UNIVERSIDAD NACIONAL DE INGENIERIA
Facultad de Ingeniería Civil

Segunda Ronda de Trabajo Perú Japón
Sobre Mitigacion de Desastres

Proposal Method Earthquake Response Diagnosis on Masonry Buildings

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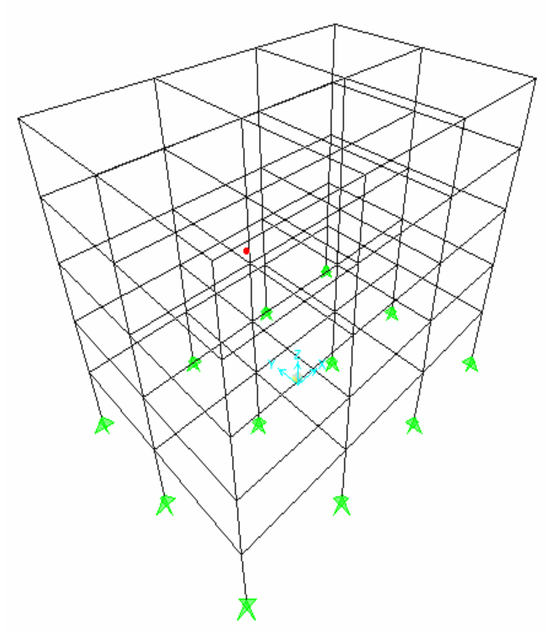
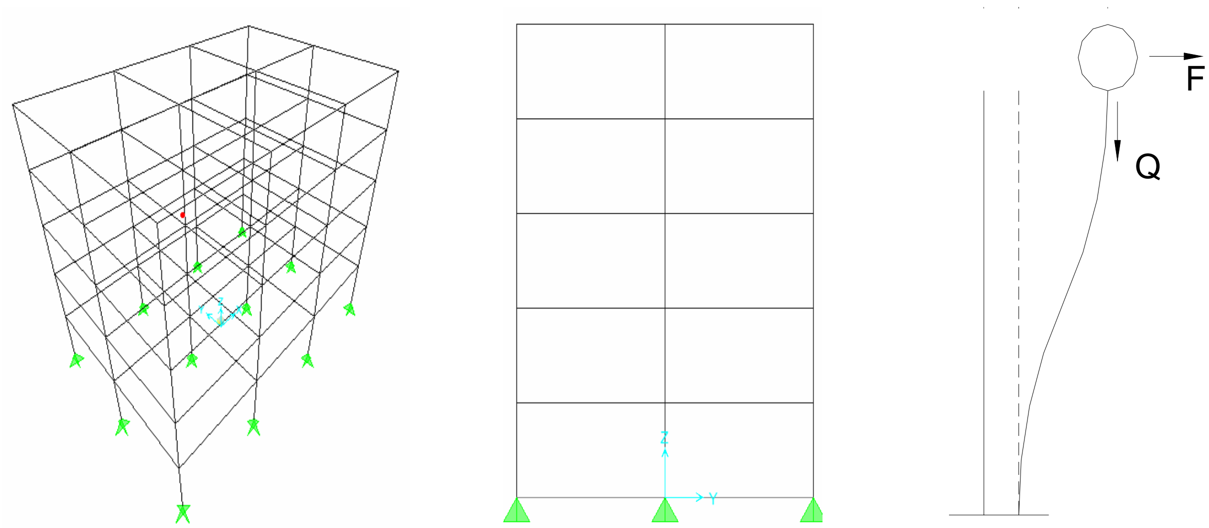
CENTRO PERUANO JAPONES DE INVESTIGACIONES SISMICAS Y MITIGACION DE DESASTRES - CISMID

How to evaluate the damage of a city?
How to compute the damage on 500,000 housing?

