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DEVELOPMENT OF LOW-COST RUBBER BEARINGS FOR SEISMIC SAFETY OF STRUCTURES IN MACEDONIA AND BALKAN

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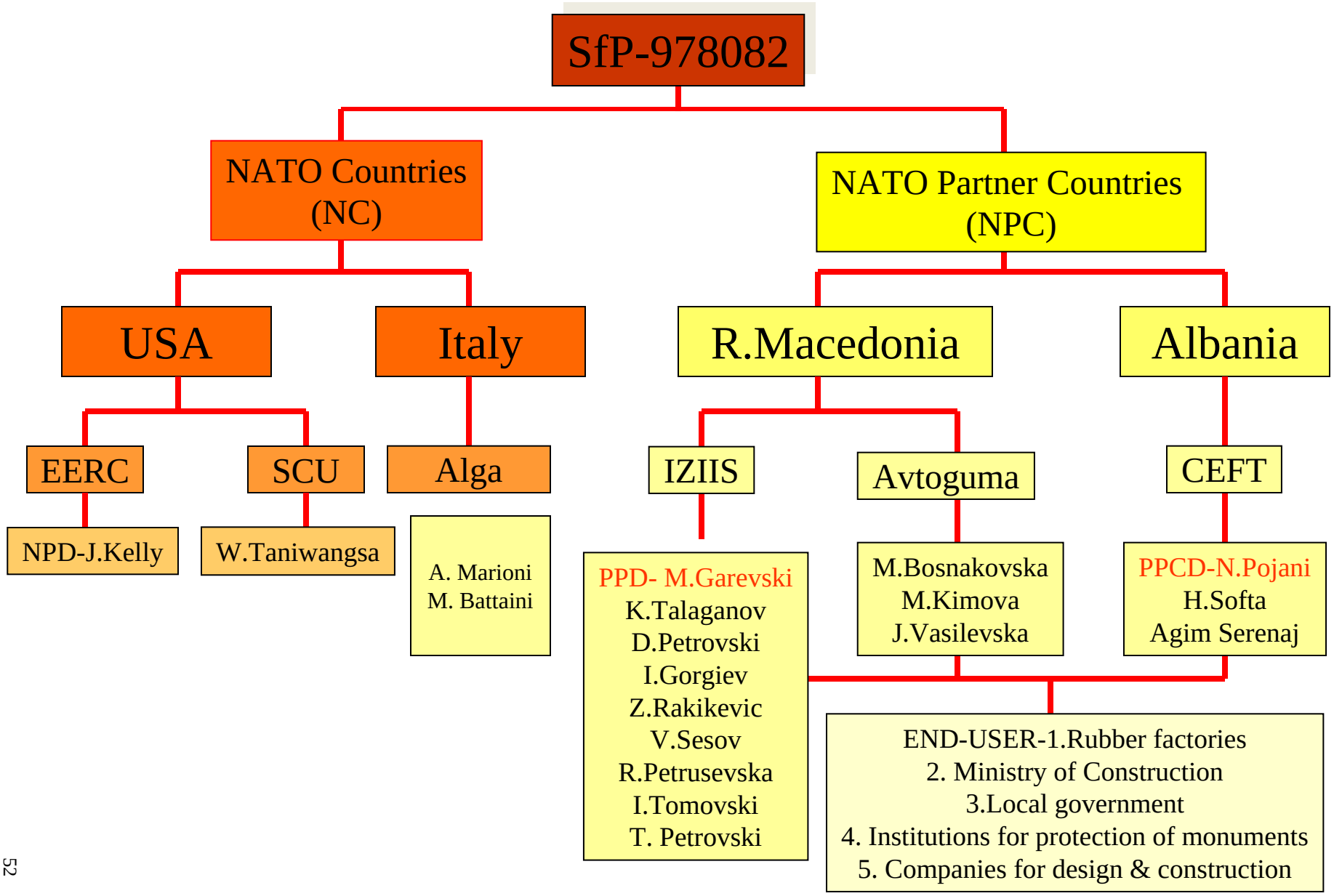
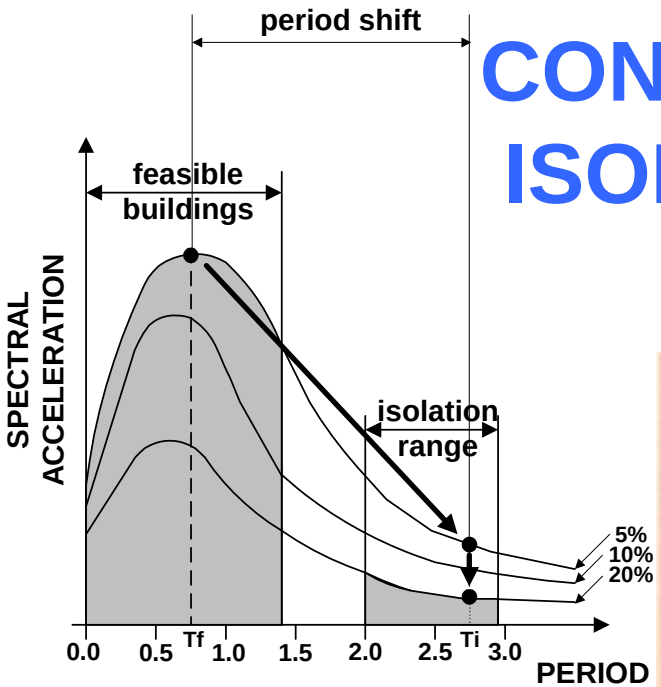


