Teaching Guide				
Identifying Data				2023/24
Subject (*)	Damage and Restoration of Stonework Structures		Code	630567122
Study programme	Mestrado Universitario en Rehabilitación Arquitectónica (Plan 2016)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First	Optional	3
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Construcións e Estruturas Arquitectónicas, Civís e AeronáuticasEnxeñaría Civil			
Coordinador		E-mail		
Lecturers		E-mail		
Web	fv.udc.es			
General description	After completing the course, the student will be able to identify, assess and deal effectively with the usual problems that masonry structures may present within the context of rehabilitation work. In order to develop these capacities, the necessary knowledge will be provided regarding the identification of injuries that occur in masonry structures, their assessment and treatment, the diagnosis of the pathology linked to the masonry structure and the basic intervention techniques on the structural elements of masonry, complementing this knowledge with the bibliography and existing regulations. These contents will be exposed in the theory classes. To ensure that the student is able to properly apply this knowledge, a series of practical classes are proposed that will deal with the presentation and debate of a series of practical cases complemented by carrying out a specific work on the subject. This work that will be related to the professional activity of the architect and technical architect within the specific content of this subject.			

Study programme competences / results	
Code	Study programme competences / results
A4	E04 - Aptitude ou capacidade para intervir no patrimonio edificado con valor histórico, aspecto que engloba a coordinación do seu estudo e a súa investigación documental, a elaboración de plans directores de conservación e a redacción e dirección da execución de proxectos de restauración e rehabilitación.
A5	E05 - Aptitude ou capacidade para a conservación da obra pesada, mediante a inspección, a análise, o control de calidade, a definición das condicións de mantemento e a estimación da seguridade das estruturas de edificación, incluídas as súas posibles cimentacións, podendo igualmente afrontar a redacción de proxectos de reparación e reforzo, e a dirección da execución asociada.
A7	E07 - Aptitude ou capacidade para a conservación da obra grosa e acabada, cuestión que comporta a inspección, a análise, o control de calidade, a definición das condicións de mantemento e a intervención nos sistemas construtivos de edificación, incluídos os elementos de compartimentación interior, as carpintarías e as solucións de envolvente.
A8	E08 - Aptitude ou capacidade para redactar informes técnicos e proxectos de rehabilitación do patrimonio edificado, incluídas actividades de asesoramento e consultoría.
A10	E10 - Aptitude ou capacidade para utilizar criterios de sustentabilidade ambiental na elección de materiais e na definición de solucións técnicas, abranguendo o uso e a integración de sistemas activos e pasivos.
B2	CB7 - Que os estudantes saiban aplicar os coñecementos adquiridos e a súa capacidade de resolución de problemas en contornos novos ou pouco coñecidos dentro de contextos máis amplos (ou multidisciplinares) relacionados coa súa área de estudo.
B3	CB8 - Que os estudantes sexan capaces de integrar coñecementos e enfrontarse á complexidade de formular xuízos a partir dunha información que, sendo incompleta ou limitada, inclúa reflexións sobre as responsabilidades sociais e éticas vinculadas á aplicación dos seus coñecementos e xuízos.
B5	CB10 - Que os estudantes manexen as habilidades de aprendizaxe que lles permitan continuar estudando dun modo que haberá de ser en gran medida autodirixido ou autónomo.
C1	T01 - Capacidade de análise e síntese
C2	T02 - Capacidade de organización e planificación
C6	T06 - Resolución de problemas
C7	T07 - Toma de decisións

C8	T08 - Aprendizaxe autónoma
C9	T09 - Creatividade
C11	T11 - Visión espacial
C12	T12 - Comprensión numérica
C13	T13 - Intuición mecánica
C14	T14 - Sensibilidade estética
C15	T15 - Cultura histórica

