



PROGETTO MAR VASTO
“Manejo de riesgos en Valparaiso”
Conferenza finale del Progetto BID



Chiesa e Convento di San Fransisco, Cerro Baron, Valparaiso, Chile
29 Settembre 2008

L'investigazione sulle tre chiese (San Francisco,
Hermanas de La Providencia, La Matriz):
indagine di vulnerabilità

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Dipartimento di Costruzioni e Trasporti
Università di Padova – Italia





**IGLESIA DEL SALVADOR
MATRIZ DE VALPARAISO**



**IGLESIA SAN FRANCISCO
DEL BARON**

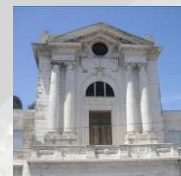


**CAPILLA DE LAS HERMANAS
DE LA PROVIDENCIA**

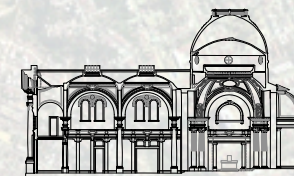
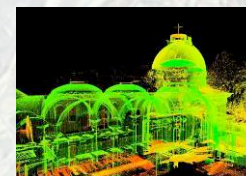


Metodologia di studio:

1. Rilievo fotografico

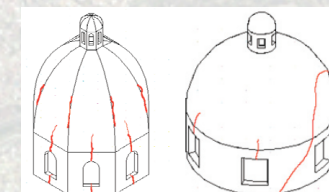


2. Rilievo laser scanner ed elaborazione dei dati

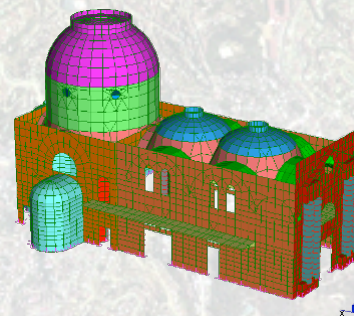


3. Rilievo mediante la 'Scheda Chiese':

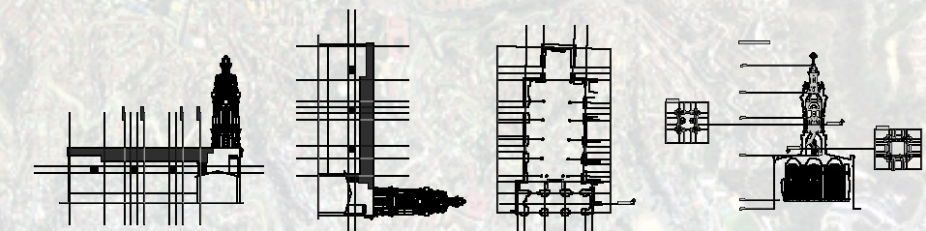
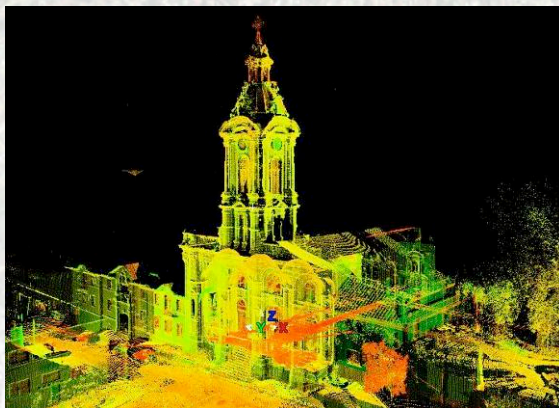
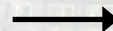
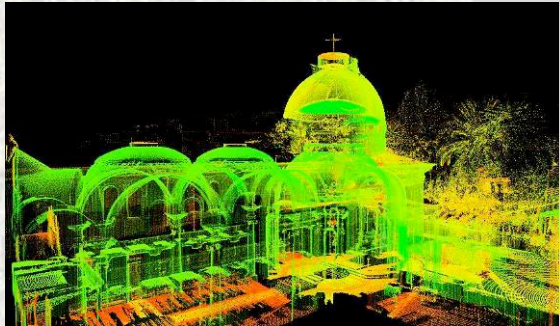
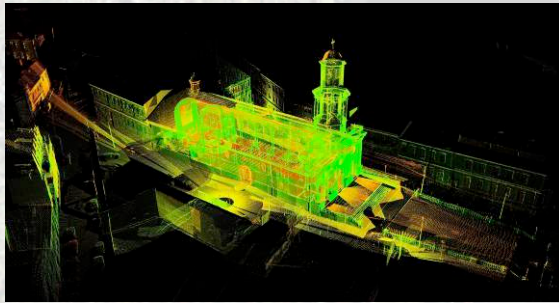
- rilievo delle strutture e dei materiali
- rilievo del danno (quadro fessurativo)
- studio della vulnerabilità