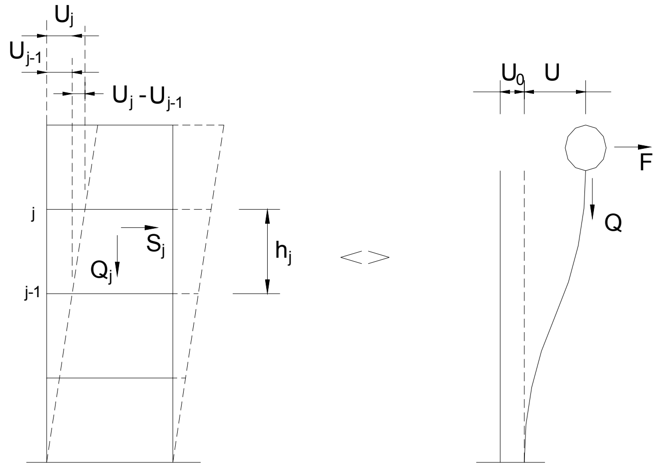
The first idea could be develop a serie of 3D models



But, Can we make 500,000 models?
It is almost impossible

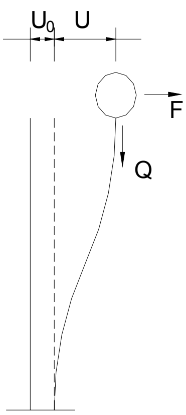


However we can make equivalent models from the actual Building using uncoupled equation of motion for the predominant mode and solve the system in aproximate way to diagnose the seismic response of the structure



Real Model

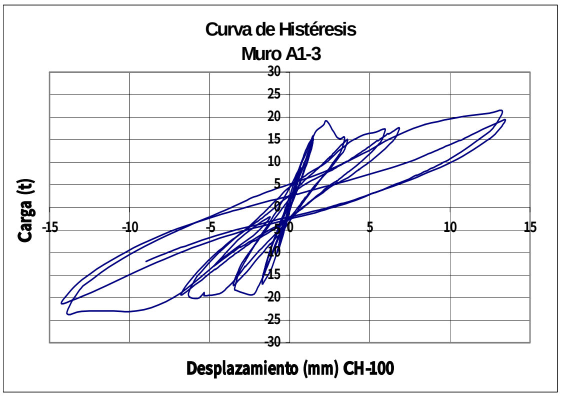
Equivalent Model

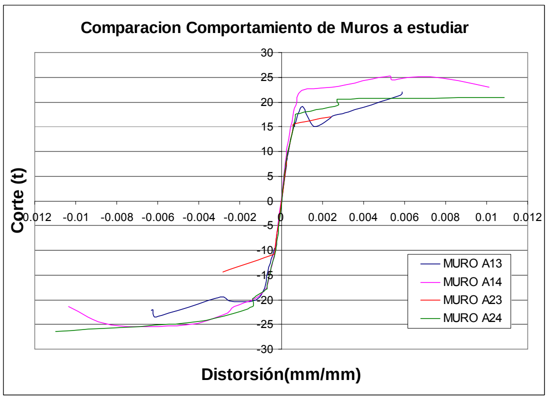


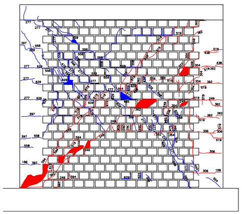
On the Equivalent model

1. The mass can be computed from the area of the building.
2. The stifness of the building can be computed from the type of materials, geometry and amount of walls and columns.
3. The stiffness of a wall could be computed using a data base from full scale experimental test results.
4. Using an spring solver program the response for a deterministic structure can be computed.

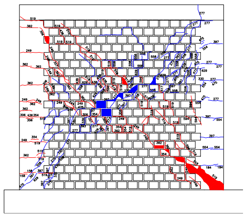
TESTING AND GETTING THE BEHAVIOR CURVE







Muro A1–3
Distorsión 1/100
Cara Frontal



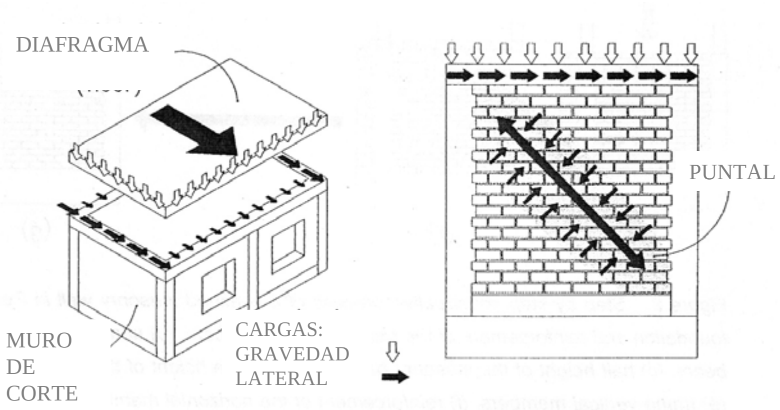
Muro A1–3
Distorsión 1/100
Cara Posterior

