

Analiza comportării structurilor cu bază izolată în condițiile seismice din Romania

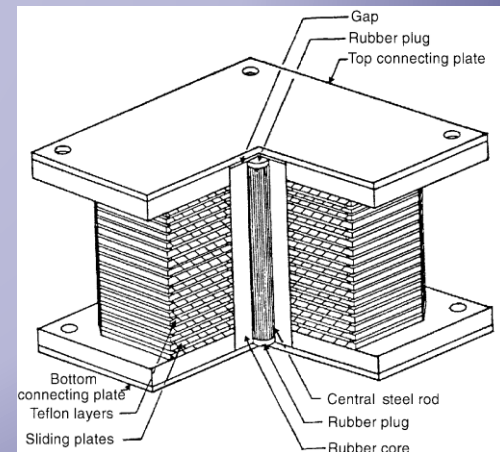
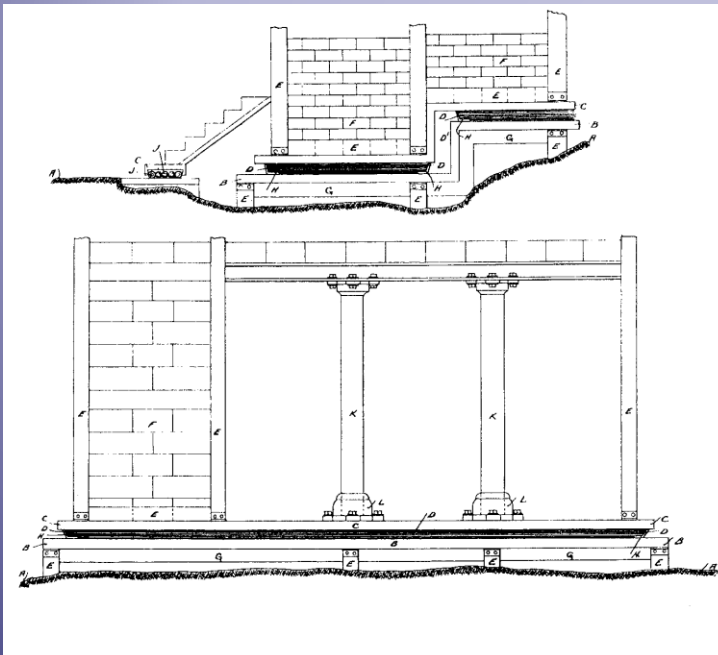
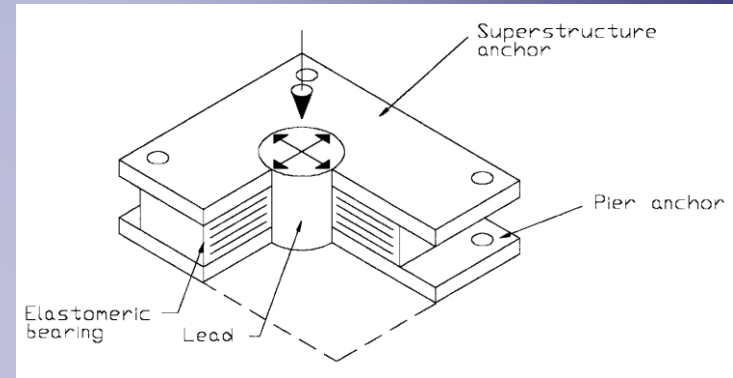
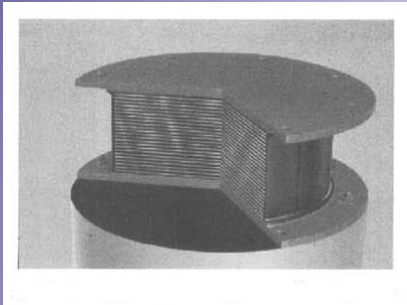
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ing. Biolan Costel**

CUPRINS

- Tipuri de izolatori și domeniul de utilizare
- Metode de calcul
- Studiu de caz:
 - Evaluarea asigurării structurale la seism a unei clădiri cu bază fixă
 - Evaluarea răspunsului seismic al structurii cu bază izolată
 - Dispozitive de control pasiv de tip izolatori din elastomer cu miez de plumb
- Concluzii

