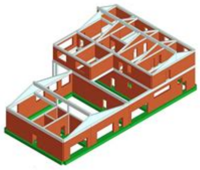

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The TREMURI program, based on the equivalent frame modelling approach, includes several macroelement models for the simulation of masonry and nonmasonry structural members. TREMURI allows performing nonlinear static and dynamic analyses of complete 3D building models with an optimal compromise between accuracy and computational burden, also providing a clear understanding of the results. Discover everything Scribd has to offer, including books and audiobooks from major publishers. Start Free Trial Cancel anytime. Report this Document Download Now save Save TREMURI Research Manual For Later 552 views 1 1 upvote 0 0 downvotes TREMURI Research Manual Uploaded by George Ar Avha Description Manual research version of 3muri Full description save Save TREMURI Research Manual For Later 1 1 upvote, Mark this document as useful 0 0 downvotes, Mark this document as not useful Embed Share Print Download Now Jump to Page You are on page 1 of 58 Search inside document Browse Books Site Directory Site Language English Change Language English Change Language. Two software with different modeling approaches were employed with the purpose of comparing and discussing the results. SismiCad12 was used to simulate the structural behavior of the historic masonry building. SismiCad12 uses the Finite Element Method FEM that allows to model and analyze most types of 3D structures, and it is suitable for masonry structures. On the other hand, a different and innovative modeling approach called Frame Macro Elements FME was also applied using the 3Muri software, specially designed for assessing the linear, nonlinear, and seismic behavior of masonry structures. Assuming the same hypothesis to construct the 3D model of the structure in each code, the results of the static analysis show a different distribution of the vertical loads in the structure, which are more realistic in the FEM modeling.http://radiantnepal.com/userfiles/comcrypt-4000m-user-manual.xml

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On the other hand, in dynamic analyzes, FME modeling is more receptive to reality, involving a massive percentage of masses participating in the first vibration modes. Download fulltext PDF V ERSION F INAL Marzo 17, 2018. ABSTRACT In this project, a historic masonry building in Sardinia, Italy, has been con sidered as a case study for the comparison of two app roaches for modeling, static and seismic analysis. Two software with different modelin g approaches were employed with the purpose of co mparing and d iscussing the results. SismiCad12 was use d to simulate the structural behavior of the historic masonry building. SismiCad12 uses the Finite Element Met hod FEM that allows to model and analyze most types o f 3D structures, and it is suitab le for masonry structures. O n the o ther hand, a different and innovative m odeling app roach called Fra me Macro Elements FME was also applied using the 3Muri s oftware, specially designed for assessing the linear, no nlinear, and seismic behavior of masonry structures. On the other hand, in dynamic analyzes, FME modeling is more receptive to reality, involving a massive percentage of m asses participating in the first vibration modes. KEY WORDS Macroelements; historic structures; p ushover analysi s. RESUMEN En este proyecto se ha considerado como caso de estudio un edificio historico de mamposteria en Cerdena, Italia, cuyo modelado, analisis estatico y sismico han sido desarrollados. En este estudio se han empleado dos programas informaticos con distintos enfoques de modelizacion con el proposito de comparar y discutir los resultados. Como primer simulador del co mportamiento de la estr uctura en mamposteria se ha elegido SismiCad12, que es una suite de Elementos Finitos FEM, por sus siglas en ingle s que per mite modelar y a nalizar la mayoria de los tipo s de estructuras 3D y es adecuado p ara estructuras de mamposteria.http://www.tries.cz/media/images/upload/comcrypt-4000i-manual.xml

Por o tro lado, se ha aplicado un metodo de modelado diferente e innovador denominado Frame Macro Elements FME con el software 3Muri, disenado especificamente para evaluar el comportamiento lineal, no lineal y sismico de las estruct uras en mamposteria. Este diferente criterio de evaluacion de las cargas verticales lleva un mecanismo de “piso suave” en el analisis de pushover en el modelado FEM, y p or lo tanto un desplazamiento ultimo inferior correspondiente al colapso de la estructura. Por lo contrario, en los analisis dinamicos el modelado FME es mas receptivos a la realidad, involucrando un porcentaje masivo de masas particip antes ya en los primeros modos de vibracion. Both codes allow linear and nonlinear analysis with the P ushover Method provided by EC 8, as well as Italian national norms with the socalled NMethod. Plasticity is in both cases molded in concentrated form at the ends of the ele ments or macro elements. The building used as a case study Figure 1 is a historic masonry b uilding located in the historical downtown of the city of Sassari, Italy, dated back to the middle of the nineteenth century, inserted into an ag gregate context of historical buildings with s imilar characteristics and belonging to the same histor ical period. It is a very articulated structure that develops on four level s, characterized by massive irregularities of mass and stiffness in plan a nd height and with a large internal cavity that guarantees the illumination of the central part of the building. The building faces streets on two side s while the remaining walls are adjacent to the contiguou s buildings, one of which has been r ecently reconstructed, and therefore constitutes a structural unit of its own. A discussion is needed considering that often the professionals of the sector consider the results of a single calculation software, w hich could lead to inappropriate results or significantly different results fro m those that would give another software.