GETTING THE FAILURE PATTERN

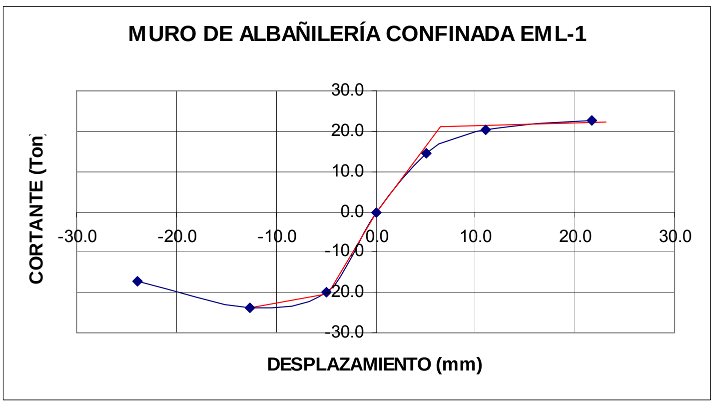
Types of walls studied experimentally and Considered for the diagnosis

Tipo	Junta	Aparejo	Refuerzo	Calidad	Espesor	Longitud	Altura	Esbeltez	K1(t/m)	K2(t/m)	Vmax (t)
1	Endentado	Cabeza	4 Φ 1/2	Artesanal	0.20	2.65	2.30	0.87	15517.33	471.97	17.74
2	Endentado	Soga	4 Φ 1/2	Artesanal	0.12	2.40	2.30	0.96	7768.40	425.90	9.50
3	Endentado	Soga	4 Φ 1/2	Industrial	0.13	2.40	2.30	0.96	14707.00	486.30	19.13
4	Endentado	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.30	0.96	9433.03	488.27	17.40
5	Sin Endentar	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.30	0.96	7752.50	737.50	16.65
6	Endentado	Soga	4 Φ 3/8	Industrial	0.12	1.80	2.40	1.33	3880.90	132.10	11.37
7	Endentado	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.40	1.00	5310.55	237.20	17.40
8	Endentado	Soga	4 Φ 3/8	Industrial	0.12	3.60	2.40	0.67	7894.05	384.75	23.56
9	Endentado	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.20	0.92	3932.40	45.69	22.41
10	Endentado	Soga	4 Φ 1/2	Industrial	0.12	2.40	2.20	0.92	4341.96	0.00	13.86
11	Endentado	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.20	0.92	4482.20	147.89	22.15
12	Endentado	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.20	0.92	5499.00	335.27	22.21
13	Endentado	Soga	4 Φ 3/8	Industrial	0.12	2.40	2.20	0.92	5017.57	57.65	21.07