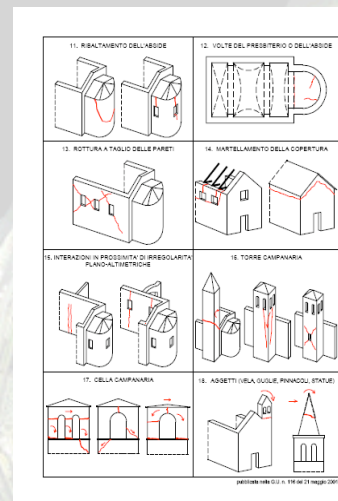
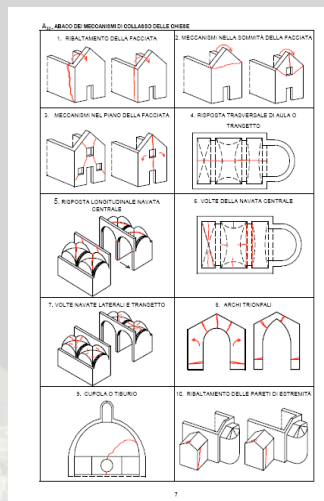
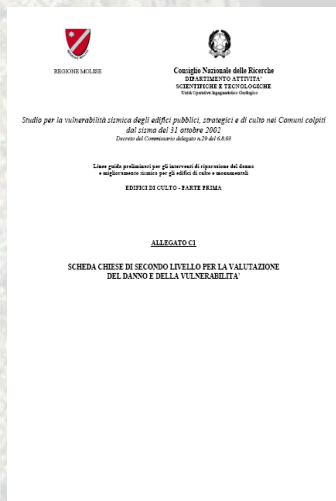
4. Calcolo strutturale



1)



2)



Parametri	
1) Ribaltamento della facciata	10) Ribaltamento delle pareti di estremità
2) Meccanismi nella sommità della facciata	11) Ribaltamento dell'abside
3) Meccanismi nel piano della facciata	12) Volte del presbiterio o dell'abside
4) Risposta trasversale di aula o transetto	13) Rottura a taglio delle pareti
5) Risposta longitudinale navata centrale	14) Martellamento della copertura
6) Volte della navata centrale	15) Interazioni in prossimità di irregolarità plano-altimetriche
7) Volte navate laterali e transetto	16) Torre campanaria
8) Archi trionfali	17) Cella campanaria
9) Cupola o tiburio	18) Aggetti (Vele guglie, pinnacoli, statue)

Presenza del macroelemento in relazione al meccanismo: Si No

Vulnerabilità	Si	No	<i>Presidi antisismici</i>	
	<input type="checkbox"/>	<input type="checkbox"/>	Presenza di catene longitudinali	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Presenza di efficaci elementi di contrasto (contrafforti, corpi addossati, altri edifici)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Ammorsamento di buona qualità tra la facciata ed i muri della navata	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Danno	Si	No	<i>Indicatori di vulnerabilità</i>	
	<input type="checkbox"/>	<input type="checkbox"/>	Presenza di elementi spingenti (puntoni di copertura, volte, archi)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Presenza di grandi aperture nelle pareti laterali in vicinanza del cantonale	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	attuale		Distacco della facciata dalle pareti o evidenti fuori piombo	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	vecchio		Distacco della facciata dalle pareti o evidenti fuori piombo	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

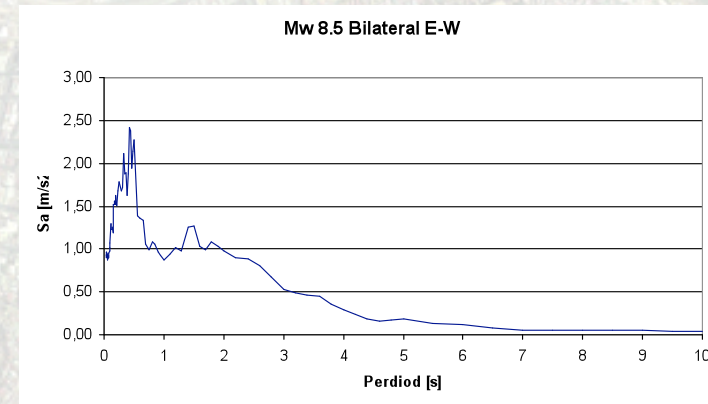
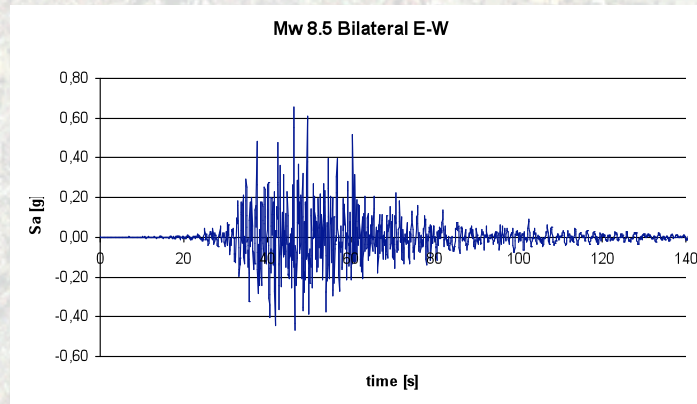
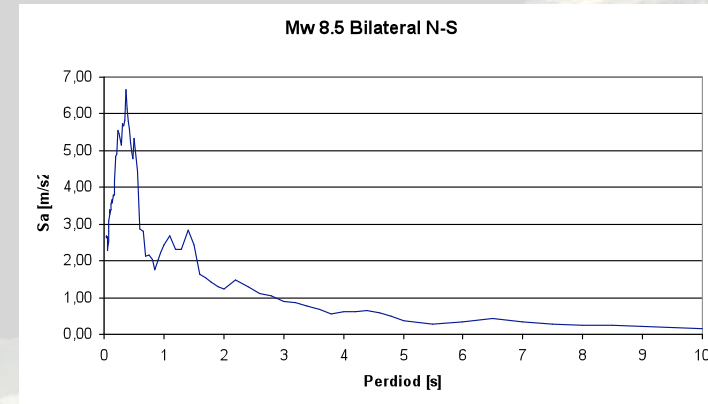
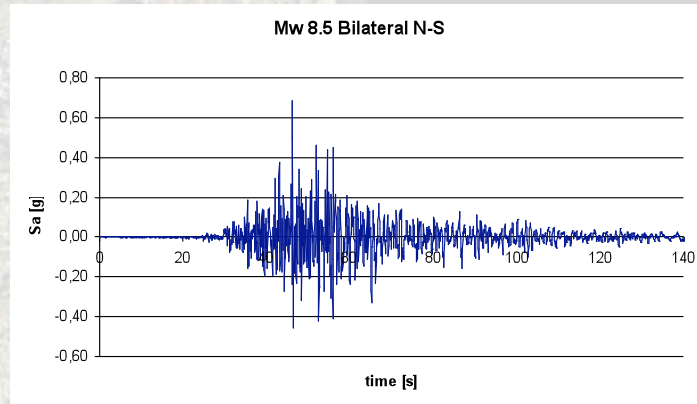
$$i_d = \frac{1}{5} \frac{\sum_{k=1}^N \rho_k d_k}{\sum_{k=1}^N \rho_k}$$