Learning outcomes			
Learning outcomes	Study programme competences / results		
Dominar as propiedades mecánicas das fábrica eas diferentes solucións estructurales coherentes con elas.	AJ5 AJ7	BJ2	CJ1
Habilitar ao alumno para a identificación e rexistro dos distintos tipos de lesións que se poden dar nas estruturas de fábrica	AJ8	BJ3	CJ6 CJ7
Coñecer as distintas técnicas de reparación e adecuación de estruturas de fábrica, así como a súa idoneidad	AJ5 AJ7 AJ8 AJ10	BJ3	CJ1 CJ6 CJ7 CJ9
Coñecer a evolución histórica das estruturas de fábrica e as dimensións alcanzadas.	AJ4	BJ5	CJ11 CJ13 CJ14 CJ15
Dominar diversas situacións particulares dos muros de fábrica na rehabilitación	AJ5 AJ7	BJ3	CJ12 CJ13 CJ14 CJ15
Coñecer os criterios estructurales aplicados ao longo da Historia.	AJ4 AJ7	BJ5	CJ8
Habilitar ao alumno para a realización de estudos básicos de equilibrio de bóvedas de fábrica.	AJ5 AJ8	BJ3	CJ12 CJ13 CJ14
Capacitar ao alumno para peritar unha estrutura a base de arcos de dovelas de fábrica	AJ5 AJ8	BJ3	CJ12 CJ13
Capacitar ao alumno para a planificación e desenvolvemento da inspección de estruturas de fábrica, así como para as actuacións deriva	AJ5 AJ7 AJ8	BJ2	CJ2
Presentar os criterios de cálculo propostos por diferentes normativas e referencias bibliográficas de fábrica e capacitar ao alumno para a escoller o método de cálculo adecuado ao problema a resolver	AJ5 AJ10	BJ5	CJ8

Contents	
Topic	Sub-topic
1. PRINCIPLES FOR INTERVENTION IN MASONRY STRUCTURES	1.1 Introduction 1.2 Structural Principles 1.3 Materials and Techniques
2. THE MASONRY: THE MATERIAL AND THE BUILDING	2.1 Types of masonries. 2.2 Characteristics and mechanical properties. 2.3 General organization of the building. Particular equilibrium solutions. 2.4 Representation of masonry structures. Special features

3. SYMPTOMATOLOGY: MECHANICAL INJURIES IN THE MASONRIES	3.1 Introduction. Deformations, stresses, cracks and fissures 3.2 Injuries derived from foundation failures 3.3 Injuries of mechanical origin 3.4 Interpretation of injuries 3.5 Specific injuries to facades and partition walls 3.6 Representation of injuries
4. CHECKS OF THE MASONRY STRUCTURE. CALCULATION METHODS	4.1 Introduction. Limit states in masonry structures. 4.2 Assessment of bearing capacity. 4.3 Methods for calculating standards and other references on factories. App. 4.4 Structural evaluation of masonry heritage buildings
5. REPAIR TECHNIQUES	5.1 Action measures on an existing building 5.2 Classifications of repair techniques 5.3 Study of techniques 5.4 Representation criteria
6. STUDY OF THE ARCHES	6.1 Origin, Types and Construction of arches 6.2 Stability and collapse of isolated arches 6.3 Combined bows 6.4 Arch survey 6.5 Arch injuries
7. INTRODUCTION TO THE STUDY OF MASONRY VAULTS	7.1 Types and construction of masonry vaults 7.2 Cracks in masonry vaults 7.3 Simplified study of equilibrium: Ungewitter tables and segment analysis 7.4 Injuries in Masonry Vaults
8. SPECIFIC ASPECTS OF MASONRY WALLS	8.1 Opening holes in masonry walls 8.2 Collapses in walls and towers 8.3 Specific problems of Foundations: load increases and modification of gradients
9. HISTORICAL EVOLUTION OF CALCULATION METHODS. THE RULES	9.1 Historical rules 9.2 Development of scientific analysis 9.3 From treatises to regulations

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Introductory activities	A4 C15	1	0	1
Diagramming	B2 C2 C7	1	1	2
Case study	A5 A7 C1 C8 C14	6	6	12
Workbook	A4 A10 B5 C1 C8	0	8	8
Guest lecture / keynote speech	A4 A5 C6 C12 C13 C14 C15	12	12	24
Problem solving	A8 B2 B3 C6 C9 C11	1	1	2
Supervised projects	A5 B3 C9 C11 C12 C13 C14	0	20	20
Events academic / information	B5 C1 C2 C8	0	3	3
Personalized attention		3	0	3
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Introductory activities	A presentation of the subject is made, explaining its interest, operation and objectives. A personalized theoretical questionnaire is carried out that tries to reveal the student's starting knowledge