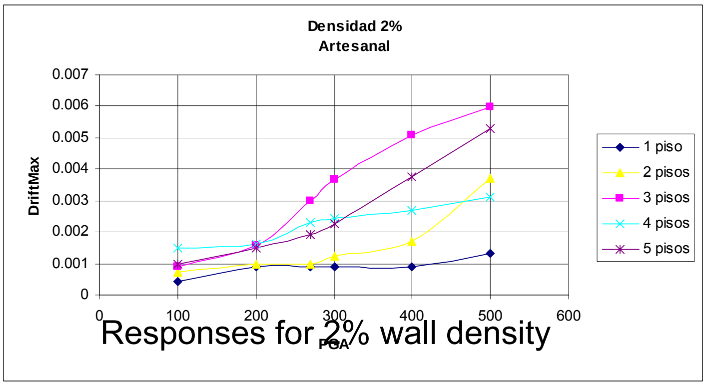
MODELLING WITH MACRO MODEL



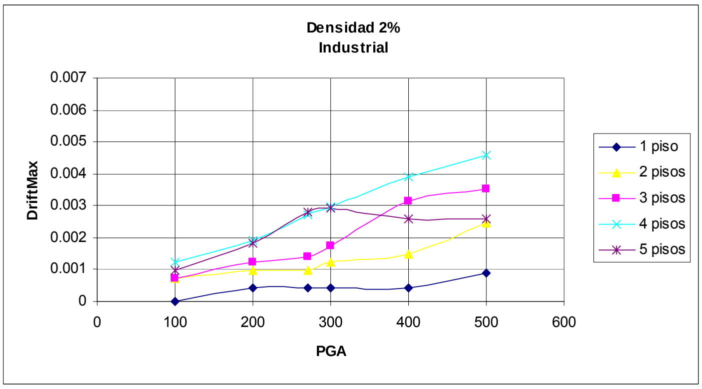
Bilinear model from testing wall



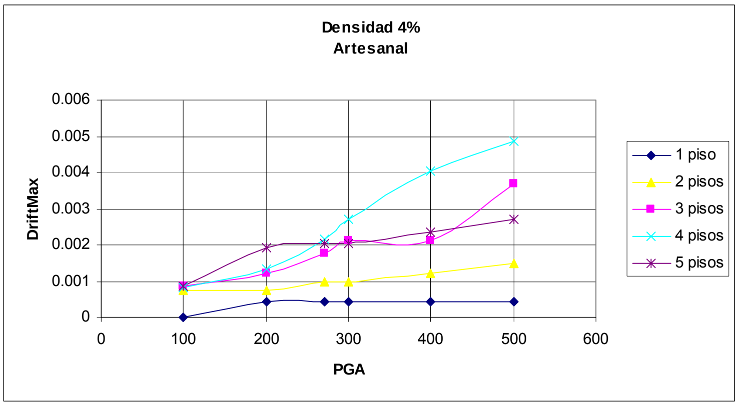
Responses for 2% wall density

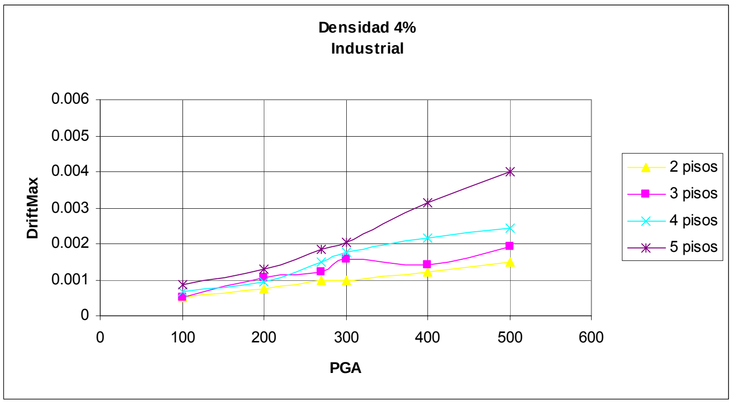


Responses for 2% wall density

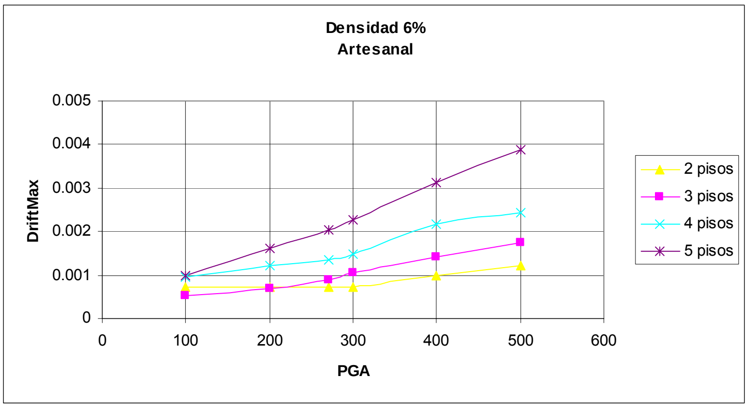


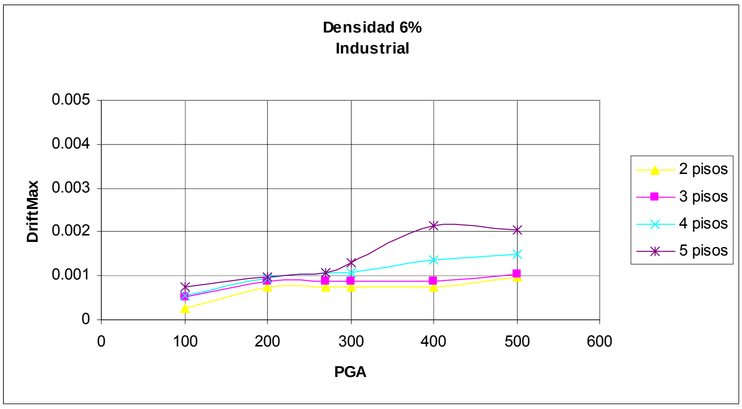
Responses for 4% wall density



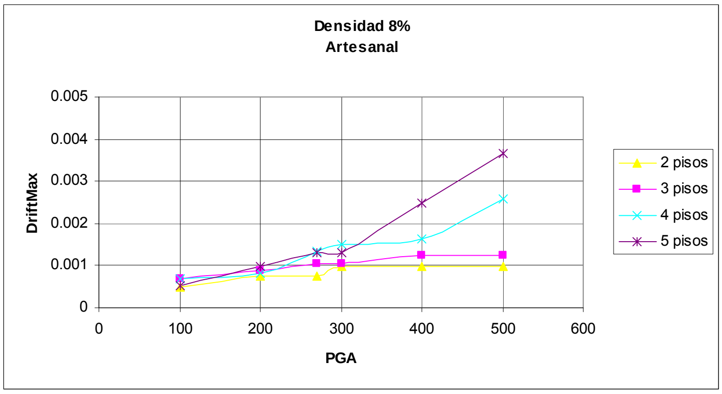


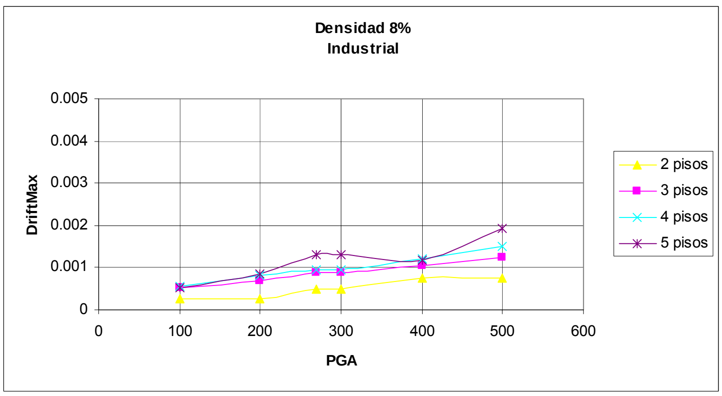
Responses for 6% wall density





Responses for 8% wall density





Application on Survey

AGREEMENT CISMID/UNI - MUNICIPALITY OF LA MOLINA
SEISMIC VULNERABILITY OF LA MOLINA DISTRICT

LOCATION ....
BLOCK.......................... **HOUSE:**..............................