indice di danno

$$i_v = \frac{1}{6} \frac{\sum_{k=1}^{28} \rho_k (v_{ki} - v_{kp})}{\sum_{k=1}^{28} \rho_k} + \frac{1}{2}$$

indice di vulnerabilità

3)



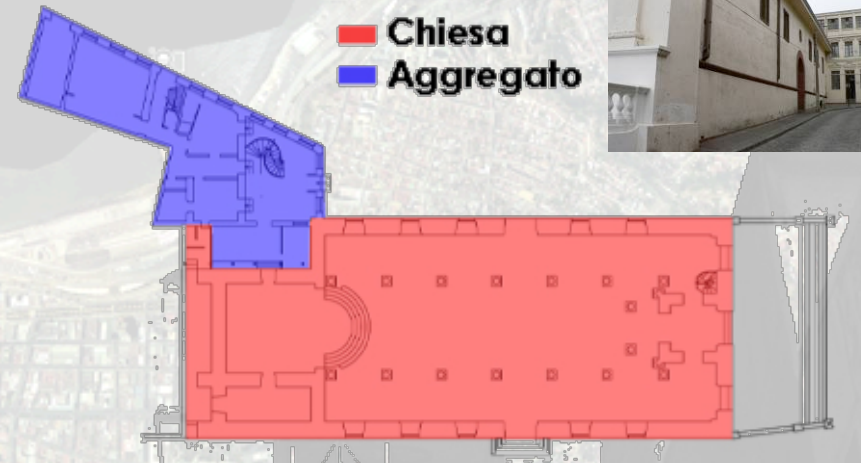
Earthquake scenario: MW 8.5 Bilateral Rupture

Time histories and related acceleration Spectrum Curve for Damping Ratio of 5.0% (vibrational period vs spectral acceleration) for each expected magnitude and for each main direction used for the spectral response analysis (dott. Fabio Romanelli – ICTP Trieste – Italia)