Diagramming	At the beginning of each class, a diagramming of the content to be developed, its need and its fit into the degree is made. In this way, the logic of the topic is evidenced and the contents can be related within the knowledge map of the subject
Case study	Students are confronted with a specific real case, with an important structural content, which describes a real situation in professional life. The student must be able to analyse a series of facts, referring to the intervention on masonry structures to reach a reasoned decision through a process of discussion in class directed by the teacher, propose a performance and confront it with the one carried out in the reality.
Workbook	Readings. Acquisition of a general conceptual framework by reading texts, questions regarding the intervention on structures, as well as deepening on the various topics of the program and others that may be specifically interesting, due to the particular conditions of the work to be carried out.
Guest lecture / keynote speech	Master session Set of classes and conferences in which the expository work of the rapporteur (teacher and / or lecturer) is essential, work that is carried out with the support of the T.I.C. They consist of the development of the various topics on the agenda. The student must get used to handling the recommended bibliography of the subject, which can be found in the ETSA library, counting as support with the class outline available in the virtual faculty. The continuous monitoring of the theoretical classes is a requirement of the subject that is considered fulfilled with the attendance to 80% of the classes at least
Problem solving	The teacher will solve exercises oriented towards future professional practice, encouraging student participation in their partial or total resolution. The result will be presented in a way that is clearly visible, indicating the numerical value with the corresponding precision and units. The most common mistakes that are usually made will be explained, evaluating them according to their severity, both conceptual and numerical.
Supervised projects	Tutored work Students - either in groups or individually depending on the specific topic - carry out work that involves the use of the techniques developed in the theoretical classes, identifying in the practical reality the contents of the theoretical exposition. Photographs, diagrams, plans and freehand texts will be used. They are a fundamental component for the final grade.
Events academic / information	Activities carried out by students that involve attendance and participation in scientific and informative events (congresses, conferences, symposia, courses, seminars, conferences, exhibitions, etc.) with the aim of deepening their knowledge of topics related to matter. These activities provide the student with current knowledge and experiences that incorporate the latest developments in the field of study.

Personalized attention	
Methodologies	**Description**

Supervised projects Case study Introductory activities	Introductory activities / Initial activities The initial questionnaire checks the previous knowledge of each student. As a consequence of its result, there may be cases in which readings are recommended to reinforce the initial knowledge. Study of cases The discussion of the practical cases will be moderated by the teacher, forcing the participation of all students - although it is not intended that all do so with the same intensity. Supervised projects (Tutored work) The student will demonstrate the effective monitoring of the subject by attending tutorials in which the development of the proposed work will be controlled, in which the contents presented in the classroom and in the basic and / or complementary bibliography will be applied This work will be complemented with the completion of the proposed exercises. Attendance and activity carried out will be controlled With regard to students who, according to the regulations governing dedication to study, are considered part-time students, a flexible attendance regime will be established by common agreement with the teacher that implies at least attendance to classes. case study, replacing the rest with the preparation of one or more previously agreed works. Carrying out supervised work is mandatory in any case.

Assessment			
Methodologies	Competencies / Results	Description	Qualification
Supervised projects	A5 B3 C9 C11 C12 C13 C14	Valoración del trabajo desarrollado	60
Problem solving	A8 B2 B3 C6 C9 C11	Asistencia	9
Guest lecture / keynote speech	A4 A5 C6 C12 C13 C14 C15	Asistencia	5
Case study	A5 A7 C1 C8 C14	Participación en las discusiones desarrolladas en el estudio de los casos	24
Introductory activities	A4 C15	Asistencia	1
Diagramming	B2 C2 C7	Asistencia	1
Others			