SKETCH

TYPE OF BUILDING:

One family house ( ) Multifamily home( ) Home & bussiness ( )

Comercial ( ) Public ( ) Private ( )

CHARACTERISTICS:

Independent ( ) Dpt. on building ( ) Share ( )

Passage ( ) Other ....

OWNER:

Own ( ) Rental ( )

TIME FROM BUILT

.... Years

NUMBER OF PERSONS: ....

OCCUPATION

Professional ( ) Technitian ( ) Business ( ) None ( )

AREA OF THE LAND .... **X** .... **=** **m2**

AREA BUILT ....**X** .... **=** **m2**

NUMER OF STORIES .... **UNDERGROUND :** YES ( ) NO ( ) No ....

STORY HEIGHT ....

HALF UNDERGROUND ( )

TOTAL HEIGHT .... **mt.**

MAIN CONSTRUCTION MATERIAL :

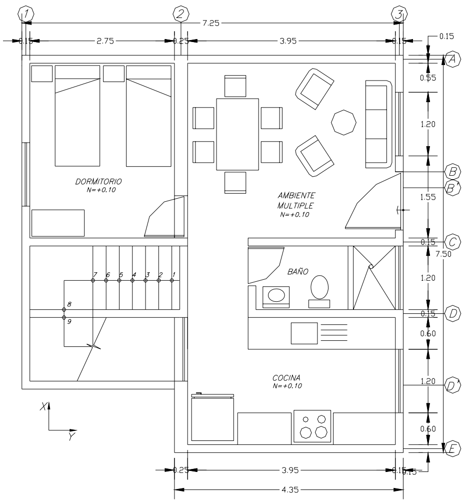
Adobe ( ) Masonry ( ) Reinforce Concrete ( ) Other...