This work aims to evidence the criticalitie s that may arise in a seismic ana lysis of a geometrically complex case of study due to different ap proaches proposed by two commercial software. Figure 1. Exterior view of the historical masonry building in this case study a side facade; b front facade. 2. MATERIALS AND METHODS The wall structure is characterized by masonry panels o f considerable thickness, varying between 0.60 and 1.00 m, and stor y height ran ging between 4.00 and 5.00 m. The first level floors are almost exclusively made of barrel vaults, in perforated brick blocks; above the vaults is a loose or slightly loose filling. There are frenels on which a horizontal bricklayer rests, on which the screed, the substrate, and the paving itself weight. In the next two levels the floors are constructed through a system of Roman Va ults a pavilion vault dissected from a horizontal plane. As far as the roof is concerned, this i s a sloping ro of that is divided into three parts, with the height of the grid plan a lmost always at 2 m, compared to the attic level, with three different peak heights. The top r oof is made of traditional roof tiles. The wall structure is p redominantly made up o f soft stone slats limestone entrenched with cement mortar. a b The project resistances will be elaborated by taking into account the M security coe fficient and a corrective factor co rrecting the le vel of knowled ge gained in the said Confidence Factor. Considering load combination of the NTC called ultimate limit status SLU, by its initials in Italian the analysis of the floor loads is calculated 1 2 3 3 2 2 1 1 95. 11 kNm G G G Q 1 Where G 1 is the structural permanent load, G 2 is the non structural permanent load, G 3 the variable load, with their respective amplification coefficients .

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Once the necessary site visits and relief operations have been carried out, includin g some limited inspection tests aimed at the knowledge of the composition of the masonry and horizons, the two models have been developed with the two reference software. The level of knowledge that has been achieved has been very superficial LC1 because of the inability to conduct an extensive and exhaustive investigation ca mpaign. The reference seismic action was determined fro m the attribution of a 50year Use ful Reference Life VN, by its initials in Italian and a Use Class “II,” that is a class of importance as compared to the functions and the potential level of crowding. The geographic location of the building in the Italian territory allowed to identify the seismic zone seismic zone 4. Thus, the seismic baseline site h azards, represented in Italian law by the seismic parameters are reported in Table 2, regarding the States LifeSaving Limits SLV, by its initials in Italian, Damage SLD by its initials in Italian, and Oper ational SLO, by its initials in Italian Limit. Table 2 includes the probability values P VR, by its initials in Italian to ex ceed the seismic intensity in the reference period VR, by its initials in Italian, assumed which is 50 years, and allow to trace its ela stic response spectrum in acceleration and displacement of the horizontal components of the earthquake, taking into account a correction for geotec hnical and topographic features of the site under review. The effects of individual modes have b een combined based on the complete q uadratic combination CQC. For linear analysis particularly for the dynamic, the Sismicad12 code allows both frame modeling and modeling with 4 node 3D shell elements. Such force systems are concomitant with per manent vertical load s. Such force s ystems are concomitant with permanent vertical loads.

These forces are applied in the X direction and Y direction separately and incremented monotonically step by step until the local collapse o f the individual structural or global elements is reached to form a mechanism follo wing the formation of a number of plastic hinges. Global verification is carried out by moving, m onitoring the maximum displacement d c of a co ntrol point of the structure, generall y coinciding with the last level mass center. The F b d c diagrams plotted for the different scenarios represent the corresponding structures capacity curves. 3. RESULTS AND DISCUSSION 3.1. Out of plane for nonseismic actions check 3.1.1. Sismicad12. For the FEM calculation, a 3D s hell element modelin g with six degrees of freedom do f per node was adopted. Thus, assigning a maxi mum mesh size of 400x400 mm and o btaining a mathematical model with 23,903 nodes and 24,220 elements Figure 2. Figure 2. Sismicad12 simulation overview a FEM model; b 3D model. Source Own elaboration. The tensile framework o btained from the anal ysis is integrated into the mesh sections corresponding to the wall panels a utomatically by the postpro cessor in or der to perform the checks on the panels provided by EC 6, EC 8 and NTC. At this stage, th e primary SLU resistance tests are those offplane compression carried out according to the socalled method EC 6 and NTC, by defining structural and conventional eccentricities. The result of verifications in nonseismic scenarios highlights some aspects of the structure, particularly on the first level masonry columns and the f ourth level perimeter wall shown i n red in Figure 3, with projected stresses exceeding 40 % the resistances. Figure 3. Results of the review of the most critical sections a Section 1; b Section 2; c First floor. 3.1.2. 3Muri. In this case, modeling is perf ormed on the effects o f all types of a nalysis with macro ele ments, and the model is characterized by only 197 knots and 359 macro elements Figure 4.