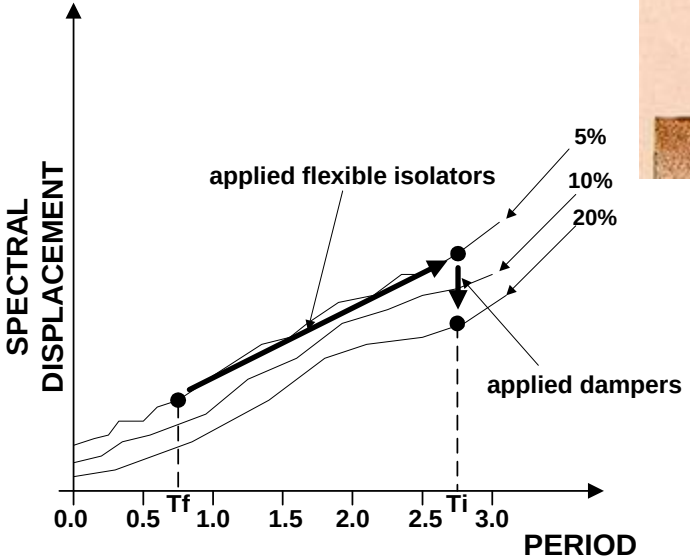
The objective of the project was to develop low-cost rubber isolators that can be used for housing, schools and other public buildings in the Balkan region.

The approach was to develop a manufacturing process using local mass-production technology to produce in Macedonia a competitive product that can be applied to buildings and bridges in the Balkan region.

CONCEPT OF BASE ISOLATION



a)