Tipuri de izolatori și domeniul de utilizare



Metode de calcul

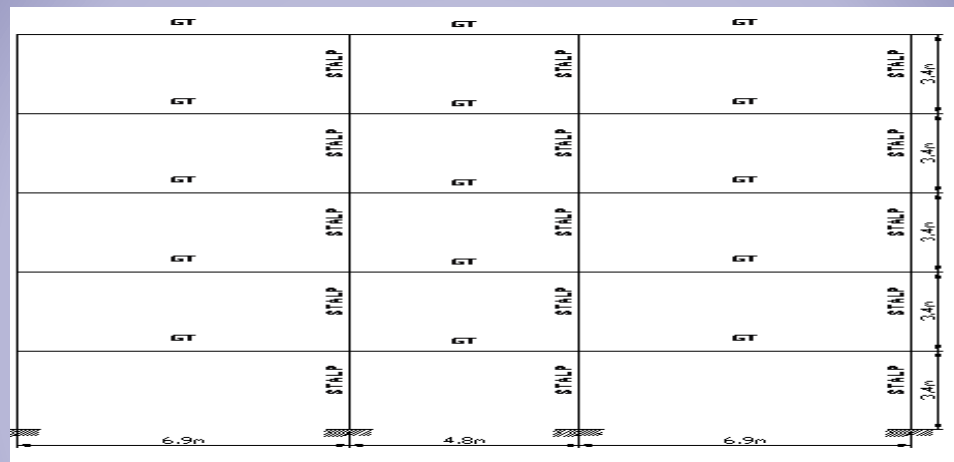
- Cerințele codului UBC pentru proiectarea clădirilor cu bază izolată diferă față de cele pentru clădiri cu bază fixă în funcție de trei aspecte importante:
 - Coeficientul de importanta, I ;
 - Valoarea numerică a ductilitatii globale R ;
 - Pentru clădiri cu bază izolată sunt diferite niveluri ale forței de proiectare pentru elementele de deasupra și de sub interfața de izolare

Metode de calcul

- Limitările de drift pentru clădirile cu bază izolată pot de asemenea să limiteze proiectarea sistemului structural:
 - Analiza spectrului de raspuns $\delta \leq 0.015/R_i$;
 - Analiza raspunsului dinamic $\delta \leq 0.015/R_i$;
- Acestea sunt mult mai restrictive decat pentru clădirile cu bază fixă unde limitele sunt:
 - $T < 0.70s$ $\delta \leq 0.025/(0.70 * R_i)$;
 - $T \geq 0.70s$ $\delta \leq 0.020/(0.70 * R_i)$.

Evaluarea asigurării structurale la seism a unei clădiri cu bază fixă

Structura noua

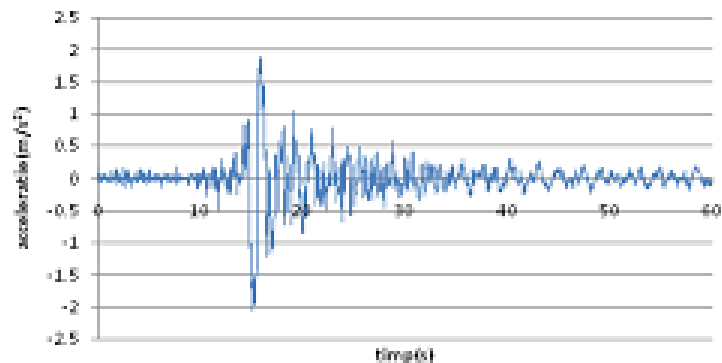


Tipul de secțiune	Dimensiuni (cm)	Aria (m ²)	I (m ⁴)	W _{ef} (m ³)	W _{pl} (m ³)
GT	65X25	0.2489	9.817E-03	0.0176	0.0264
STALP	75X75	0.5625	0.0264	0.0703	0.1055

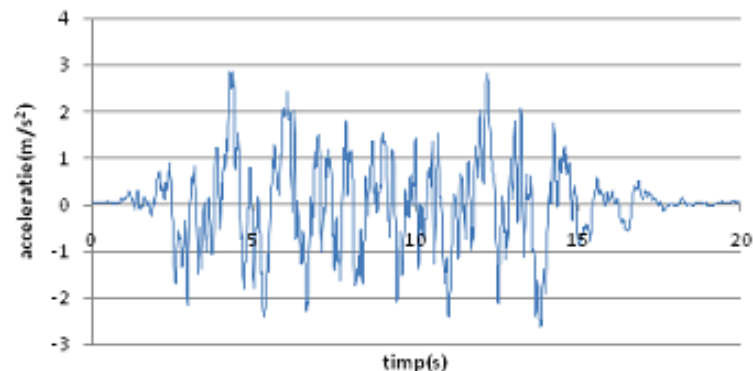
Structura: Beton C25/30, Armare otel OB37