IGLESIA DEL SALVADOR – MATRIZ DE VALPARAISO

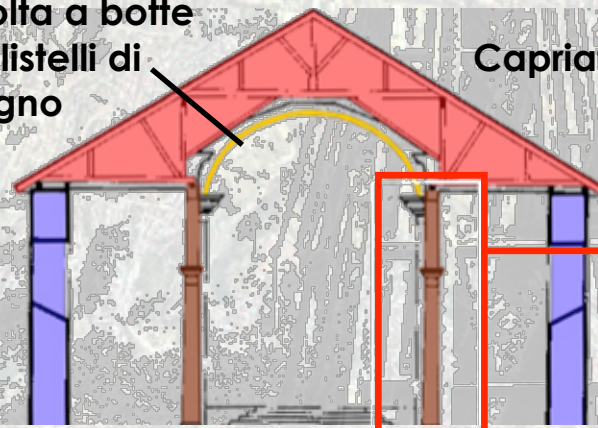


Interno torre
Acciaio



Volta a botte
in listelli di
legno

Muratura
in adobe



Capriata in legno

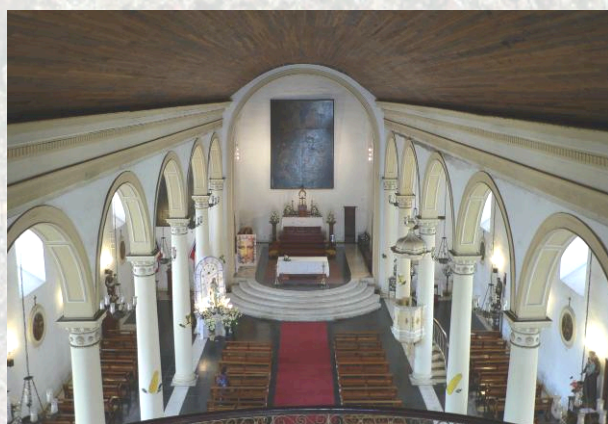


Colonne
in legno



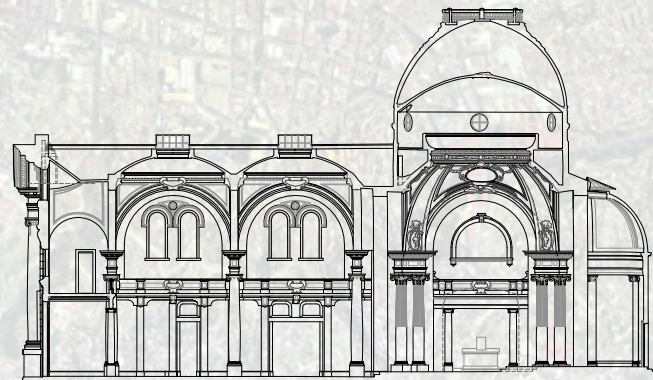
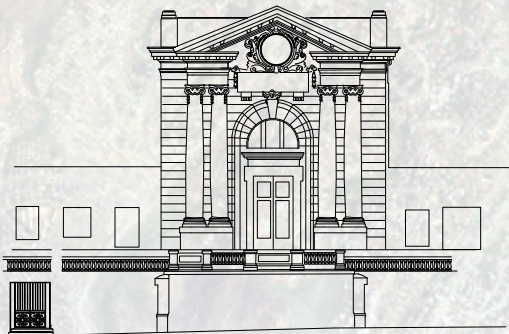
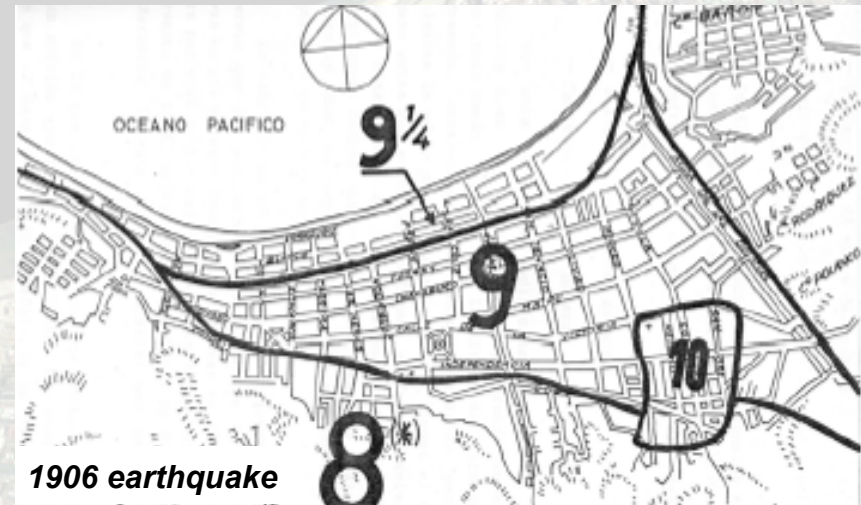
Arch. Marco Miglioli
Arch. Giampaolo Simonini

Failure mechanism	
1 OVERTURNING OF THE FACADE	16 OVERTURNING OF THE APSE
2 OVERTURNING OF THE GABLE	18 VAULTS OF THE APSE AND OF THE PRESBYTERY
3 SHEAR MECHANISMS IN THE FACADE	10-22 OVERTURNING OF OTHER WALLS (TRANSEPT FAÇADE, CHAPELS)
5 TRANSVERSAL VIBRATION OF NAVE	11-17-23 SHEAR FAILURE OTHER WALLS (TRANSEPT, CHAPELS, APSE, PRESBYTERY)
6-7 LONGITUDINAL VIBRATION OF THE CENTRAL AND LATERAL NAVE	19-20-21 HAMMERING AND DAMAGE IN THE ROOF COVERING
8 VAULTS OF THE CENTRAL NAVE	25 INTERACTION BETWEEN ELEMENTS OF DIFFERENT BEHAVIOUR
9 VAULTS OF THE LATERAL NAVES	26 OVERTURNING OF STANDING OUT ELEMENTS
13 KINEMATISM IN THE TRIUMPHAL ARCHES	27 GLOBAL COLLAPSE OF THE BELL TOWER
14 COLLAPSE OF THE DOME AND THE TIBURIO	28 MECHANISMS IN THE BELL CELL
Global index damage = 8%	Local index damage -



