

Titolo Italiano: Analisi strutturali di archi e volte in muratura (3CFU; 24 ore)

Titolo Inglese: Structural analysis of masonry arches and vaults (3CFU; 24 hours)

Course description

Masonry curved elements – such as arches, domes and vaults – represent one of the most widespread structural typologies in the historical buildings. Their stability is due to their shape and self-weight magnitude and distribution.

This course has the scope of introducing the main approaches for the analysis of their stability and safety and the design of repairing and strengthening interventions.

After a historical introduction on the typologies characterizing masonry curved structures, the traditional rules of art used in the past centuries for the design of the shape and of the geometry of the constitutive elements (arch thickness, buttress height and width, etc.) are discussed.

Both the classical and advanced analysis methods for arches and vaults are reviewed. Particular attention is devoted to the Limit Analysis (LA) approach based on the Heyman's assumptions for the masonry material.

Some of the main theories for modelling arches and vaults are presented. In particular the catenary equation, the funicular polygon, the membrane theory of shells and the generalized eccentricity method are introduced as modelling tools for the analysis of arches and vaults. Then, some criteria for the assessment of the structural safety, both under vertical loads and under earthquake actions are discussed and applied to practical examples.

Finally, a vast part of the course is devoted to the Thrust Network Analysis (TNA) of masonry vaults, a computational technique for the limit analysis of masonry vaults subjected to both vertical and horizontal loadings. With this regard some case studies are presented regarding the analysis of real masonry arches and vaults. Finally, a MATLAB code that implements the specialization of the TNA to the case of planar arches is presented and discussed.

Course program

#	Date	Time	Topics	Teacher
1	3 Febr.	15.00-18.00	Introduzione al corso e validazione storica del teorema statico <i>Course introduction and historical validation of the safe theorem.</i>	Marmo Francesco
			Sezioni non reagenti a trazione. Analogia della catenaria. Poligono funicolare. <i>No tension cross section. Catenary analogy. Funicular polygon.</i>	
2	5 Febr.	15.00-18.00	Archi e volte in muratura: inquadramento storico, tipologie e regole dell'arte <i>Masonry arches and vaults: historical overview, typologies, and rules of art</i>	Brandonisio Giuseppe
			Metodi di calcolo classici e moderni per l'analisi di archi e volte in muratura <i>Classical and advanced analysis methods for masonry arches and vaults</i>	
3	10 Febr.	15.00-18.00	Curva funicolare. Equazione della catenaria. <i>Funicular curve. Catenary equation.</i>	Marmo Francesco
			Analisi della curva di spinta. Codice MATLAB. Forma ideale degli archi. <i>Thrust line analysis. MATLAB code. Ideal shape of arches.</i>	
4	12 Febr.	15.00-18.00	L'analisi limite degli archi in muratura e le ipotesi di Heyman <i>Limit analysis of masonry arches and Heyman's assumptions</i>	Brandonisio Giuseppe
			Sicurezza statica di archi e volte in muratura <i>Static assessment of masonry arches and vaults</i>	
5	17 Febr.	15.00-18.00	Superficie funicolare. Teoria membranale dei gusci (MTS). <i>Funicular surface. Membrane theory of shells (MTS).</i>	Marmo Francesco
			Soluzione della TMG mediante il metodo delle differenze finite. <i>Solution of the MTS by the finite difference method.</i>	
6	19 Febr.	15.00-18.00	Il comportamento sismico di archi e volte in muratura: dall'analisi del danno ai metodi di analisi strutturale <i>Seismic behaviour of masonry arches and vaults: from the damage to the analysis methods</i>	Brandonisio Giuseppe
			Analisi sismica degli archi e volte in muratura <i>Seismic assessment of masonry arches and vaults</i>	
7	24 Febr.	15.00-18.00	Analisi del reticolo di spinta (TNA) per l'analisi di volte in muratura <i>Thrust network analysis (TNA) of masonry vaults</i>	Marmo Francesco
			Casi studio per l'applicazione della TNA. <i>Case studies for the application of the TNA.</i>	
8	26 Febr.	15.00-18.00	Valutazione della sicurezza sismica di archi e volte in muratura: applicazioni <i>Seismic assessment of masonry arches and vaults: applications</i>	Brandonisio Giuseppe
			Effetto della geometria ed efficacia degli interventi di adeguamento sismico di archi e volte in muratura <i>The role of geometry and effectiveness of seismic retrofit of arches and vaults</i>	