Accelerogramele artificiale si inregistrate generate pentru a calibra izolatorul

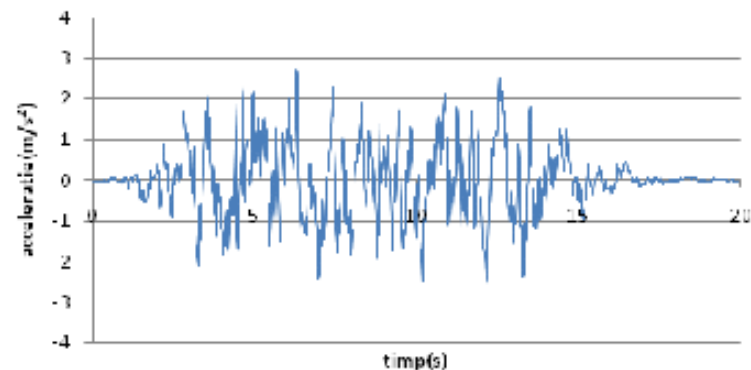
INCERC77



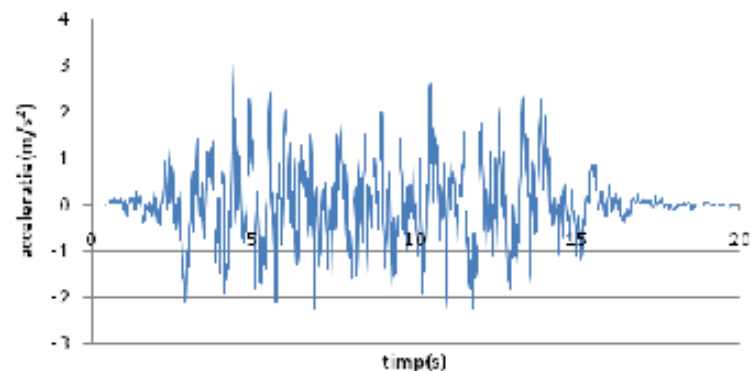
AccTc1.60



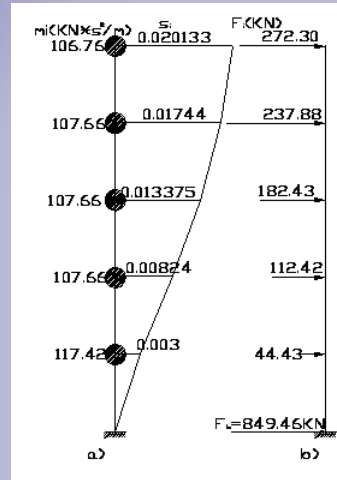
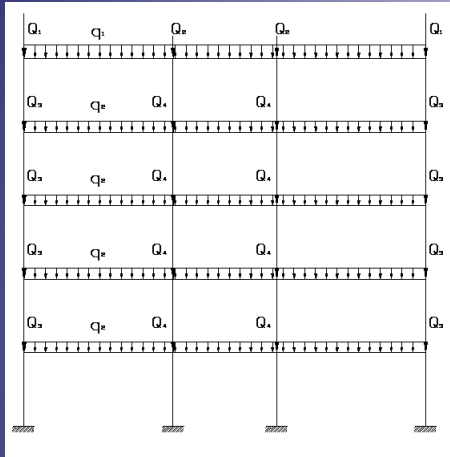
AccTc1.00



AccTc0.70



Structura noua: P100-2006



$$F_b = \gamma_I S_d(T_1) m \lambda$$

$$T_B \leq T_1 \leq T_C \Rightarrow S_d(T_1) = a_g \beta(T_1) / q$$

$$a_g = 0.32g$$

$$\beta(T_1) = 2.75$$

$$q = 3.5 \alpha_u / \alpha_1 = 4.725$$

factorul de
suprarezistentă (1.35)

clasa de ductilitate (M)

Mode n	T_n (s)	ε_n	m_n (KN*s ² /m)
1	0.561	0.801	20.75
2	0.167	0.117	7.92
3	0.085	0.050	5.17


$$\gamma_I = 1.0 \rightarrow \text{clasa de importanta (III)}$$

Structura noua:

$$r = F_{Rd,k} / F_{Ed,k} \geq 1 ?$$

$$d_r^{SLS} < 0.004h ?$$

$$d_r^{ULS} < 0.025h ?$$


$$F_{Rd,k} = \sum_{j=1}^{nc} \left(\frac{M_{Rd,j}^{top} + M_{Rd,j}^{bot}}{h_k} \right)$$

