| Teaching Guide | | | |
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| Identifying Data | | | 2024/25 |
| Subject (*) | Sructural Analysis of Historical Buildings | Code | 630548017 |
| Study programme | Máster Universitario en Rehabilitación Arquitectónica | | |

| Descriptors | | | | |
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| Cycle | Period | Year | Type | Credits |
| Official Master's Degree | 2nd four-month period | First | Optional | 3 |

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| Language | Spanish | | |
| Teaching method | Face-to-face | | |
| Prerequisites | | | |
| Department | Construcións e Estruturas Arquitectónicas, Civís e AeronáuticasEnxeñaría Civil | | |
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| Lecturers | Martín Gutiérrez, Emilio | E-mail | emilio.martin@udc.es |
| Web | moodle.udc.es | | |
| General description | The focus of the subject is oriented to the practical application of numerical methods in stability and structural behavior studies related to buildings with historical value and rehabilitation works in general. Thus useful instrumental skills are developed in expert work or when comparatively assessing the incidence of different intervention alternatives. | | |

| Study programme competences / results | |
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| Code | Study programme competences / results |
| 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 |
| A8 | E08. Aptitud o capacidad para redactar informes técnicos y proyectos de rehabilitación del patrimonio edificado, incluyendo actividades de asesoramiento y consultoría |
| B1 | CB6. Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación |
| B2 | CB7. 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 |
| B4 | CB09.Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades |
| C1 | T01. Capacidad de análisis y síntesis |
| C4 | T04. Conocimientos de informática relativos al ámbito de estudio |
| C5 | T05. Capacidad para la gestión de la información |
| C6 | T06. Resolución de problemas |
| C12 | T12. Comprensión numérica |
| C13 | T13. Intuición mecánica |

| Learning outcomes | | | |
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| Learning outcomes | Study programme competences / results | | |
| Acquire generic knowledge of instrumental techniques for auscultation and monitoring of historical constructions. | AJ5<br>AJ8 | | |
| Become familiar with the use of tools that facilitate the tasks of inspection and technical control, and that can be used to analyze the repercussions to be taken into account when faced with a specific intervention. | AJ5<br>AJ8 | BJ1<br>BJ2 | CJ4<br>CJ6<br>CJ12<br>CJ13 |

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| Deepen the study of the mechanical behaviour of the masonry work and the models that allow its analytical characterization to be addressed. | AJ5<br>AJ8 | | |
| Propose an approach to the structural diagnosis techniques of buildings with historical value and rehabilitation works in general, using computer applications based on the programming of numerical methods. | AJ5<br>AJ8 | BJ1<br>BJ2 | CJ4<br>CJ6<br>CJ12<br>CJ13 |
| Encourage the development of autonomous attitudinal capacities: a tendency to continuous learning, ability to solve problems effectively, capacities for analysis and synthesis, organization and personal planning, productive management of documentation, and use of information and comunication technologies. | | BJ4 | CJ1<br>CJ5 |

| Contents | |
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| **Topic** | **Sub-topic** |
| Principles, techniques and tools for data collection. | |
| Complementarity of instrumental and analytical techniques. | |
| Mechanical behaviour of the masonry work. | |
| Numerical simulation techniques. | |

| Planning | | | | |
|---|---|---|---|---|
| **Methodologies / tests** | **Competencies / Results** | **Teaching hours (in-person & virtual)** | **Student?s personal work hours** | **Total hours** |
| Guest lecture / keynote speech | A5 B1 B2 | 12 | 12 | 24 |
| Workshop | A5 B1 B2 C4 C6 C12 C13 | 9 | 13.5 | 22.5 |
| Problem solving | A5 B1 B2 C4 C6 C12 C13 | 0 | 5 | 5 |
| Supervised projects | A5 A8 B1 B2 B4 C1 C4 C5 C6 C12 C13 | 0 | 22.5 | 22.5 |
| Personalized attention | | 1 | 0 | 1 |
| **(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.** | | | | |

| Methodologies | |
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| **Methodologies** | **Description** |
| Guest lecture / keynote speech | An exhibition methodology complemented by audiovisual means is applied in order to significantly illustrate the contents treated and to facilitate their understanding.<br>However, and independently of the above, during these sessions the aim is to achieve a certain quota of participation by the students, enhancing their involvement, promoting feedback on the process (and therefore the two-way nature of communication), and energizing the learning mechanisms through interaction techniques. |
| Workshop | The exercise is proposed through guided practices developed with computer means.<br>It contemplates the acquisition of an operational methodology based on practical assumptions with an increasing level of complexity. |
| Problem solving | Practical tests are proposed, in which specific problematic situations have to be faced, designed from the previously worked content. |