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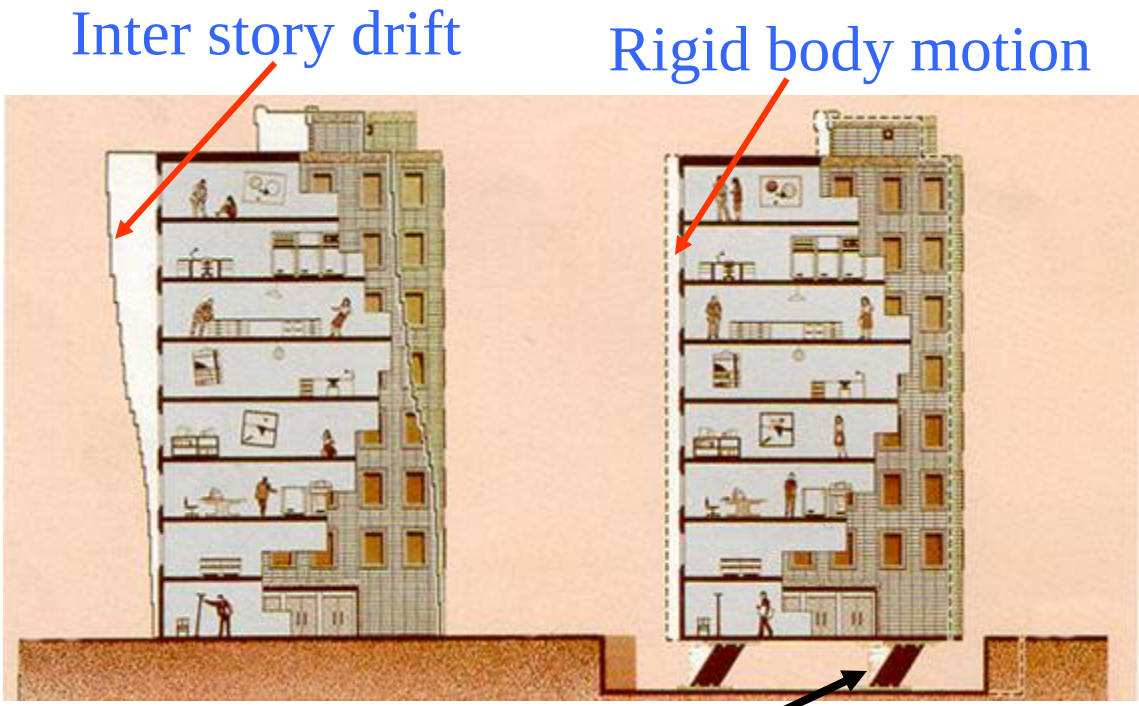
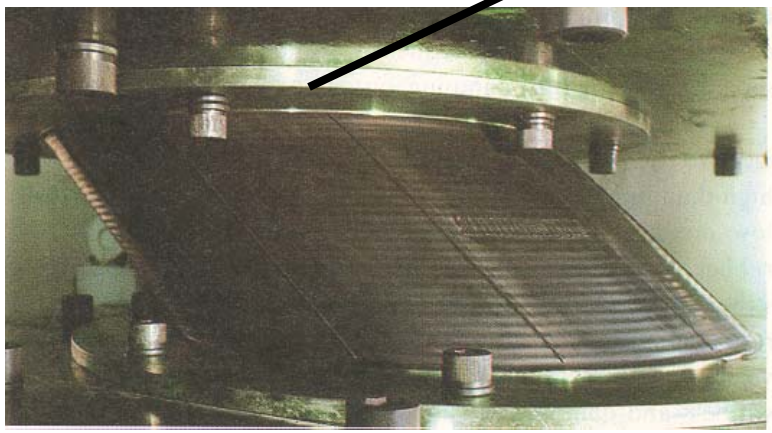
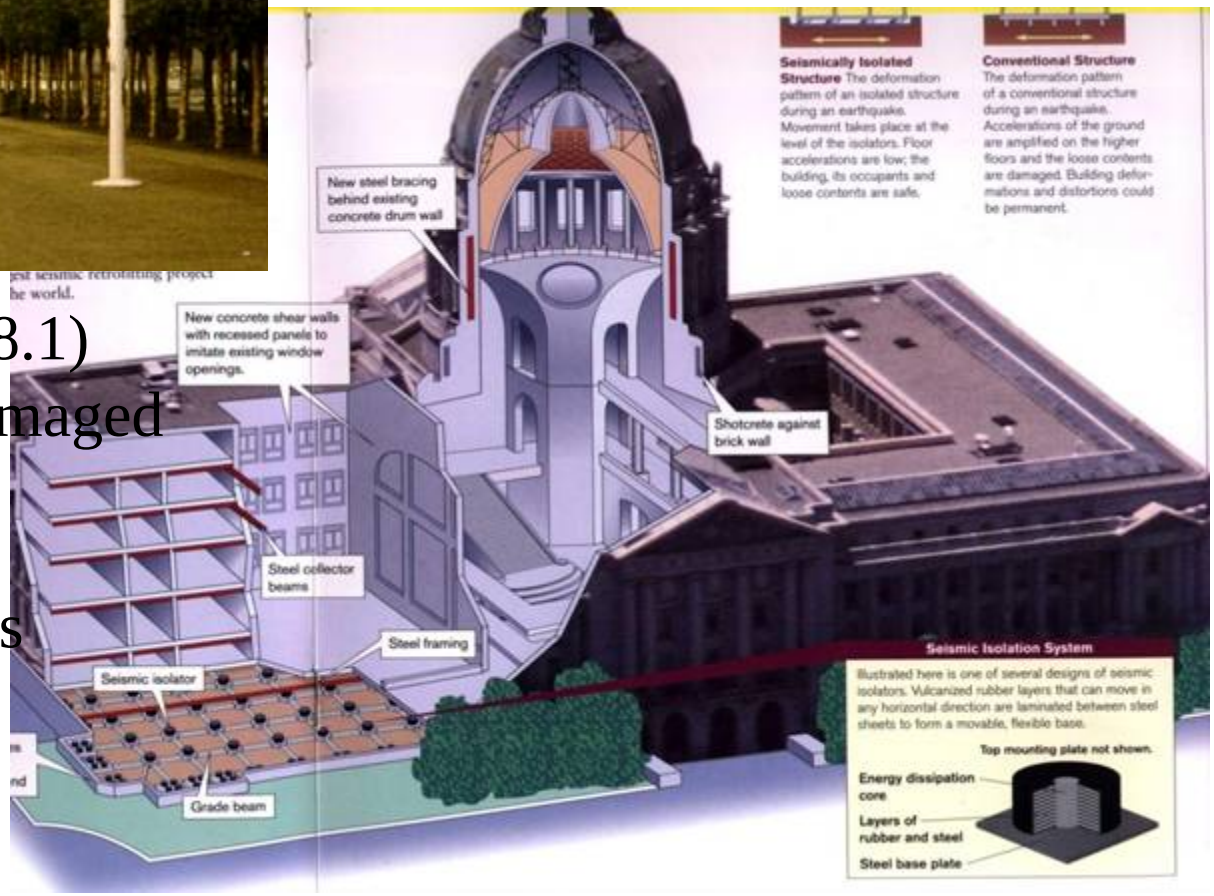