CAPILLA DE LAS HERMANAS DE LA PROVIDENCIA

Arch. Victor Auclair

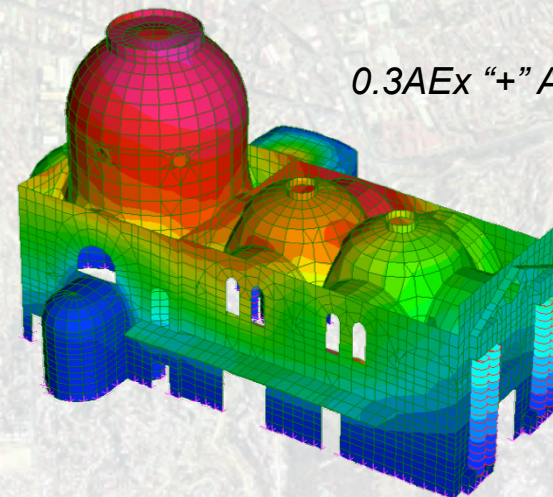
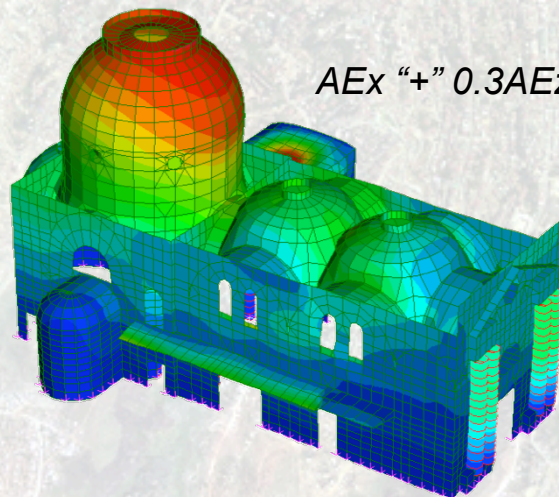
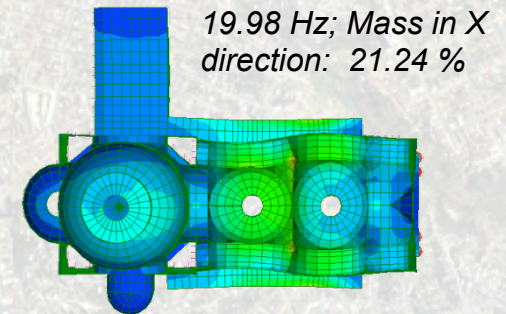
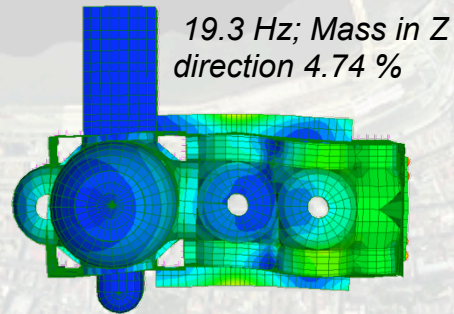
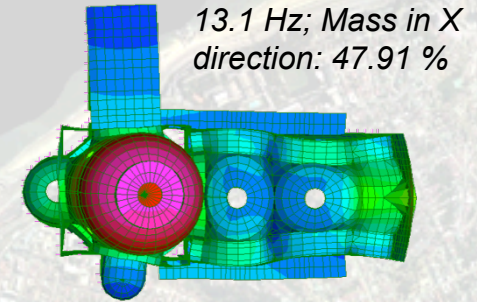
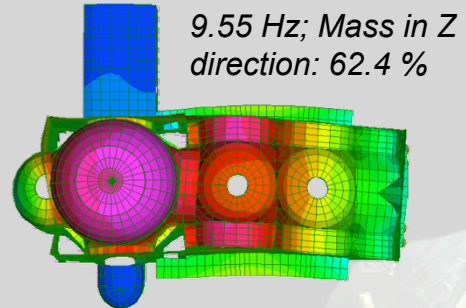
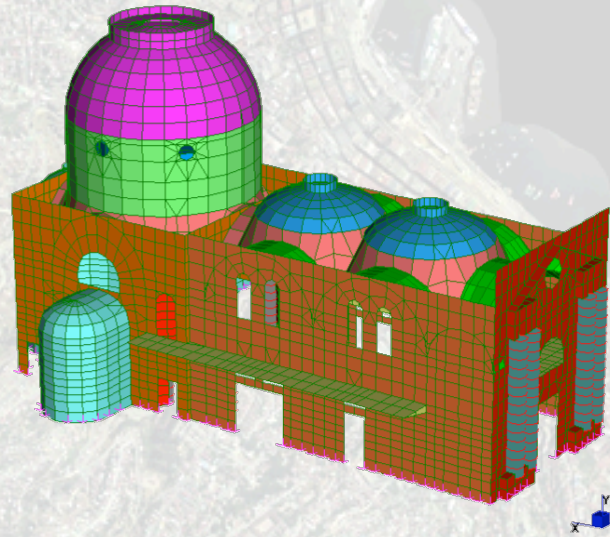


Struttura in conglomerato cementizio armato primitivo

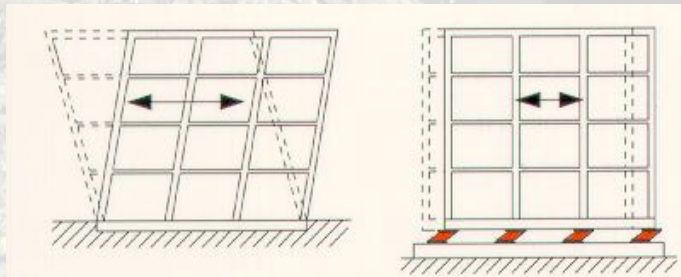
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Global index damage = 58%	
Local index damage -	