$$\nu = 0.5$$

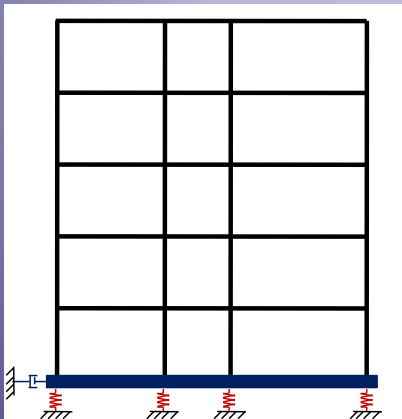
$$c = 3 - 2.5 T_1 / T_c$$

Raspunsul seismic al structurii cu dispozitive de izolare a bazei

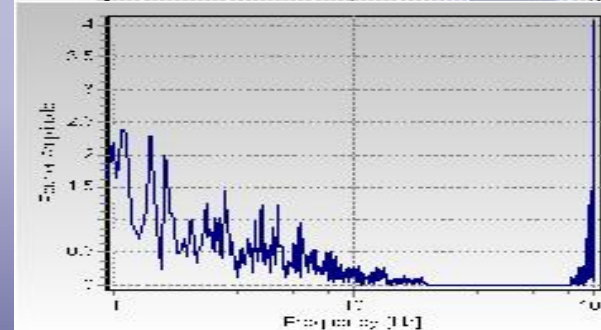
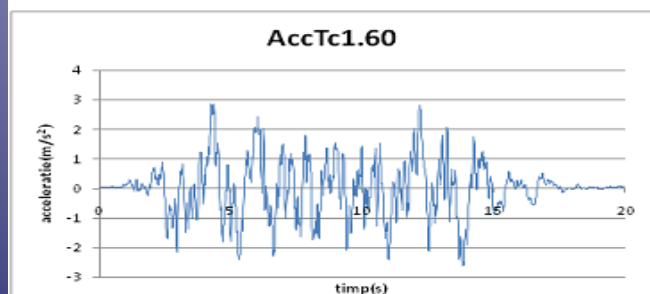
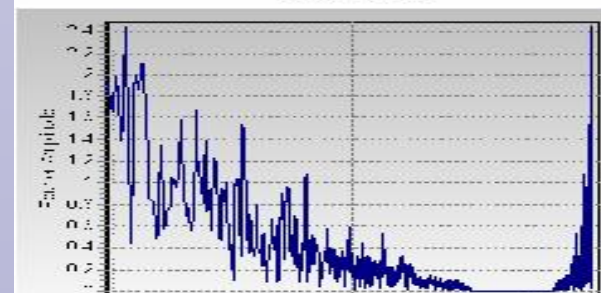
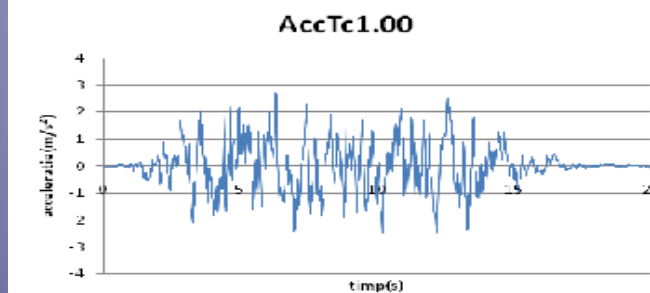
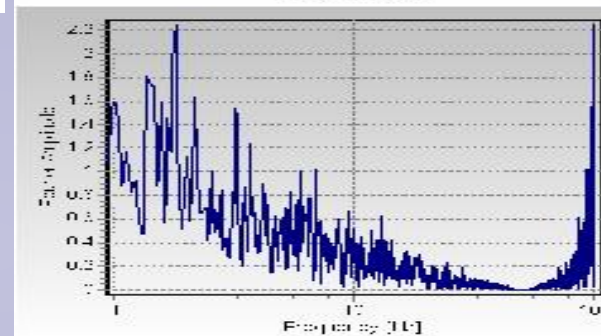
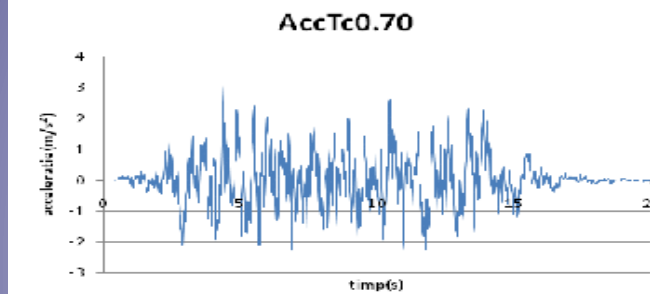
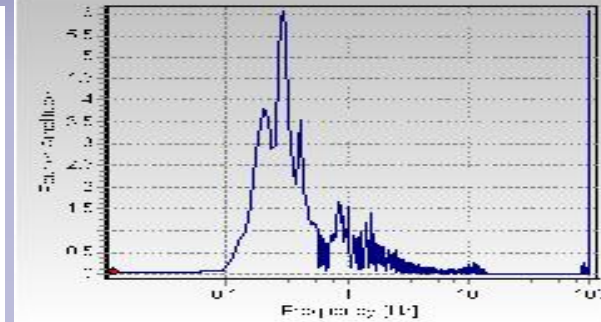
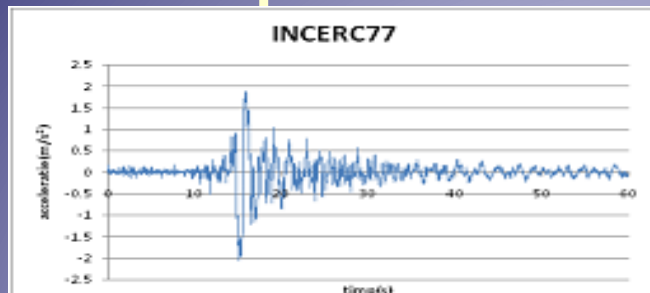
$$F_{b, \max} = r_{\min} F_b; r_{\min} \Rightarrow c_r = q/r > T_D=3s$$