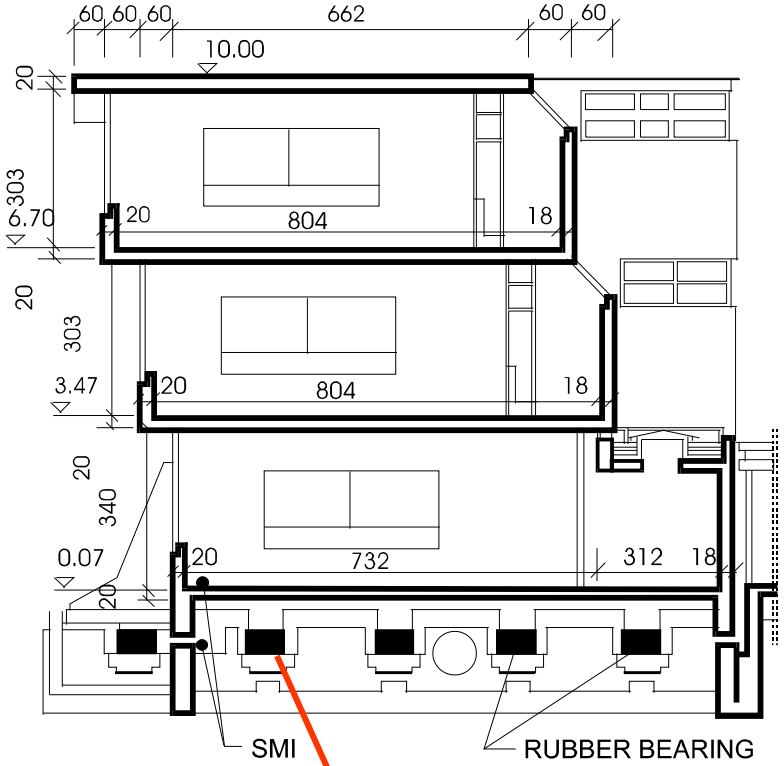
Total project cost: $105milion
Base isolation portion: $40milion

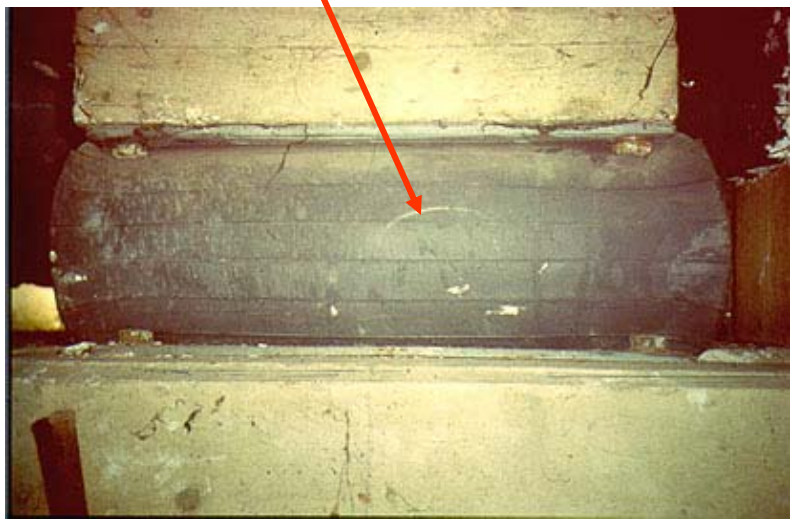
Heavily damaged 1906 (8.1)
1998 Loma Prieta EQ damaged
Building again

530 lead rubber bearings
62 sliders columns



ELEMENTARY SCHOOL "PESTALOZZI"