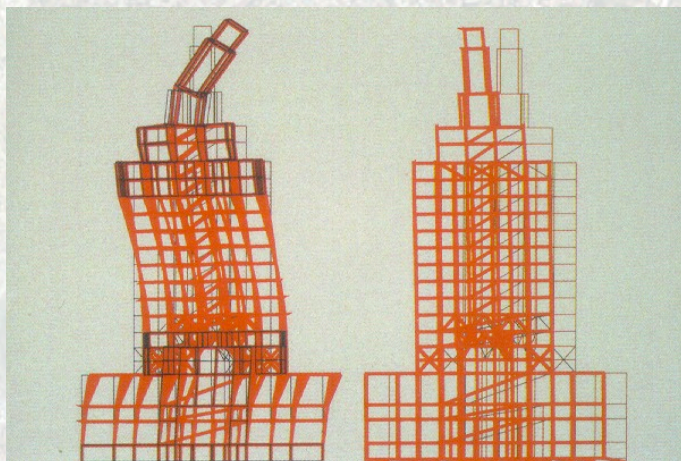
FEM Model



Possibile intervento per evitare la perdita di questo monumento: isolamento sismico alla base



San Francisco City Hall



IGLESIA SAN FRANCISCO DEL BARON

Arch. Eduardo Provasoli



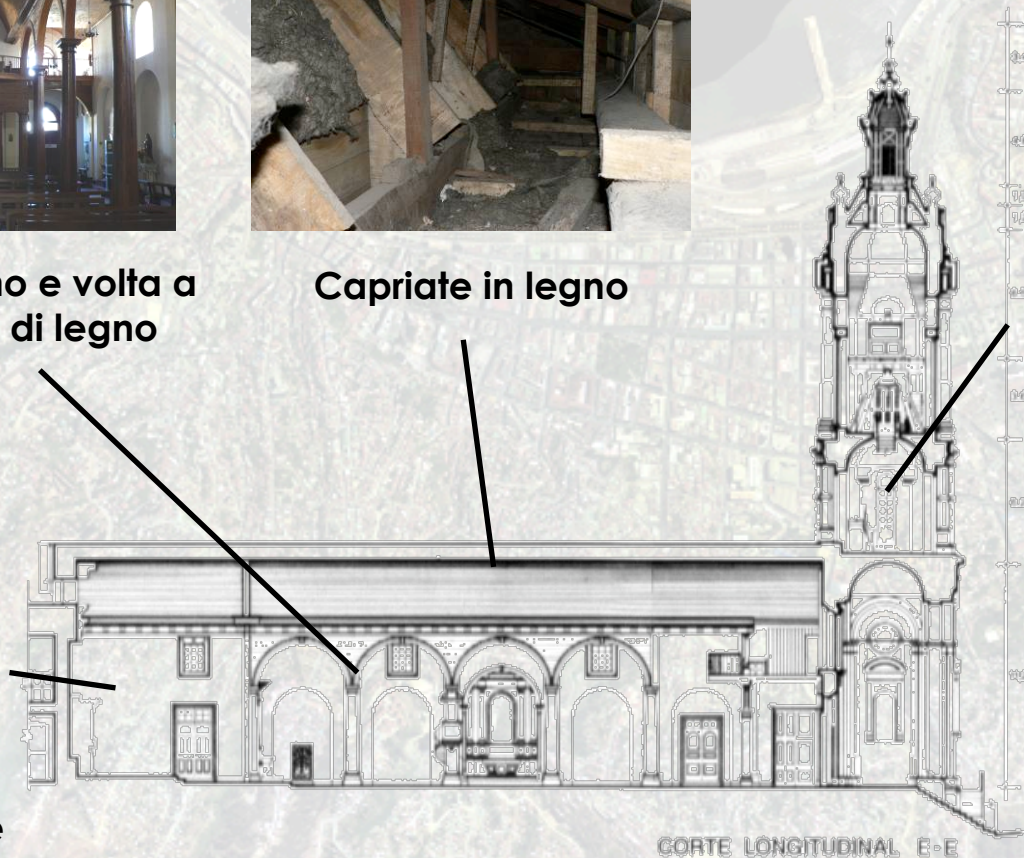
Colonne in legno e volta a botte in listelli di legno