factorul de reducere al
acceleratiilor raspunsului elastic

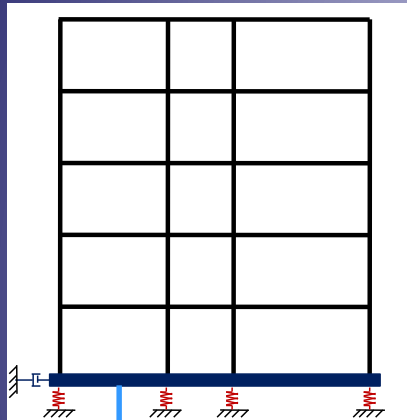
↑ perioada fundamentala



Accelerogramele inregistrate si artificiale si spectrele Fourier corespunzatoare



Dispozitive de izolare a bazei



$h = 60 \text{ cm}$
 $G = 1339 \text{ kN}$

Ipotenze: izolare totala \longleftrightarrow raspuns elastic al structurii

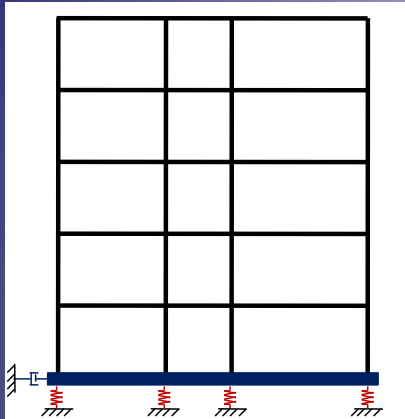
$$a_s = \frac{S_e(T)}{c_r} = \frac{a_g \beta(T)}{c_r} = \begin{cases} a_g \beta_0 \frac{T_C}{T} & T_C < T \leq T_D \\ a_g \beta_0 \frac{T_C T_D}{T^2} & T_D < T \end{cases}$$

$$T_1 = \sqrt{c_r T_C T_D}$$

Bucuresti: $T_C = 1.6 \text{ s}$, $T_D = 2.0 \text{ s}$

Focsani: $T_C = 1.0 \text{ s}$, $T_D = 3.0 \text{ s}$

Dispozitive de izolare a bazei: caracteristicile elastice si dinamice, deplasari maxime



$$K_{bi} = \frac{1}{n_{bi}} \omega_{bi}^2 M = \left(\frac{2\pi}{T_{bi}} \right)^2 \frac{M}{n_{bi}}$$

$$C_{bi} = \frac{2\omega_{bi}\xi_{bi}M}{n_{bi}}$$

$$M = M_s + M_{bi} = 5366 + 1339 = 6755 \text{ kN}$$

$$n_{bi} = 4, \xi_{bi} = 10\%$$

$$d_{\max} = \gamma_1 \frac{S_e(T_{bi})}{\omega_{bi}^2} \eta = \begin{cases} \gamma_1 \beta_0 \frac{T_C T_D}{4\pi^2} a_g \eta & T_{bi} \geq T_D, & S_D(T) = \text{const.} \\ \gamma_1 \beta_0 \frac{T_C T_{bi}}{4\pi^2} a_g \eta & T_C \leq T_{bi} \leq T_D \end{cases}$$

$$\eta = \sqrt{10/(5 + \xi)}$$



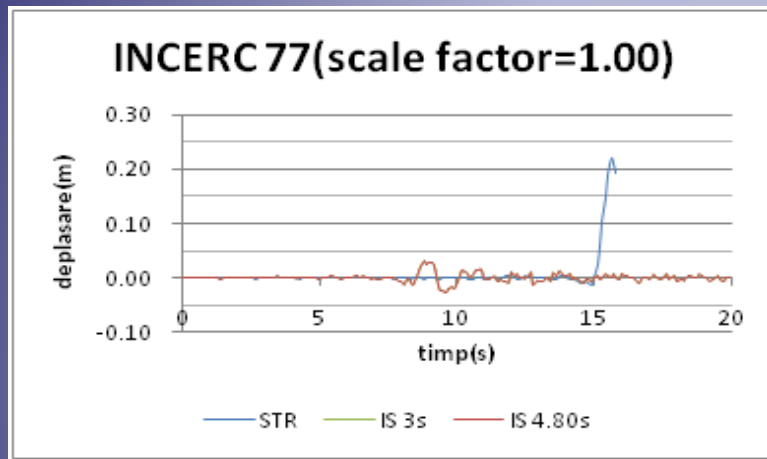
$$\eta = 0.817$$

Device	T_{bi} (s)	K_{bi} (kN/m)	C_{bi} (kNs/m)	d_{\max} (m)
IS3.0	3.0	740.90	70.75	0.320
IS4.8	4.8	289.42	44.22	0.270
IS2.0	2.0	1666.95	106.12	0.367