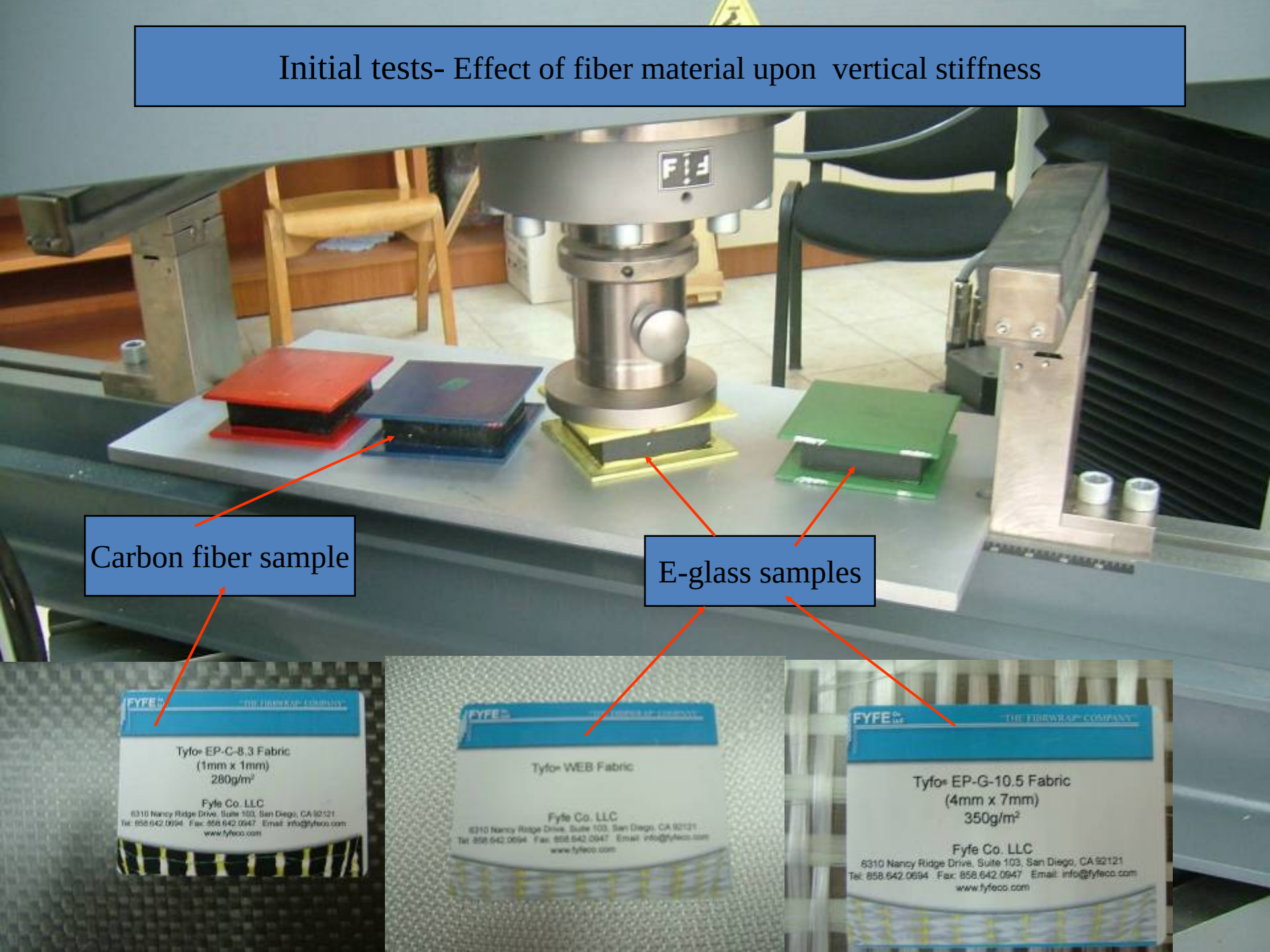


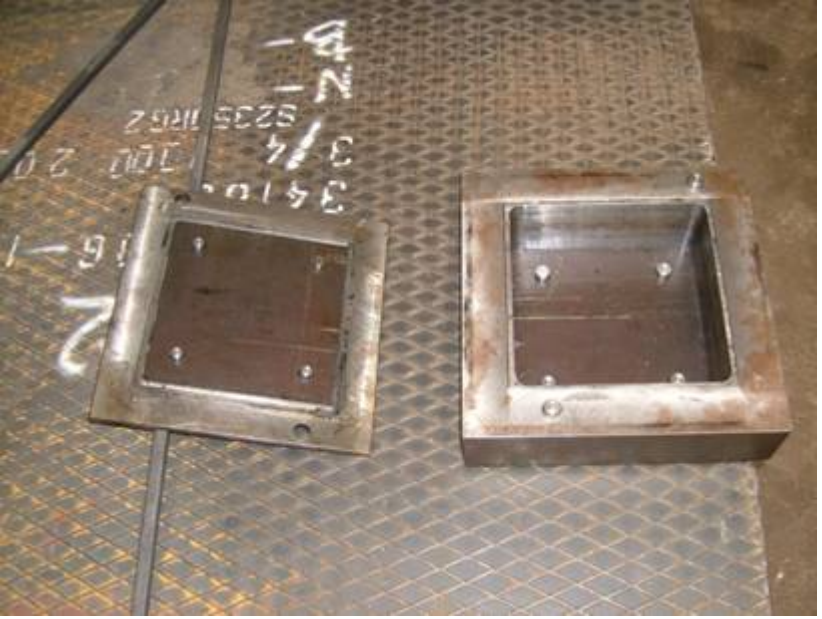
vertical cracks in the rubber

Old bearing of the Pestalozzi school building

Bearings manufacturing machine

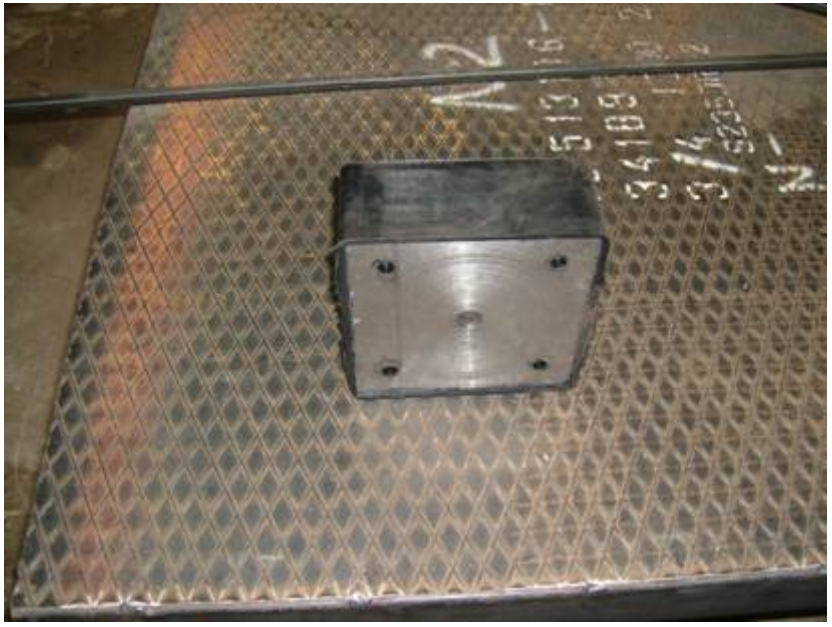