Following the checks at the SLU, this structure is now verified under vertical loads with some minor issues spread in the first level. The same columns of the first level shown in Figure 3, even in 3Muri are not verified. However, the projected stresses ex ceeds the resistance by just 9 %, in this case. 3.2. Linear Dynamic analysis with response spectrum Both software allow to calculate the project response spectrum automatically by introducing the input d ata previously calculated and then deter mine the stresses for each mode.Source Own elaboration. 3.2.1. Sismicad12. The linear dynamic a nalysis was carried out by t he Sismicad12 program as defi ned by the NT C. A careful analysis considering a num ber of vibrational modes equal to 22, either in the X direction or in the Y direction, to involve a participating m ass 85 % is required by the regulations. The masses in Z direction are not taken into account by the soft ware. Table 3 sho ws only t he most significant values of the mas ses, concentrated between the vibration modes 19 and 22. Table 3. Results of Sismicad12 simulation. Mode Period s Mass X % Mass Y % 19 0.36 15.7 0.02 20 0.29 0.53 24.9 21

0.21 63.6 1.67 22 0.19 0.95 56.8 In this ca se, the rocking and shrinkage tests in the plan for seismic action are taken into acco unt in conjunction with vertical loads. The first level elements highlighted in red in Figure 5 are unverified. Figure 5. Firstlevel verification views. Regarding the white masonry piers, they do not meet the geometric req uirements req uired by the regulations. Therefore, they do not contribute to the resistance of the structure to seismic actions. Similar results have been found in the other levels. 3.2.2. 3Muri. The linear dynamic analysis was carried out by the 3Muri program as per the NT C.

Given the simplicity of modeling and the smaller number of GDLs in thi s case, it is satisfactory to consider a number of vibrational modes equal to 3 in the X direction and 2 in the Y direction to in volve a parti cipating mass 85 %. However, it is required by the NTC to consider modes to stimulate at least 5 % o f the participating mass. Analyzing the results, it ca n be seen here that t he structure fully satisfies t he press reflection and c utoff checks in the plan for seismic action Table 4. Table 4. Results of 3Muri simulation. The elements adopted are common beam elements with a formulation that takes into account the contribution of the shear deformation, connected by rigid br acts representing the nodal intersection zones of the males and planes, within which no deformations occur. The most critical capacitance curves obtained according to the approach described, it is in the X and Y directions are shown in Figure 6. The total number of combinations, and therefore the capacity curves taken into account is 8. b a It has been observed that in relation to the distribution o f vertical loads, the pertinence of the individual elements is processed differently by the algorithms of the two software. In any case, the similarity between the r esults of the checks is probably beca use in the case of study, and as is the case of historical buildings, the elements are considerably oversized over the loads. Conversely, if the build ing had been d imensioned in a more optimized way and closer to the verification limits, there would undoubtedly be more apparent difference s between the static tests of the two models. By analyzing the results of the dynamic analysis carried out with both models Tables 3 and 4, it c an be seen the vibrational modes along the X and Y directions have very different period s and masses of par ticipants, which results reasonably because of the disparity of the structure.

In Sismicad12 the modes of vibration 19 and 21 in the X direction, as well as 20 and 22 in the Y direction involve enormous participant masses compared to th e remaining vibration m odes. In fact, the first 18 modes are local and involve single walls, which are not very significant from a global point of view.This assumption was derived from t he analysis of the characteristics of the hedging structure, and it is not of a general nature. However, th ese vibration modes, while having a mass less t han 5 %, contribute to 85 % of the participating mass, and as envisaged by the legislation cannot be neglected, therefore they must be taken into account for the determination of the seismic action. With 3Muri software instead, in the first three modes of vibration, both in the X direction and Y direc tion, there are enormous participant masses that exceed the 85 % of the standard. The different modeling style bo th in terms of approach and complexity proposed by the two codes is, t herefore, a source of significant differences in dynamic analysis. In the light of the above, it seems inapp ropriate to compare the modes of vibratio n in the order of calculation but may better appropriate a comparison of the modes that involve more significant participatin g masses, which, as seen for both software, focus on 2 or 3 modes. In the case of 3Muri all the check s are verified, but in the ca se of Sismicad12, there are several negative tests, especially with shear in the plane. The difference in modeling approach, o n the other hand, also af fects mass distribution, for which a lumped approach is adopted, due to the different number of nodes offered by the two models.