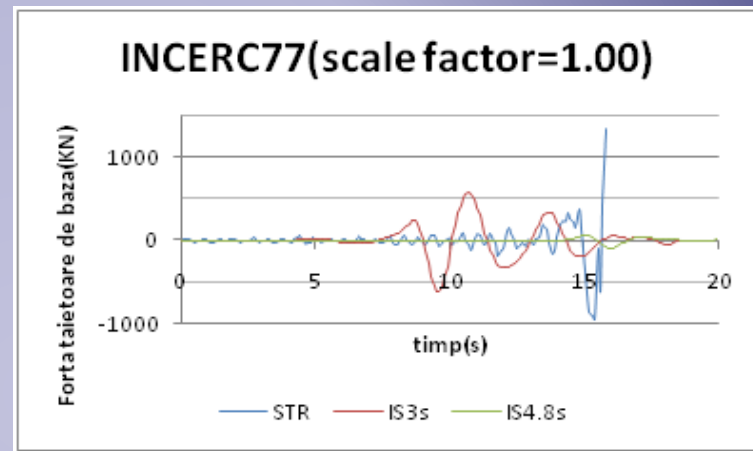
Rezultatele analizei

Bucuresti, Vrancea/N-S/1977

deplasarea de la ultimul nivel

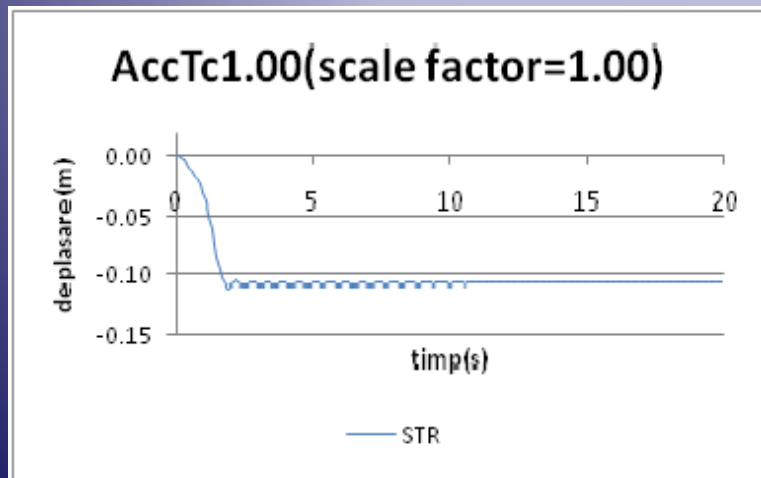


forta taietoare de baza

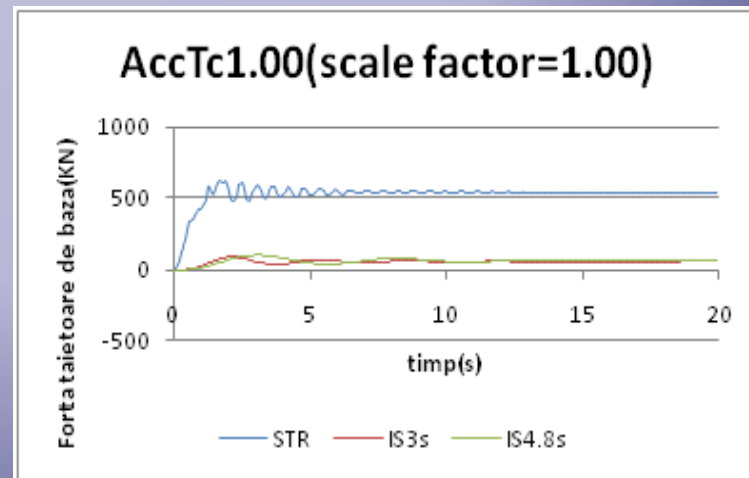


Focsani: accelerograma artificiala

deplasarea de la ultimul nivel



forta taietoare de baza

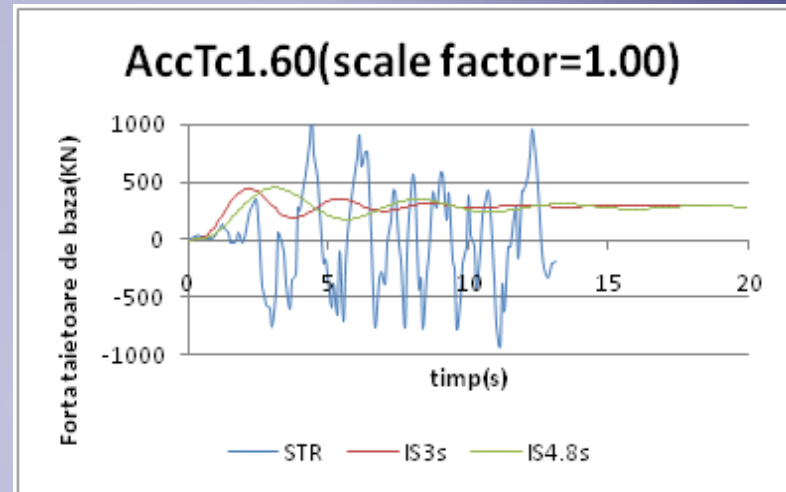
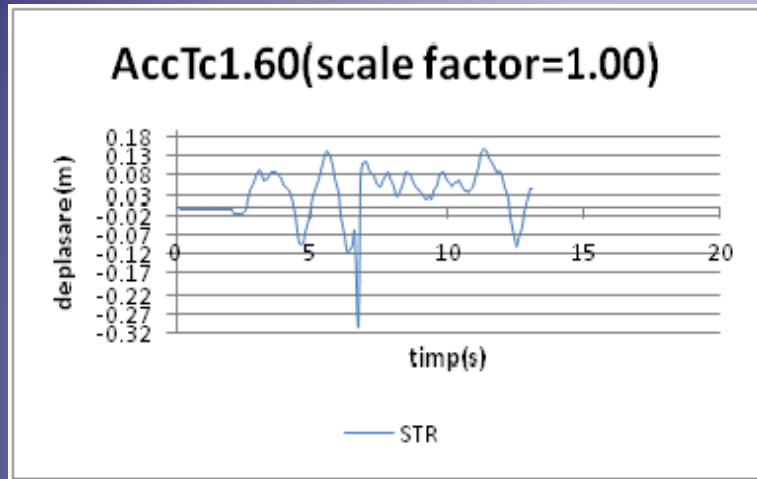