Initial tests- Effect of fiber material upon vertical stiffness





20cmx20 cm - rubber bearings

Mould for small bearings



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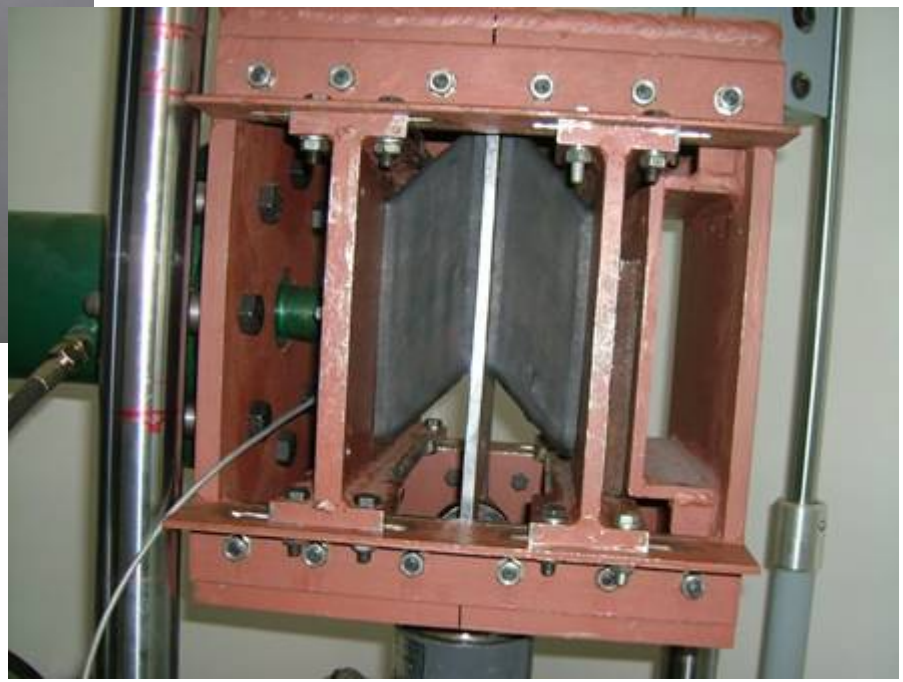
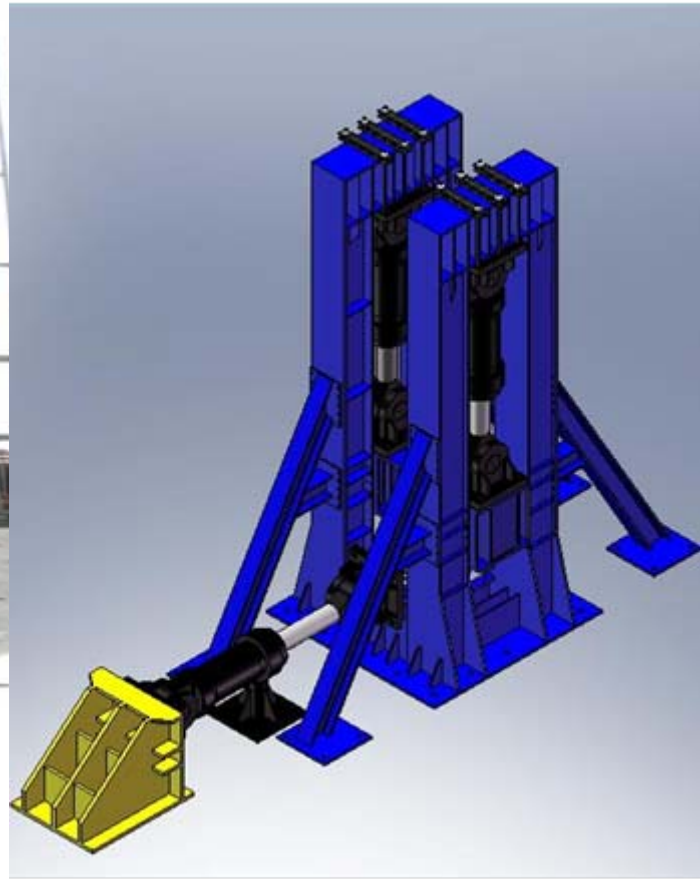
SMALL TESTING MACHINE

