 24): 22 points A; 19 B; 17 C; 14 D; 11 E; 10 FX.

Date: Friday, January 15, 2020, 8.00 – 10.30. **Halls:** B22, D42, L31, L42, Q1.

Please, note, that each student will receive an individual location for the exam. This will be e-mailed to the student's KTH e-mail prior to the exam. Don't use automatic forwarding of e-mails to a private e-mail address since the current KTH e-mail system does not allow such automatic forwarding.

Final grade in the entire course AF2023

The following grading combinations of TENA and TENB lead to the following resulting grade of the entire course:

AA gives A; AB, BB give B; AC, AD, BC, BD, CC give C; AE, BE, CD, CE, DD give D; DE, EE give E; one or two FX give possibilities to FX exam(s).

Literature on Theory & Methodology of Science

S O Hansson: "The Art of Doing Science" (available on Canvas).

Additional texts, slides and lecture scripts, (available on Canvas).

Literature on Risk & Safety

Course book:

- H Sundquist: "Safety, Loads and Load Distribution on Structures", TRITA-BKN, Report 108, SEK 125 (can be purchased at Student office, Brinellvägen 23, and PDF file available on Canvas).

Additional mandatory reading (available on Canvas):

- A Krounis & F Johansson: "The influence of correlation between cohesion and friction angle on the probability of failure for sliding of concrete dams." In Proceedings of Risk analysis, Dam Security and Critical Infrastructure Management, 2012, pp. 75-80.
- A Krounis & F Johansson: "Estimation of the probability of failure of a gravity dam for the sliding failure mode." In Proceedings of XI ICOLD benchmark workshop on numerical analysis of dams, Valencia, October 20-21, 2011.
- J Spross, L Olsson & H Stille, 2018: "The Swedish Geotechnical Society's Methodology for Risk Management: a Tool for Engineers in Their Everyday Work." Georisk 12(3), 183-189.
- J Spross, L Olsson, S Hintze & H Stille: "Would risk management have helped? – A case study." In Proceedings of International Symposium on Geotechnical Safety and Risk V, Rotterdam, October 2015, pp. 745-751.
- Slides and lecture scripts, available on Canvas.

Other reading material (not mandatory)

- S Larsson, J Spross, W Bjureland & R Ignat: "Tar husbyggare geoteknisk säkerhet på allvar?" Samhällsbyggaren nr 3, 2016, s. 30-31 (available on Canvas).
- H Stille, J Andersson & L Olsson: "Information Based Design in Rock Engineering", SveBeFo Rapport 61 (available on Canvas).
- SGF. 2014. Risk Management in Geotechnical Engineering Projects – requirements. Report 1:2014E. SGF: Linköping (available on Canvas).

Annex A – Learning aims & Grading criteria, TaMoS part

Learning aims

Efter genomgången kurs ska studenten kunna

Lärandemål 1:
Identifiera definitioner och beskrivningar av begrepp, teorier och problemområden, samt identifiera den korrekta applikationen av dessa begrepp och teorier.
Learning outcome 1:
Identify definitions and descriptions of concepts, theories and problem areas, as well as identify the correct application of these concepts and theories.

Lärandemål 2:
Redogöra för begrepp, teorier och generella problemområden, samt tillämpa begrepp och teorier på specifika fall.
Learning outcome 2:
Account for concepts, theories and general problem areas, as well as apply concepts and theories to specific cases

Lärandemål 3:
Kritiskt diskutera definitionerna och tillämpningarna av begrepp och teorier med avseende på specifika fall av vetenskaplig forskning.
Learning outcome 3:
Critically discuss the definitions and applications of concepts and theories as they apply to specific cases of scientific research.

Grading criteria

	Lärandemål 1: Identifiera definitioner och beskrivningar av begrepp, teorier och problemområden, samt identifiera den korrekta applikationen av dessa begrepp och teorier. ***Learning outcome 1:*** *Identify definitions and descriptions of concepts, theories and problem areas, as well as identify the correct application of these concepts and theories.*	**Lärandemål 2:** Redogöra för begrepp, teorier och generella problemområden, samt tillämpa begrepp och teorier på specifika fall. ***Learning outcome 2:*** *Account for concepts, theories and general problem areas, as well as apply concepts and theories to specific cases*	**Lärandemål 3:** Kritiskt diskutera definitionerna och tillämpningarna av begrepp och teorier med avseende på specifika fall av vetenskaplig forskning. ***Learning outcome 3:*** *Critically discuss the definitions and applications of concepts and theories as they apply to specific cases of scientific research.*
A	Studenten identifierar **ett flertal** av definitioner och beskrivningar av begrepp, teorier och problemområden korrekt samt identifierar den korrekta tillämpningen av dessa begrepp och teorier. *The student identifies **multiple** definitions and descriptions of concepts, theories and problem areas, and identifies the correct application of these concepts and theories.*	Studenten redogör korrekt, samt med **stor utförlighet** och precision för kursbegrepp, teorier och problemområden samt gör rimliga tillämpningar av dessa begrepp och teorier på ett **mycket övertygande sätt**. *The student provides correct, **extensive** and precise accounts for concepts, theories and general problem areas, and provides **very convincing** applications of those concepts and theories to specific cases.*	Studenten framställer en **välargumenterad** diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning på ett utförligt, **självständigt** och **mycket precist** sätt. *The student presents a **well-argued, independent,** extensive and **very precise** discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research.*
B		Studenten redogör korrekt och med **precision** för kursbegrepp, teorier och problemområden samt gör rimliga	Studenten framställer en **huvudsakligen välargumenterad** diskussion av definitionerna och tillämpningarna av