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| Supervised projects | The teaching methodology is basically oriented according to the criterion of learning in action, in order to enhance the acquisition of specific skills. In this context, the elaboration of a comprehensive work takes center stage, where the professional skills of the subject come together, therefore linked to the use of numerical analysis applications, with others of a transversal nature, such as, among others, the search for documentation (often making use of new technologies), the organization and planning of activities, the management of information, or oral and written expression. Schematically, the following steps are distinguished: topic selection, preparation of a generic work script, on-site examination, photographic report, planimetric survey, location and consultation of reference sources, construction and adjustment of models, interpretation of results, and writing a final report that covers the entire work. Given the supervised nature of the same, regular follow-up sessions must be held with the teaching staff, in order to optimize or, where appropriate, redirect the activities in progress. |

| Personalized attention | |
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| **Methodologies** | **Description** |
| Supervised projects | Given the specificity of the contents linked to the subject, and the different level of computer training with which students can access it, it is understood to be crucial to articulate personalized attention mechanisms that attend to possible singularities. To this end, the development of face-to-face tutorials and consultations through the resources of the virtual platform is used. |

| Assessment | | | |
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| **Methodologies** | **Competencies / Results** | **Description** | **Qualification** |
| Supervised projects | A5 A8 B1 B2 B4 C1 C4 C5 C6 C12 C13 | Its development is fully understood individually and of a non-presential nature. In order to guarantee the authorship of the work, and the adequate acquisition of competences, in its evaluation the successive control sessions are considered relevant, and therefore the degree of compliance in relation to the indications formulated in each case by the teaching staff. Other aspects to assess are: the depth and rigor of development; the search for information sources; the relationships built between the different sections; analysis and synthesis capabilities; the correction of the methodological study, the constructive and structural diagnosis, the modeling and the appropriate conclusions; argumentation; and the grammatical, graphic and technical quality of the final documentation. | 100 |

| Assessment comments |
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| As in the other subjects that make up this postgraduate degree, attendance is also required not less than 80% relative to all the scheduled face-to-face sessions.This requirement will have no effect with students who have recognized part-time dedication according to the Norm that regulates the regime of dedication to study and the permanence and progression of undergraduate and master's students at the UDC.Any finding of plagiarism or relevant breach of the conditions established for the development of deliveries and/or exams will result in a failure grade (0) in the matter and in the corresponding call, invalidating any assessment obtained in all previous assessment activities, facing subsequent calls. |

| Sources of information |
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| **Basic** | Hendry, A.W, 1998. Structural Masonry. Macmillan.León, J., 2000. Planteamiento del análisis estructural. Identificación de modos de fallo y criterios de decisión.Lombillo, I., Villegas, L., Silió, D., Hoppe, C., 2008. Evaluación no destructiva del patrimonio construido. Revista Internacional Construlink 16, 40?53.Lourenco, P.B. Gaetani, A., 2022. Finite element analysis for building assessment. Advanced use and practical recommendations. Routledge.Macchi, G., 1992. Diagnosis estructural y rehabilitación de edificios históricos, Cuadernos INTEMAC. INTEMAC, Madrid.Martínez, J.L., Martín-Caro, J.A., León, J., 2001. Comportamiento mecánico de la obra de fábrica, Monografías sobre el análisis estructural de construcciones históricas de fábrica. Universidad Politécnica de Madrid, Madrid.Schuller, M.P., 20003. Nondestructive testing and damage assessment of masonry structures. Prog. Struct. Engng Mater. 5, 239?251. doi:10.1002/pse.160Vázquez M., López, E., 2001. El método de los elementos finitos aplicado al análisis estructural. Noela, Madrid.Bibliografía |