By comparing the pushover analysis performed with the two models, considering the same control point, the last shift and the number of steps, it was noted that in the FEM approach of Sismicad12, 16 capacity curves are provided, of which 8 for group 1 and 8 for group 2 and considering directions X and Y, and eccentricity along X and Y. In FME modeling, instead, 24 capacity curves are provided, in addition to the previous, eight curves do not take into account the general eccentricity provided by the standards. As indicated by the NTCs, seismic action mus t be applied for each direction, in both possible d irections and the most unfavorable effects of t he two analyzes should be considered. Comparing the heavie st capacity curves presented by the t wo software, both in direction Y, one can see a marked difference in behavior Figure 8. While in the initial part of the case study curve there is a substantial equality, indicative of a similar representation of elastic stiffness, there is a significant difference in the evaluation o f the maximum cut in t he base of the last displace ment and the deca y of the capacity curve same. Figure 8. Comparison of capacity curves similarly loaded. The reason lies in the fact that S ismicad12 modeling shows the existence of a soft floor mechanism Figure 9, with the plasticization focused on the first level, causing a rapid decay of the overall structural ductility to achieve cutoff defor mations in the plane of the wall elements involved, while the walls of the overlying planes do not appear to be particularly affected by the boost.

22,49; 3280 47; 5900 0 1000 2000 3000 4000 5000 6000 7000 0 10 20 30 40 50 Fb kN dc mm Sismicad12 3Muri By analyzing the modeling perfor med by 3Muri, it can be observed that the mechanism that generates a decay of the structure capacity under the seismic shear action at the base Figure 10, results in t he achievement of local buckling mechanisms and the last relative displacement with contemporar y shear plasticization of several male wales, but rarely reaching the conventional breakdown or displacement provided by the NTC. A key role in such a marked difference in results is thought to be possible by the alr eady discussed mode of vertical co mputing actions that is a markedly different between the two software. The normal agent action dramatically influences the behavior under horizo ntal actions of the individual m urals, and therefore o f the overall behavior, to the extent that the higher the vertical load are, as is generally the case in the soft ware 3 Muri higher will be the shear and compression resistance of th e males, in the fie ld of low stresses. Viceversa, where it is lesser, as, in the Sismicad12 software, there is a predominant shear breakdown concerning the buckling action. Figure 10. Decay of the structure capacity of 3Muri in a representative section. Static checks reveal substantial differences in the e valuation of vertical action acti ng on individual wall elements due to a marked difference between th e two algorithms. Such checks seem to be more in line with reality if done with the model to the finite elements, in fact, this model allows to take into acco unt the effects of the mutual link, the mutual collabor ation betwee n walls of the box, and redistribution of stresses in a concrete w ay easily guessed that finds real practical consistency.

As far as modal analysis is co ncerned, there are reservations about the FEM method because the first 18 vibration modes have little significance because they are initially considered to be the single walls of th e last level. It would seem, moreover, that the FME model provides results that are more responsive to reality, involving a very m assive percentage of participants already in the first modes of vibration, as would have been expected. In the pushover analysis, the appearance of the soft floor mechanism in Sismicad12 and the different evaluation of the vertical loads between t he two software lead to qualitatively and q uantitatively differe nt results, especially regarding last shift. Lastly, it is concluded that the modeling of existin g masonry buildings is particularly complex and burdensome. Commercial soft ware provides reasonable approximations of the actual behavior of the structures, bu t it is cruc ial to have a high level of knowledge of the structure, to know the modeling types adopted, to recognize its limits and to understand the results. Therefore, a comprehensive awareness and caution by the operator are needed, necessary to understand and better define the output results of the software itself. 5. ACKNOWLEDGEMENT This project has been funded with support o f the European Commission.Being built before the introduction of proper seismic code provisions, this unreinforced masonry building could be representative of many other vulnerable historic buildings in earthquakeprone urban areas. First, a simplified model of the global seismic response was analyzed according to the LV1 assessment level provided by the Italian Guidelines on Cultural Heritage. The results obtained using old and updated versions of these guidelines were compared.