ADOBE	MASONRY	REINFORCE CONCRETE
FOOTING Stine and mud ( ) Stone and Cement ( ) Other	**FOOTING** Beam without reinforce ( ) Beam with reinforce ( ) Other	**FOOTING** Isolate ( ) Conected ( ) Other ....
STATE OF CONSERVATION Good ( ) Regular ( ) Bad ( ) No settlements ( ) With settlements ( )	**STATE OF CONSERVATION** Good ( ) Regular ( ) Bad ( ) No settlements ( ) With settlements ( )	**STATE OF CONSERVATION** Good ( ) Regular ( ) Bad ( ) No settlements ( ) With settlements ( )
ADOBE	**MASONRY**	**REINFORCE CONCRETE**
ROOF SYSTEM Wood( ) Cain ( ) Mud ( ) Other:	**ROOF SYSTEM** Concrete Slab ( ) Light slab ( ) Other:	**ROOF SYSTEM** Concrete slab ( ) Light slab ( ) Other: ....
STATE OF WALLS GOOD ( ) REGULAR ( ) BAD ( ) WITH COVERING ( ) WITHOUR COVERING ( ) COMENTARY..	**STATE OF WALLS** GOOD ( ) REGULAR ( ) BAD ( ) WITH COVERING ( ) WITHOUR COVERING ( ) COMENTARY..	**ELEMENTS :** **COLUMNS ( )** WITHOUT CRACKS ( ) WITH CRACKS ( ) COMENTARY..................................
REINFORCE ON WALLS YES ( ) NO ( ) COMENTARY	**VERTICAL AND/ OR HORIZONTAL REINFORCE IN WALLS** YES ( ) NO ( ) IF ANSWER IS POSITIVE FILL THE FOLLOWING: ONLY COLUMNS ( ) ONLY BEAMS ( ) BEAMS AND COLUMS ( ) WITH REINFORCE INSIDE THE BLOCKS ( ) COMENTARY :	**BEAMS :** .... WITHOUT CRACKS ( ) WITH CRACKS ( ) COMENTARY.................................. **CONCRETE WALLS:** .... WITHOUT CRACKS ( ) WITH CRACKS ( ) COMENTARY..................................

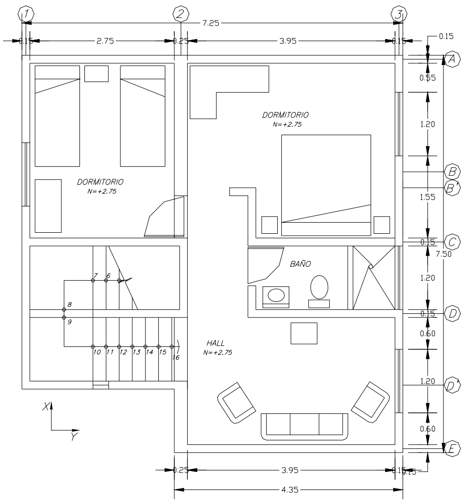
FORMAT

Important key data
- Story number
- Amount of walls
- Type of construction
- Material