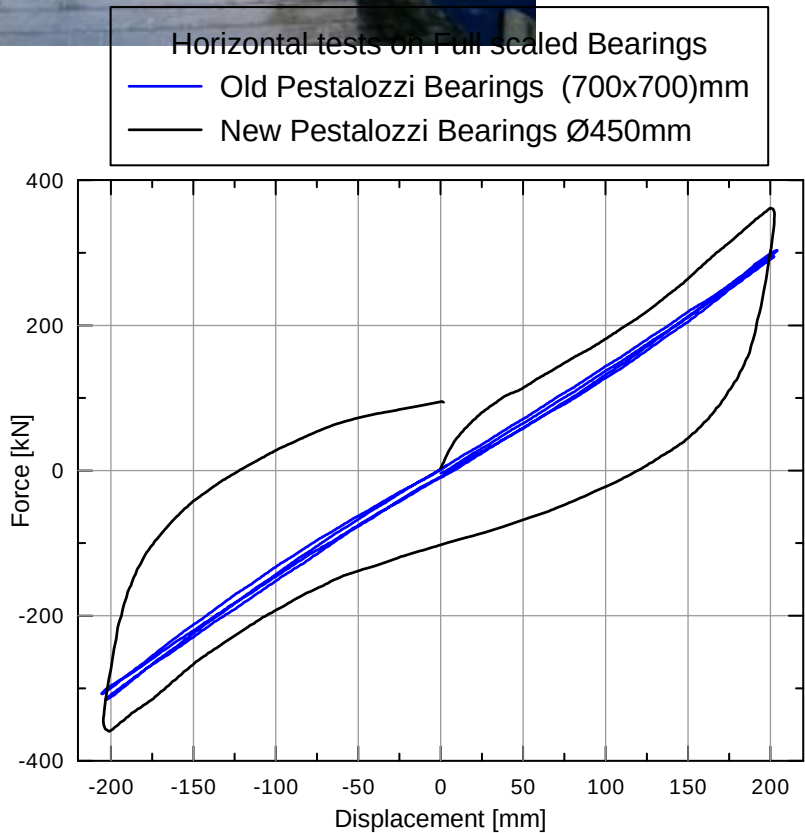


mould for the bearings

LARGE TESTING MACHINE



Horizontal test



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New and Old Rubber bearings

INVITES

14th European Conference on Earthquake Engineering

To Skopje, Macedonia

June 2010

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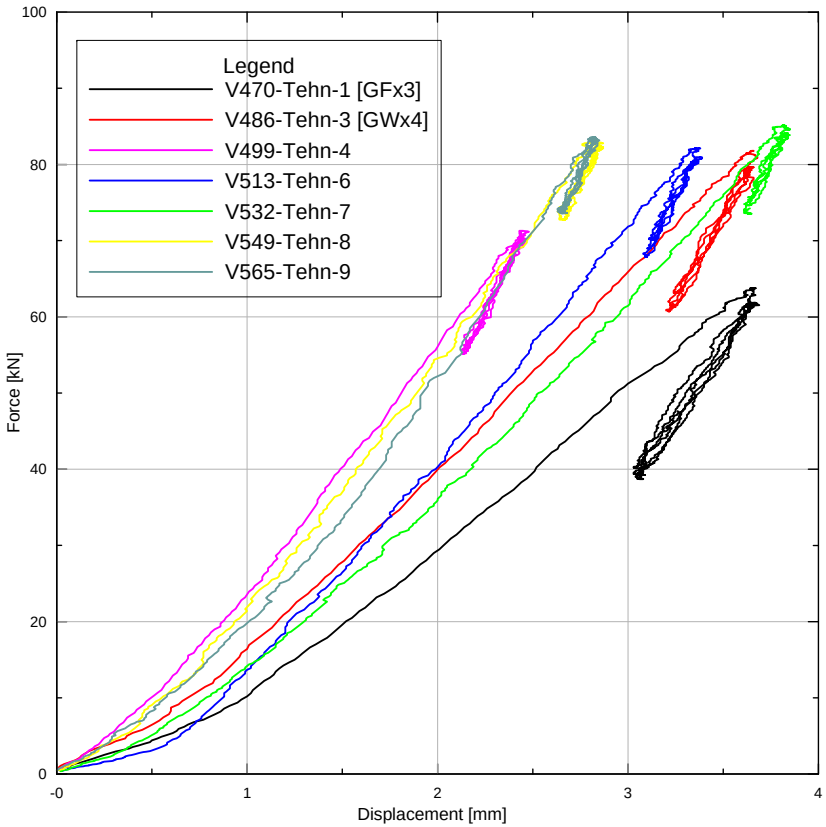
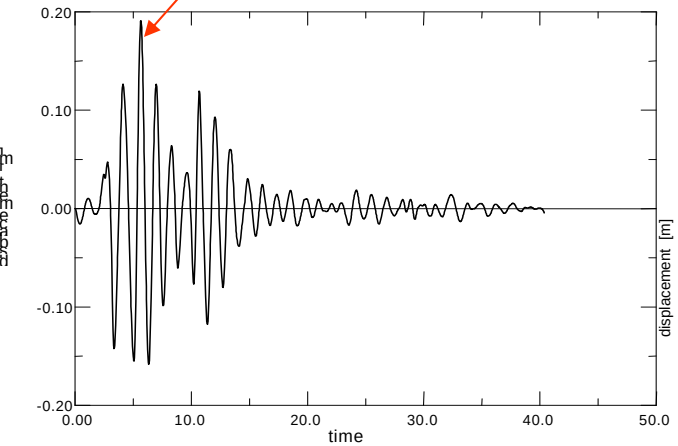