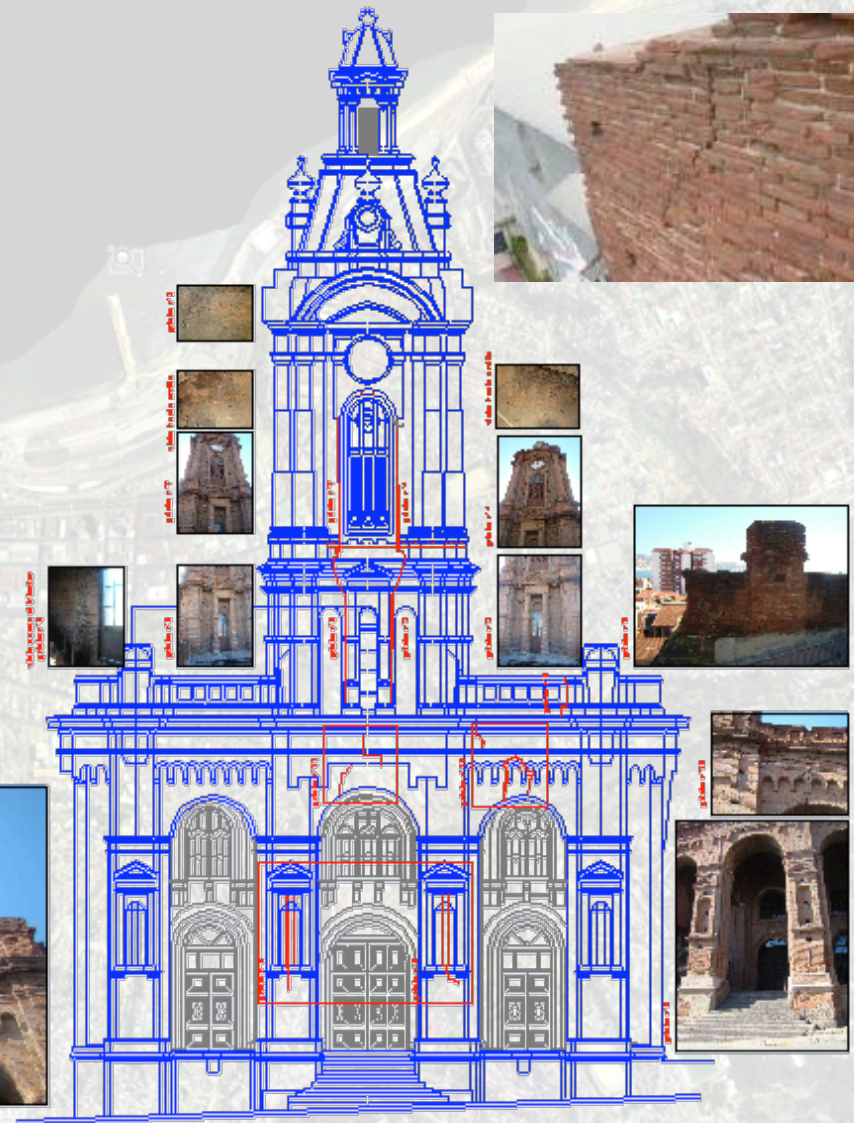
Capriate in legno



Pareti in adobe



Facciata in muratura di mattoni e malta di calce



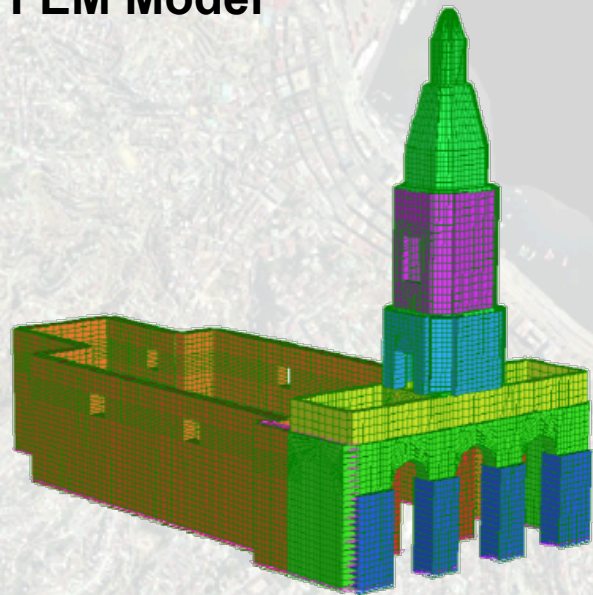
Arch. Claudia Zuñiga



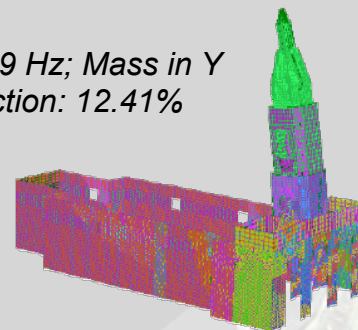
Failure mechanism

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Global index damage = 33%	Local index damage on the facade = 66%