Assessment comments
The subject is structured in part theoretical and part practical, this one with a more personalized treatment. In the theoretical classes the expository work of the teacher is predominant. This work is completed with the presentation of practical cases related to the theoretical topics presented. For the effective use of the subject, it is essential to monitor it continuously, estimating that this is fulfilled with an attendance equal to or greater than 80%. The evaluation of the students will be carried out by evaluating a practical work developed by them once the minimum attendance has been covered. Their involvement in the practical cases discussed and the resolution of the practices carried out in class will also be taken into account. If this practical work is not presented, the assigned grade will be Not Presented.These same criteria will be applied to the second opportunity and early call.With regard to students who, according to the regulations governing dedication to study, are considered part-time students, the percentage of marks assigned to activities in which these students are not present will be applied to the assessment of substitute activities. planned. Carrying out supervised work is mandatory in any case.

Sources of information

Basic	- AA.VV. (2005). Actas II Congreso Internacional Antiguos espacios para nuevos tiempos. El material pétreo y sus fábricas en el patrimonio. Santiago - Monjo Carrió-Maldonado Ramos (2001). Patología y técnicas de intervención en estructuras arquitectónicas.. Munilla-Lería - Ortega Andrade, F. (1999). La obra de fábrica y su patología. C. O. A. Canarias - AA.VV. (1998). Tratado de Rehabilitación. Tomo 3. Patología y técnicas de intervención. Elementos estructurales.. UPM - Munilla-Lería - Lozano Apolo, G. et alli (1995). Curso de Técnicas de Intervención en el Patrimonio Arq. Tomo II. Reestructuración de Edificios de Muros de Fábrica.. C.O.A.yA.T. A Coruña - Heyman, J (1995). Teoría, historia y Restauración de Estructuras de Fábrica.. CEHOPU-Instituto Juan de Herrera-CEDEX - AA.VV. (1991). Curso de Patología. Conservación y Restauración de edificios. Tomo 1.. C.O.A. Madrid - López Collado, G. (1976). Ruinas en Construcciones antiguas. Causas, consolidaciones y traslados.. Madrid - I. E. T. C. C. (1971). PIET 70. Obras de Fábrica.. Madrid - Lahuerta Vargas, J. (1984). Rehabilitación de Obras de Fábrica. Curso de Rehabilitación. Tomo 5. La Estructura. C.O.A.Madrid - Heyman, J. (1999). El esqueleto de Piedra.. CEHOPU-Instituto Juan de Herrera-CEDEX - Huerta, S. (2004). Arcos, bóvedas y cúpulas. Geometría y equilibrio en el cálculo tradicional de estructuras de fábrica. Instituto Juan de Herrera-CEHOPU - Palaciones Gonzalo, J.C. (2009). La Cantería Medieval. La construcción de la bóveda gótica española. Munilla-Lería - Croci, G. (2000). The conservation and Structrual Restoration of Architectural Heritage. Computational Mechanics Publications
Complementary	- Heyman, J. (2015). Teoría, historia y Restauración de Estructuras de Fábrica. Volumen II. CEHOPU-Instituto Juan de Herrera-CEDEX - Heyman, J. (1982). The Masonry Arch. Elis Horwood Series in Engineering Scienca - Fortea Luna, M. & López Bernal, V. (1998). Bóvedas Extremeñas. Proceso constructivo y análisis estructural de bóvedas de arista. C.O.A. Extremadura - Heyman, J. (2001). La ciencia de las estructuras. Instituto Juan de Herrera - Mas-Guindal Lafarga, A.J. (2011). Mecánica de las estructuras antiguas. Cuando las estructuras no se calculaban.. Munilla-Lería - Thunnissen, H.J.W. (1950 (2012)). Bóvedas: su construcción y empleo en la arquitectura. Instituto Juan de Herrera

Recommendations
Subjects that it is recommended to have taken before
Building Inspection/630567110 Construction Assemblies Inspection/630567109
Subjects that are recommended to be taken simultaneously
Inspección e Recalce de Cimentacións/630426116 Patoloxía dos Materiais/630467121
Subjects that continue the syllabus
Modelos Avanzados para a Análise Estrutural de Edificios Históricos/630467104 Patoloxía e Recuperación de Estruturas de Madeira/630467118
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.