VERIFYING THE PROPOSAL WITH A REAL BUILDING



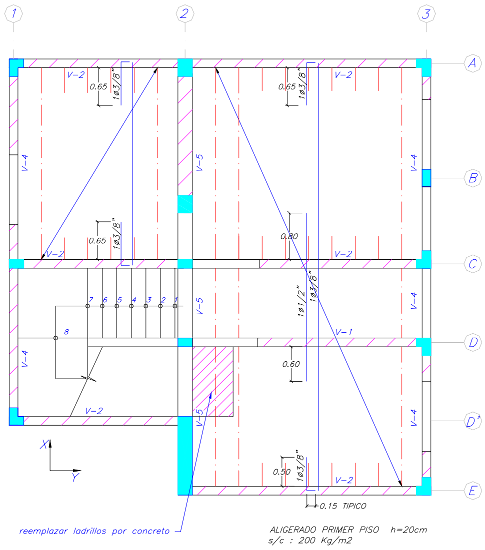
PLANTA PRIMER NIVEL

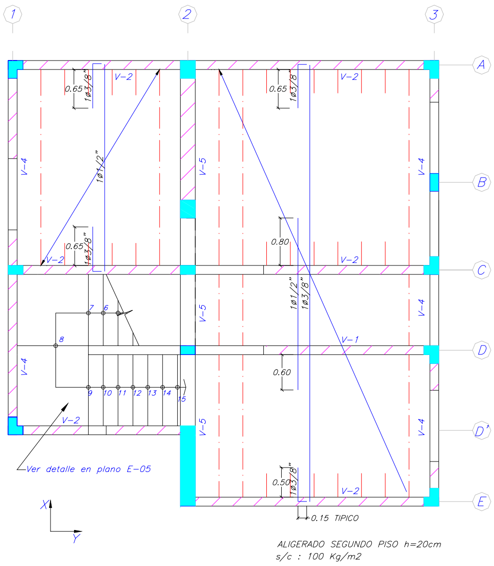


PLANTA SEGUNDO NIVEL

ARCHITECTURAL PLAN

STRUCTURAL PLAN OF THE BUILDING

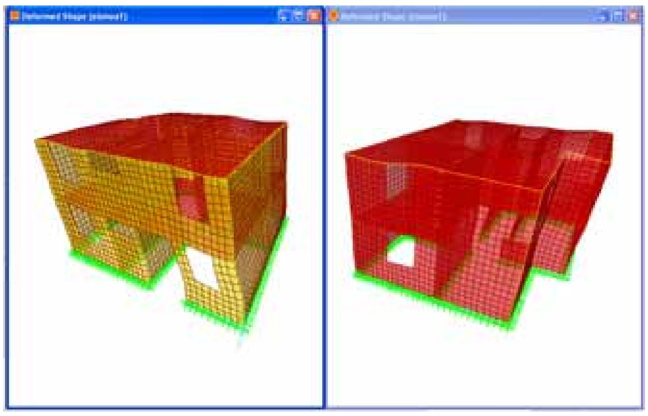




DMx= 4.%

DMy= 4.7%

MODELLING WITH FEM PROGRAM



FEM RESULTS

Table 10: Maximo Drift sismo moderado

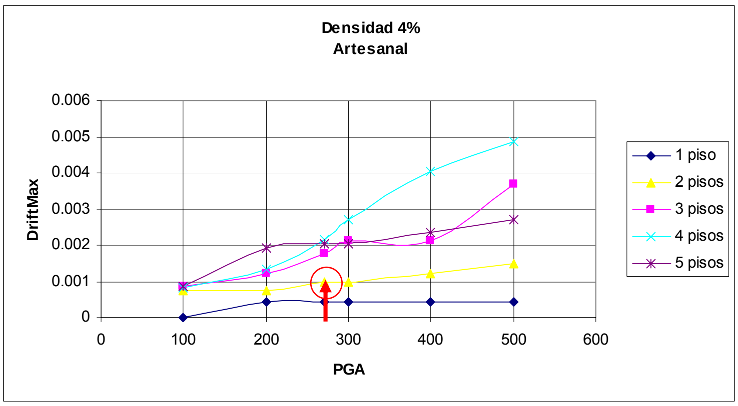
	Vx(kg)	Kx(kg/cm)	δx i (cm)	Δx i	
Story 2	18539.78	261401.9	0.319159874	0.001276639	<1/200
Story 1	27284.96	279239.6	0.439702385	0.001758810	<1/200

En nuestro eejemplo, para el sismo severo en la direccion X tenemos:

Table 11: Maximo Drift sismo severo

	Vx(kg)	Kx(kg/cm)	δx i (cm)	Δx i	
Piso2	18539.78	261401.9	0.319159874	0.001276639	<1/200
Piso1	27284.96	279239.6	0.439702385	0.001758810	<1/200

GETTING OUR PROPOSAL RESULTS



For DMy=4% the diagnosis response is 0.00100

From SAP the diagnosis response is 0.00127

CONCLUSIONS

This report shows the first steps in the development of a method for evaluation of seismic response of buildings, both in urban or rural area. We consider our experimental background to shear the behavior curves and maximum threshold for each type of wall.
However there are many influences we continue studying such as the influence of axial loads, overturning moments and other external factors. The authors consider this methodology a diagnosis proposal for screening evaluation. We want to provide in near future a second version of the method with the consideration of the drift thresholds proposed on [4] to evaluate the damage by the quake demand