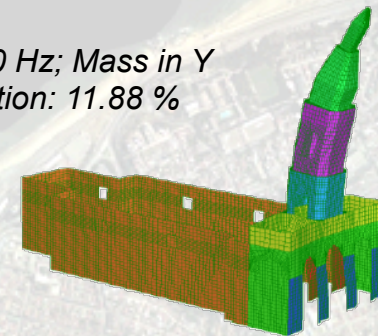
FEM Model



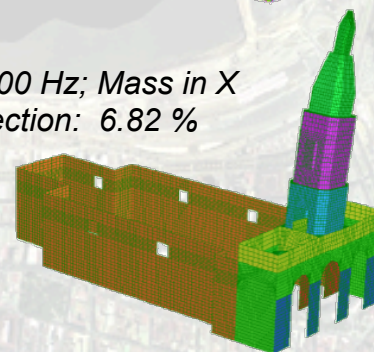
2.059 Hz; Mass in Y direction: 12.41%



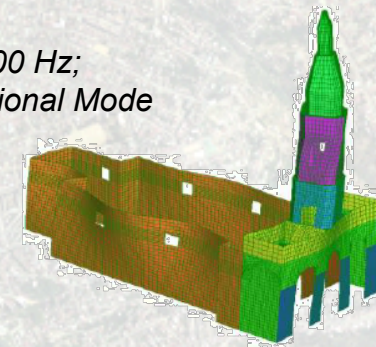
4.500 Hz; Mass in Y direction: 11.88 %



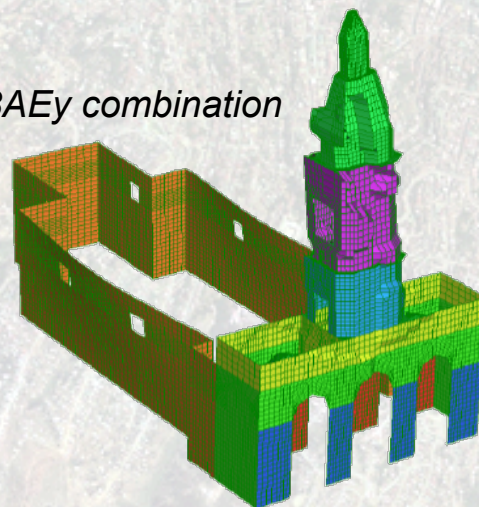
2.700 Hz; Mass in X direction: 6.82 %



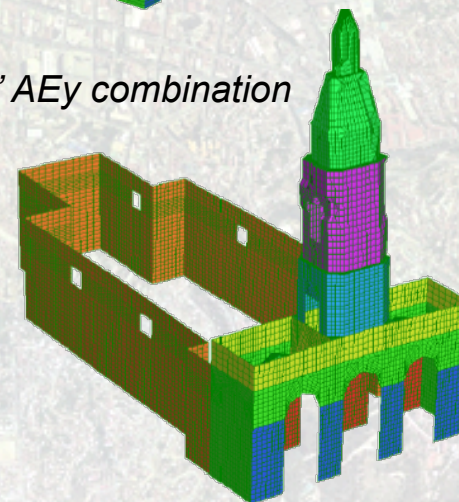
7.800 Hz; Torsional Mode



$AEx + 0.3AEy$ combination

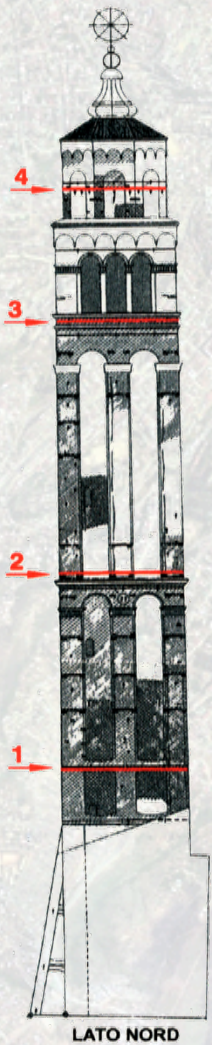


$0.3AEx + AEy$ combination

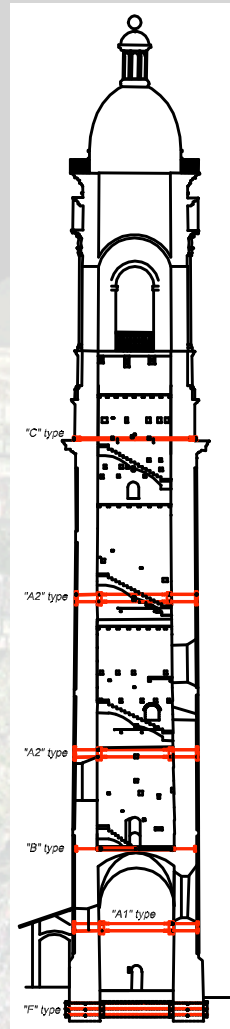


Ing. Enrico Milani
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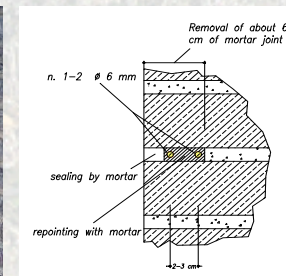
Campanile “S. STEFANO” - Venezia



Campanile della Cattedrale - Monza



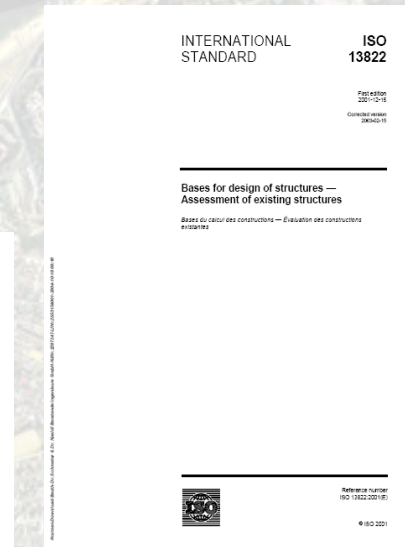
- cerchiature
- iniezioni
- ristilatura amata
- scuci - cuci



Prof Claudio Modena - Università di Padova - Italia

Normative di riferimento per lo studio e l'intervento strutturale sul patrimonio culturale:

- ISO 13822
Bases for design of structures - Assessment of existing structures
- ICOMOS – International Scientific Committee for Analysis and Restoration of Structures of Architectural Heritage
Recommendations for the analysis, conservation and structural restoration of architectural heritage
- Ministero per i Beni e le Attività Culturali – Dipartimento per i beni culturali e paesaggistici – Direzione generale per i beni architettonici e paesaggistici
Linee Guida per la valutazione e riduzione del rischio sismico del patrimonio culturale





PROGETTO MAR VASTO
“Manejo de riesgos en Valparaiso”
Conferenza finale del Progetto BID



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29 Settembre 2008

L'investigazione sulle tre chiese (San Francisco,
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