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| Complementary | A. Zucchini, Lourenco, P.B, 2007. Mechanics of masonry in compression: Results from a homogenisation approach. Computers & Structures 85, 193?204. doi:10.1016/j.compstruc.2006.08.054Alawadhi, E.M, 2010. Finite element simulations using Ansys. CRC Press, Boca Raton.Álvarez de Buergo, M., González, T., 1994. Restauración de edificios monumentales: estudio de materiales y técnicas instrumentales. Centro de Estudios y Experimentación de Obras Públicas, Madrid.Anzani, A, L. Binda, Mirabella, G., 2000. The effect of heavy persistent actions into the behaviour of ancient masonry. Materials and Structures 33, 251?261. doi:10.1007/BF02479335Arede, A., Costa, A., 2002. Inspecção e Diagnóstico Estrutural de Construções Históricas. Algumas contribuições da FEUP. Presented at the 1o Seminário quot;A Intervenção no Património. Práticas de Conservação e Reabilitação.Asteris, P.G, 2008. On the structural analysis and seismic protection of historical masonry structures. 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First historical, experimental and numerical investigations. Presented at the Historical constructions 2001: possibilities of numerical and experimental techniques, Guimarães, pp. 431?444.Betti, M., Galano, L, 2012. Seismic Analysis of Historic Masonry Buildings: The Vicarious Palace in Pescia (Italy). Buildings 2, 63?82. doi:10.3390/buildings2020063Binda, L., Baronio, G., Palma, M., Penazzi, D., n.d. Il patrimonio storico architettonico ed il terremoto: la diagnosi e gli interventi di recupero. Località di roccanolfi di preci e montesanto di sellano: redazione di schede per il rilievo tipológico e dei danni sismici agli edifici.Binda, L., Cantini, L., Fernandes, F., Saisi, A., Tedeschi, C., Zanzi, L., 2004. Diagnostic investigation on the historical masonry structures of a castle by the complementary use of non destructive techniques. Presented at the 13 th International Brick and Block Masonry Conference, Amsterdam.Binda, L., Cardani, G., Saisi, A., Valluzzi, M.R, 2006. Vulnerability analysis of the historical buildings in seismic area by a multilevel approach. Asian Journal of Civil Engineering (Building and Housing) 7, 343?357.Binda, L., Modena, C., Baronio, G., Abbaneo, S., 1997. Repair and investigation techniques for stone masonry walls. Construction and Building Materials 11, 133?142. doi:10.1016/S0950-0618(97)00031-7Binda, L., Saisi, A., 2009. Application of NDTs to the diagnosis of Historic Structures. Presented at the NDTCE?09, Non-Destructive Te sting in Civil Engineering, Nantes, France.Binda, L., Saisi, A., 2005. Research on historic structures in seismic areas in Italy. Prog. Struct. Engng Mater. 7, 71?85. doi:10.1002/pse.194Binda, L., Saisi, A., 2004. Il ruolo delle indagini nella diagnostica strutturale.Binda, L., Saisi, A., 2001a. Mechanical damage due to long term behaviour of multiple leaf pillars in Sicilian Churches. 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WIT Press, Southampton; Boston.Brebbia, C.A, International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture (Eds.), 2009. Structural studies, repairs and maintenance of heritage architecture XI. WIT, Southampton.Brebbia, C.A, International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture (Eds.), 2007. Structural studies, repairs and maintenance of heritage architecture X. WIT, Southampton.Brebbia, C.A, International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture (Eds.), 2005. Structural studies, repairs and maintenance of heritage architecture IX. WIT, Southampton; Boston.Brebbia, C.A, International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture (Eds.), 2003. Structural studies, repairs and maintenance of heritage architecture VIII. WIT, Southampton.Brebbia, C.A, International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture (Eds.), 2001. Structural studies, repairs, and maintenance of historical buildings VII. WIT Press, Southampton, UK; Boston.Brebbia, C.A, Jäger, W., International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture (Eds.), 1999. Structural studies, repairs and maintenance of historical buildings VI. WIT, Southampton; Boston.Brebbia, C.A, Leftheris, B., International Conference on Structural Repair and Maintenance of Historical Building (Eds.), 1995. Structural studies, repairs and maintenance of historical buildings IV. Computational Mechanics.Brignola, A., Frumento, S., Lagomarsino, S., Podestà, S., 2008. Identification of Shear Parameters of Masonry Panels Through the In-Situ Diagonal Compression Test. International Journal of Architectural Heritage 3, 52?73. doi:10.1080/15583050802138634Buyukozturk, O, NDTMS (Symposium) (Eds.), 2013. Nondestructive testing of materials and structures. Springer, Dordrecht; New York.Calabresi, G., Fattorini, M., 2003. Safety assessment of the foundations of the Basilica of Maxentius in Rome. Transactions on the Built Environment 66.Cámara, L., Latorre, P., 2003. El Modelo Analítico Tridimensional obtenido por fotogrametría. Descomposición, manipulación y aplicaciones en el campo de la restauración arquitectónica. Arqueología de la Arquitectura 2, 87?96.Carpinteri, A., Invernizzi, S., Lacidogna, G., 2009. Historical brick-masonry subjected to double flat-jack test: Acoustic emissions and scale effects on cracking density. Construction and Building Materials 23, 2813?2820. doi:10.1016/j.conbuildmat.2009.03.003Carpinteri, A., Invernizzi, S., Lacidogna, G., 2007. 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| Recommendations |
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| Subjects that it is recommended to have taken before |
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| Subjects that are recommended to be taken simultaneously |
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| Subjects that continue the syllabus |
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| Other comments |
| Certain skills are required in the use of computer-aided design tools, as well as elementary knowledge about the theoretical bases of the finite element method. |

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