Rezultatele analizei

Bucuresti: accelerograma artificiala

deplasarea de la ultimul nivel

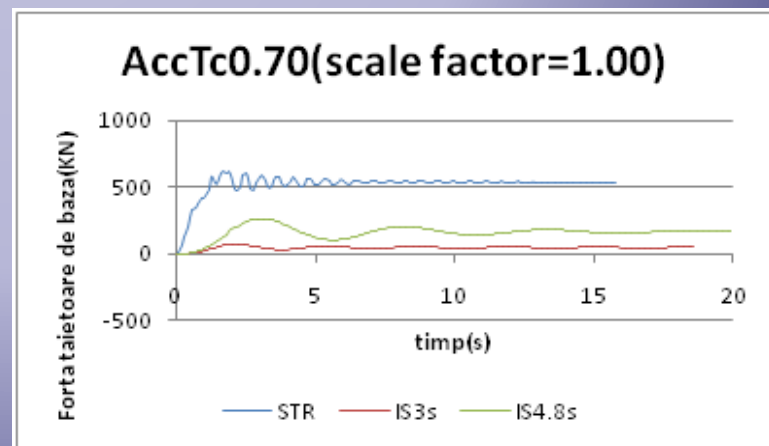
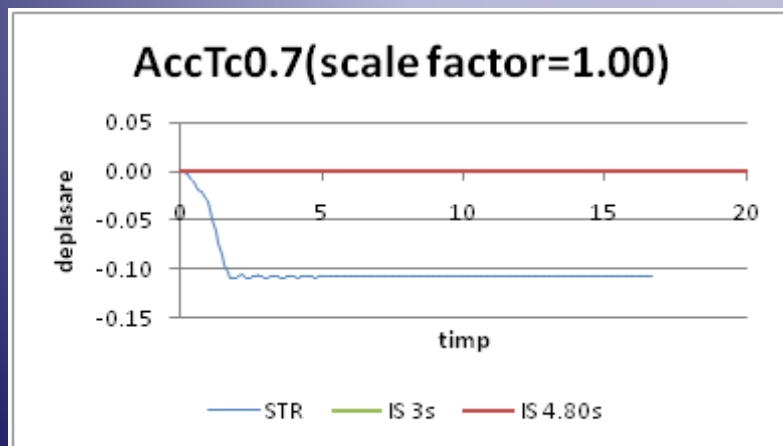
forta taietoare de baza