A good agreement was revealed with reference to the detection of the weaker direction and the prevailing failure mechanism, but some differences were found about the calculation of the base shear capacity and the corresponding ground acceleration. Then, the achieved results were compared with those obtained using a more refined approach of nonlinear static analysis according to the LV3 assessment level. The results were reported in terms of damage and collapse mechanisms of masonry walls, pushover curves and seismic safety indexes. A further comparison was carried out between the model with flexible horizontal structures and that with the assumption of all the floor diaphragms as completely rigid. Although the two assessment methods LV1 and LV3 are not alternative to each other, since belonging to two different levels of evaluation, some critical issues were addressed in order to derive useful information on the reliability and the limits of validity of the simplified mechanical model, characterized by a forcebased approach. View Show abstract Resistencia de vigas esbeltas de acero inoxidable bajo cargas concentradas mediante analisis por elementos finitos Article Fulltext available Jun 2017 Asdrubal Jose Ayestaran Carlos Graciano Octavio Andres Gonzalez Estrada El uso de acero inoxidable en estructuras ha cobrado fuerza en los ultimos anos debido a su gran relacion costobeneficio en el tiempo, brindando una gran proteccion a la corrosion, resistencia al fuego y una resistencia a la fluencia mayor que la brindada por los aceros estructurales de uso comun en la industria. A pesar de este incremento en su uso todavia existe cierto grado de incertidumbre y desconocimiento de sus aplicaciones, pues los codigos de diseno de acero enfocan su atencion en el acero estructural.

Por lo tanto, en el presente trabajo se reportan los resultados del estudio numerico de vigas esbeltas de acero inoxidable utilizado en puentes, sometidos a carga concentrada con el objeto de aumentar el estado del arte de esta aplicacion en particular. Un modelo por elementos finitos es construido tomando en cuenta el comportamiento no lineal del material y las imperfecciones iniciales deflexiones en el alma y esfuerzos residuales. Finalmente, se obtiene que el uso del acero inoxidable presenta ventajas en su comportamiento postcritico respecto a paneles geometricamente similares de acero estructural, permitiendo la optimizacion estructural de vigas esbeltas para puentes. View Show abstract Seismic Risk Assessment of Historic Masonry Towers Comparison of Four Case Studies Article Mar 2017 J PERFORM CONSTR FAC Gianni Bartoli Michele Betti Silvia Monchetti This paper focuses on the seismic risk assessment of historic masonry towers according to the Italian “Guidelines for the Assessment and Mitigation of the Seismic Risk of the Cultural Heritage.” The latter identifies a methodology of analysis based on three different levels of evaluation, according to increasing requirements on the structural knowledge LV1 analysis at territorial level, LV2 local analysis, and LV3 global analysis. Regardless of the methodology of analysis, the more advanced the achieved level of knowledge, the higher the reliability of these approaches becomes. In this field, a fundamental task is the estimation of the uncertain parameters both material properties and boundary conditions affecting the structural behavior.

The effect of these uncertainties on the global structural response is herein approachedThe seismic risk of these towers was analyzed in the framework of Seismic Risk of Monumental Buildings RiSEM is the Italian acronym, a research project granted by the Tuscany Regional Administration, and this paper summarizes the results obtained for two of the preceding three levels, which highlights a few issues concerning the seismic risk of historic masonry towers. Useful conclusions are drawn in order to quantify, when performing an LV3 approach through nonlinear models, the effects of the uncertainties on the seismic risk evaluation of such structural typology. The paper, in particular, confirms once more how strongly the effect of confinement reflected on tower seismic performances and stresses that specific attention should be paid to the definition of the effective portion of the structure to be considered as confined with respect to adjacent buildings. View Show abstract External Jacketing of Unreinforced Historical Masonry Piers with OpenGrid BasaltReinforced Mortar Article Nov 2016 J COMPOS CONSTR Pelin Elif Mezrea Irem Ylmaz Medine Ispir Alper Ilki Existing unreinforced masonry buildings in seismically active regions are in urgent need of consolidation and preservation against seismic action to prevent damage and loss of financial resources. In this research, an experimental study of externally confined brick masonry piers, which are frequently preferred as loadbearing elements in historical buildings, was conducted. The confinement system included a combination of opengrid basalt textile and mortar. Eighteen masonry pier specimens were produced using solid bricks collected from a historical building constructed in approximately the 1930s and a local mortar with substandard mechanical characteristics to simulate mortar properties in existing heritage buildings.

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