Legend
V470-Tehn-1 [GFx3]
V486-Tehn-3 [GWx4]
V499-Tehn-4
V513-Tehn-6
V532-Tehn-7
V549-Tehn-8
V565-Tehn-9
Force [kN]
Displacement [mm]
100
80
60
40
20
0
-0
1
2
3
4

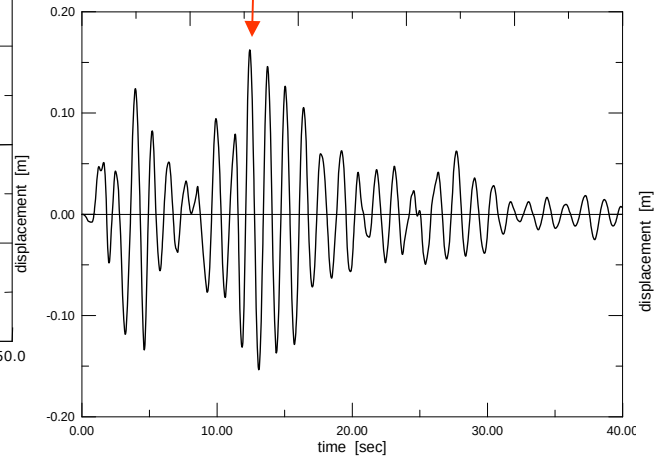
Seismic Response of the Structure

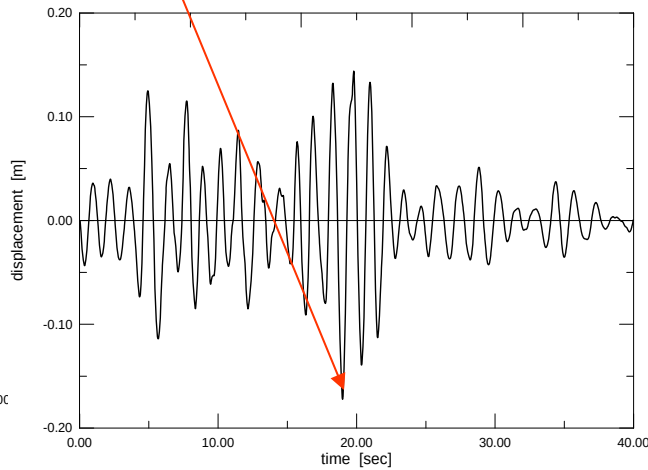
Displacements of nodes JOZ1000 to JOZ1019 due to dead weight (DL) and the three earthquakes: Ulcinj-Albatros (ALB), El Centro (ELC) and Taft (TAF) for 5%.damping

		Base Isolated Damp=5%			
Node	Dir.	DL [m]	DL+ALB[m]	DL+ELC [m]	DL+TAF[m]
JZ1000	UX	-4.076e-04	***0.1907***	***0.1622***	***-0.1727***
	UY	-1.474e-04	0.0843	-0.1069	***-0.1120***
	UZ	-0.0523	***-0.0835***	-0.0711	-0.0717
JZ1005	UX	8.242e-06	0.1946	0.1658	-0.1754
	UY	1.170e-03	0.0931	-0.1187	-0.1299
	UZ	-0.0526	-0.0853	-0.0739	-0.0725
JZ1011	UX	8.403e-05	0.1985	0.1692	-0.1787
	UY	2.824e-03	-0.1070	-0.1331	-0.1519
	UZ	-0.0527	-0.0854	-0.0740	-0.0726
JZ1017	UX	2.037e-04	0.2022	0.1725	-0.1818
	UY	4.405e-03	-0.1220	-0.1472	-0.1734
	UZ	-0.0527	-0.0855	-0.0741	-0.0727
JZ1019	UX	2.347e-04	***0.2040***	0.1741	-0.1833
	UY	4.903e-03	0.1247	0.1521	***-0.1806***
	UZ	-0.0527	***-0.0855***	-0.0741	-0.0727

Seismic gap with width of 0.2 m.







IZMIT -soft end weak first story