		tillämpningar av dessa begrepp och teorier på ett **övertygande sätt**. *The student provides correct and **precise** accounts for concepts, theories and general problem areas, and provides **convincing** applications of those concepts and theories to specific cases.*	begrepp och teorier med avseende på vetenskaplig forskning på ett **utförligt** och precist sätt samt med **viss självständighet** i framställningen. *The student presents an **extensive,** precise**, mostly well-argued**, and **somewhat independent** discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research.*
C		Studenten redogör **korrekt och tydligt** för kursbegrepp, teorier och problemområden samt gör **rimliga tillämpningar** av dessa begrepp och teorier på specifika fall. *The student accounts, **correctly and clearly** for concepts, theories and general problem areas, and provides **reasonable applications** of these concepts and theories to specific cases**.***	Studenten framställer en diskussion av definitionerna och tillämpningar av begrepp och teorier med avseende på vetenskaplig forskning på ett **precist** sätt med **ansats till argumentation och självständighet**. *The student presents a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research in a **precise way** with an **attempt at independent and argumentative** reasoning.*
D		Studenten redogör **i huvudsak korrekt** och med **tillräckliga beskrivningar** av kursbegrepp, teorier och problemområden och gör acceptabla tillämpningar av dessa begrepp och teorier på specifika fall. *The student provides mostly correct and **sufficiently satisfactory** accounts of concepts, theories and general problem areas, and provides acceptable applications of these concepts and theories to specific cases**.***	Studenten framställer en diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning **utan större felaktigheter eller motsägelser**. *The student presents a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research **without substantial errors or contradictions**.*
E		Studenten redogör **med knapphändiga beskrivningar i huvudsak korrekt** för kursbegrepp, teorier och problemområden och gör **acceptabla tillämpningar** av begrepp och teorier på specifika fall. *The student provides **sparse, but mostly correct** accounts of concepts, theories and general problem areas and provides **acceptable** applications of those concepts and theories to specific cases**.***	Studenten framställer en diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning **som knapphändig, eller i enstaka fall felaktig eller motsägelsefull.** *The student presents a **sparse** discussion of the definitions and applications of concepts and theories, as they apply to specific cases of scientific research, with **some notable errors or contradictions**.*
FX		Studentens redogörelser av kursbegrepp, teorier och problemområden **är markant inkorrekta eller mycket knapphändiga**. Studentens tillämpningar av begrepp och teorier på specifika fall är **delvis inkorrekta.** *The student's accounts of concepts, theories and general problem areas are **very sparse or contains substantial errors**. The student's applications of those concepts and theories are **partially incorrect**.*	Studenten gör en **ansats** till att diskutera definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning, men framställningen är **markant otydlig, felaktig eller motsägelsefull**. *The student presents an **attempt** at a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research, but the discussion is **substantially unclear, wrong or contradictory**.*
F	Studenten identifierar som mest **enstaka** definitioner och beskrivningar av begrepp, teorier och problemområden korrekt eller identifierar inte	Studentens redogörelser av kursbegrepp, teorier och problemområden **saknas eller är** (mestadels eller helt) **inkorrekta** och tillämpningarna av begrepp och teorier på	Studenten **genomför inte** en diskussion av definitionerna eller inte av tillämpningen av kursbegreppen, eller så är dennes diskussion **otydlig, felaktig eller motsägelsefull**.

	den korrekta tillämpningen av dessa begrepp och teorier. *The student identifies at most a few definitions and descriptions of concepts, theories and problem areas, or does not identify the correct application of these concepts and theories.*	specifika fall **saknas eller är i stor utsträckning felaktiga**. *The student's accounts of concepts, theories and general problem areas are (substantially or completely)* ***incorrect or missing****. The student's applications of those concepts and theories are* ***largely incorrect or missing****.*	*The student* ***does not present*** *a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research, or their discussion is* ***unclear, wrong or contradictory****.*

Annex B – Learning aims & Grading criteria, R&S part

Learning aims

After completing the course, the student should be able to analyse risk and safety related issues concerning buildings and civil engineering structures.

Grading criteria

For grade E

- Describing the fundamental principles in a structured and probability based risk management in construction projects
- Using probability based methods for solving relatively simple risk-oriented problems for buildings and civil engineering structures

For grade C

- Using probability based methods for solving more advanced risk-oriented problems for buildings and civil engineering structures
- Applying the fundamental principles for a structured and probability based risk management in construction projects

For grade A

- Evaluating risk-oriented issues for buildings and civil engineering structures by using probability based methods
- Analysing risks in construction projects based on a deep understanding of the theoretical principles for a structured risk management