Teaching Guide				
Identifying Data				2023/24
Subject (*)	Damage and Restoration of Stonework Structures		Code	630548021d
Study programme	Máster Universitario en Rehabilitación Arquitectónica (a distancia)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First	Optional	3
Language	Spanish			
Teaching method	Non-attendance			
Prerequisites				
Department	Construcións e Estruturas Arquitectónicas, Civís e AeronáuticasEnxeñaría Civil			
Coordinador	Freire Tellado, Manuel Jose	E-mail	manuel.freire.tellado@udc.es	
Lecturers	Freire Tellado, Manuel Jose	E-mail	manuel.freire.tellado@udc.es	
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	
Code	Study programme competences
A4	E04. Aptitud o capacidad para intervenir en el patrimonio edificado con valor histórico, aspecto que engloba la coordinación de su estudio e investigación documental, la elaboración de planes directores de conservación, y la redacción y dirección de ejecución de proyectos de restauración y rehabilitación
A5	E05. Aptitud o capacidad para la conservación de la obra pesada, mediante la inspección, el análisis, el control de calidad, la definición de las condiciones de mantenimiento, y la estimación de la seguridad de las estructuras de edificación, incluyendo sus posibles cimentaciones, pudiendo igualmente afrontar la redacción de proyectos de reparación y refuerzo, y la dirección de ejecución asociada
A7	E07. Aptitud o capacidad para la conservación de la obra gruesa y acabada, cuestión que conlleva la inspección, el análisis, el control de calidad, la definición de las condiciones de mantenimiento, y la intervención en los sistemas constructivos de edificación, incluyendo los elementos de compartimentación interior, las carpinterías y las soluciones de envolvente
A8	E08. Aptitud o capacidad para redactar informes técnicos y proyectos de rehabilitación del patrimonio edificado, incluyendo actividades de asesoramiento y consultoría
A10	E10. Aptitud o capacidad para utilizar criterios de sostenibilidad medioambiental en la elección de materiales y en la definición de soluciones técnicas, abarcando el uso y la integración de sistemas activos y pasivos
B2	CB07. Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio
B3	CB08. Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios
B5	CB10. Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.
C1	T01. Capacidad de análisis y síntesis
C2	T02. Capacidad de organización y planificación
C6	T06. Resolución de problemas
C7	T07. Toma de decisiones

C8	T08. Aprendizaje autónomo
C9	T09. Creatividad
C11	T11. Visión espacial
C12	T12. Comprensión numérica
C13	T13. Intuición mecánica
C14	T14. Sensibilidad estética
C15	T15. Cultura histórica

Learning outcomes			
Learning outcomes	Study programme competences		
Master the mechanical properties of the masonry and different structural solutions consistent with them.	AJ5 AJ7	BJ2	CJ1
Enable the student to identify and record the different types of injuries that can occur in masonry structures	AJ8	BJ3	CJ6 CJ7
Know the different techniques for repairing and adapting masonry structures, as well as their suitability	AJ5 AJ7 AJ8 AJ10	BJ3	CJ1 CJ6 CJ7 CJ9
Know the structural criteria applied throughout history.	AJ4 AJ7	BJ5	CJ8
Know the historical evolution of factory structures and the dimensions reached.	AJ4	BJ5	CJ11 CJ13 CJ14 CJ15
Master various particular situations of masonry walls in rehabilitation	AJ5 AJ7	BJ3	CJ12 CJ13 CJ14 CJ15
Enable the student to carry out basic studies of equilibrium of masonry vaults.	AJ5 AJ8	BJ3	CJ12 CJ13 CJ14
Train the student to assess a structure based on masonry voussoir arches	AJ5 AJ8	BJ3	CJ12 CJ13
rain the student for the planning and development of the inspection of factory structures, as well as for the actions derived from	AJ5 AJ7 AJ8	BJ2	CJ2
Present the calculation criteria proposed by different regulations and factory bibliographical references and enable the student to choose the appropriate calculation method for the problem to be solved.	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	Ordinary class hours	Student?s personal work hours	Total hours
Diagramming	B2 C2 C7	1	2	3
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 C6 C9 C11	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
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. In an on-line format, this methodology is carried out through synchronous sessions, using the university's videoconferencing platform and the study of the documentation hosted on Moodle. 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	Study of cases In the distance modality, the discussion of the practical cases will be carried out through the delivery of an analysis document on each of the analyzed examples. Supervised projects (Tutored work) The student will demonstrate the effective follow-up of the subject by attending tutorials in which the development of the proposed work will be controlled, in which the presented contents and in the basic and / or complementary bibliography will be applied This work will be complemented by carrying out the proposed exercises. Attendance and activity carried out will be controlled

Assessment			
Methodologies	Competencies	Description	Qualification
Supervised projects	A5 B3 C6 C9 C11	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	25
Diagramming	B2 C2 C7	Asistencia	1
Others			

Assessment comments
The course is structured in a theoretical part and a practical one, this part with a more personalized treatment. In the theoretical classes, the expository work of the teacher is preponderant, although in this modality in an asynchronous way. This work is completed with the exposition of practical cases related to the exposed theoretical subjects. For the effective use of the subject, continuous monitoring of it is essential, considering that this is fulfilled by overcoming the controls of the proposed theoretical content and the delivery of the analysis papers on the practical cases developed. The evaluation of the students will be carried out through the assessment of a practical work developed by them once the previous monitoring criterion has been passed. If this practical work is not presented, the grade assigned will be Not Presented. These same criteria will apply to the second opportunity and advanced call. Carrying out supervised work is mandatory in any case.Plagiarism. In accordance with article 11, section 4 b), of the Disciplinary Regulations for UDC students, the detection of plagiarism, as well as the fraudulent performance of tests or evaluation activities, once verified, will directly imply the grade of failing "0" in the subject in the corresponding call, thus invalidating any grade obtained in all evaluation activities.

Sources of information	
Basic	- Croci, G. (2000). The conservation and Structrual Restoration of Architectural Heritage. Computational Mechanics Publications - AA.VV. (1991). Curso de Patología. Conservación y Restauración de edificios. Tomo 1.. C.O.A. Madrid - AA.VV. (2005). Actas II Congreso Internacional Antiguos espacios para nuevos tiempos. El material pétreo y sus fábricas en el patrimonio. Santiago - Heyman, J (1995). Teoría, historia y Restauración de Estructuras de Fábrica. CEHOPU-Instituto Juan de Herrera-CEDEX - 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 - 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 - López Collado, G. (1976). Ruinas en Construcciones antiguas. Causas, consolidaciones y traslados. Madrid - 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 - Monjo Carrió, J. (coord) (2001). Tratado de Rehabilitación. Tomo 3. Patología y técnicas de intervención. Elementos estructurales. UPM - Munilla-Lería - Monjo Carrió, J. & Maldonado Ramos, L. (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 - Palaciones Gonzalo, J.C. (2009). La Cantería Medieval. La construcción de la bóveda gótica española. Munilla-Lería

Complementary	- Fortea Luna, M. & López Bernal, V. (1998). Bóvedas Extremeñas. Proceso constructivo y análisis estructural de bóvedas de arista. C.O.A. Extremadura - Heyman, J. (1982). The Masonry Arch. Elis Horwood Series in Engineering Scienca - Heyman, J. (2001). La ciencia de las estructuras. Instituto Juan de Herrera - Heyman, J. (2015). Teoría, historia y Restauración de Estructuras de Fábrica. Volumen II. CEHOPU-Instituto Juan de Herrera-CEDEX - 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.