Targoviste: accelerograma artificiala

deplasarea de la ultimul nivel

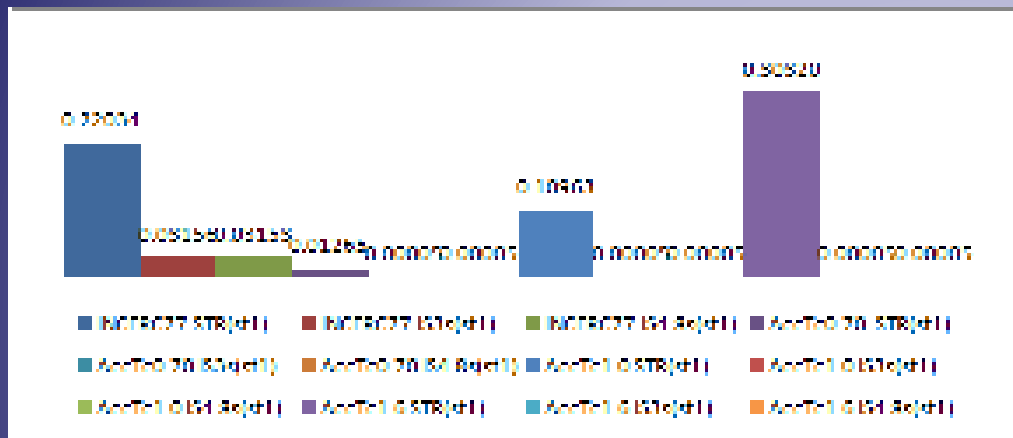
forta taietoare de baza



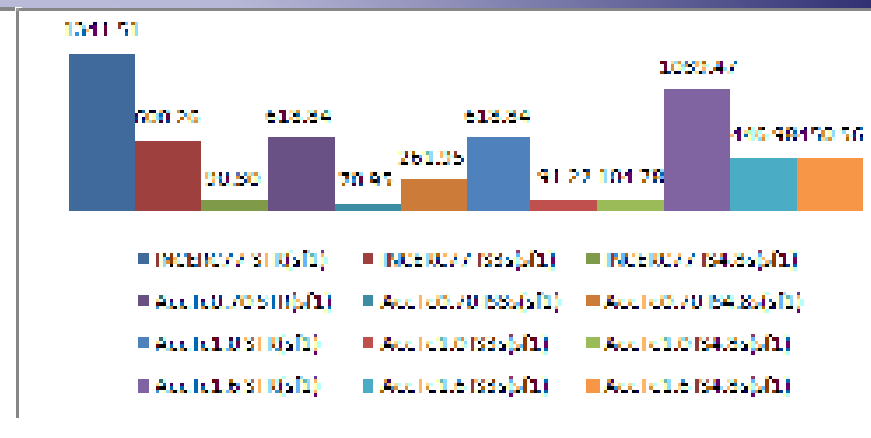
Rezultatele analizei

Valori maxime

Deplasarile de la ultimul nivel



Forța tăietoare de baza



85.7 % d_{max}

93.3 % $F_{b,max}$

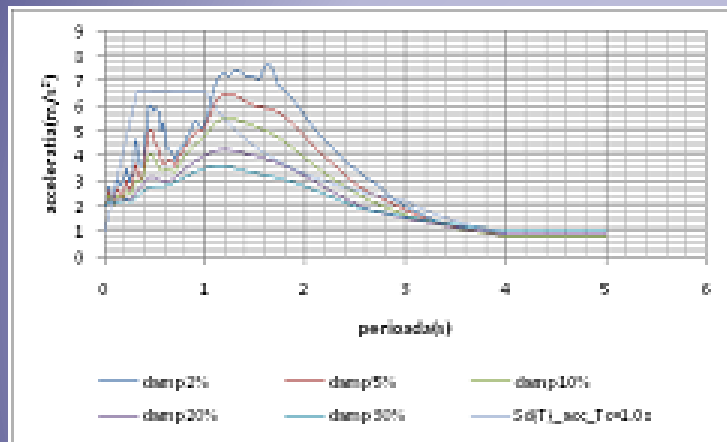
89.4 % F_b/γ_1

IS4.8

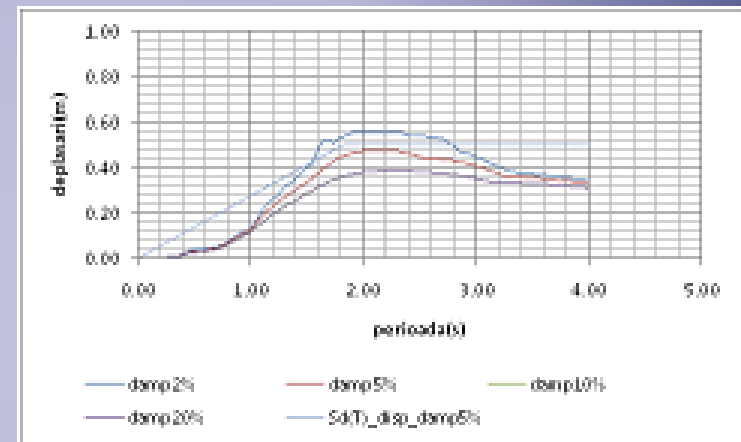
→ Izolare totala, raspunsul structural elastic

Spectrele de raspuns in cazul accelerogramei INCERC77 si diferite valori ale amortizarii critice

Spectrul acceleratiilor absolute



Spectrul deplasarii relative



$\xi = 5\%$  $\xi = 30\%$



{ acceleratii absolute
deplasari relative

Izolarea bazei: mai eficienta solutie in reducerea fortei taietoare de baza



$$T_1 \geq T_D$$



forta taietoare de baza

Concluzii

□ Dispozitive de izolare a bazei

- Raspunsul structural este mutat din zona de amplificare
- Spectrul Fourier pentru solurile din Romania: perioada fundamentala a structurii poate fi mai mare decat $T_C \Rightarrow T_{bi} \geq 3T_C$
- Deplasari laterale mari \leftrightarrow in vecinatatea cladirilor
 - $T_{bi} = 3T_C, d_{\max} \cong 40 \text{ cm}; T_{bi} = 2T_C, d_{\max} \cong 50 \text{ cm}$
- $\xi = 20\% \rightarrow T_{bi} \geq T_D$

- ## □ Accelerogramele artificiale s-au dovedit sa fie prea restrictive, ca o consecinta fireasca a compatibilitatii lor cu spectrul de proiectare, care este o anvelopa a spectrului de raspuns actual.

