Slika 4: Prvi zgrajeni objekt (enodružinska hiša) na seizmični blazini v svetu.

Figure 4: First finished building (one-family house) with 'seismic foundation pillow' in the world.

Vojko Kilar

OBNAŠANJE XPS PRI TLAČNI IN STRIŽNI OBREMENITVI

POVZETEK

V okviru raziskovalnega projekta smo v Konstrukcijsko-prometnem laboratoriju na UL FGG izvedli eksperimentalne meritve mehanskih karakteristik toplotnoizolacijskih plošč iz ekstrudiranega polistirena (XPS) pri tlačni in strižni obremenitvi. Preiskave so potekale v skladu z določili standardov SIST EN 826: 1997 (obnašanje pri tlaku) in SIST EN 12090: 1999 (obnašanje pri strigu). Najprej smo izvedli monotone preiskave, nato pa še ciklične. Testirali smo preskušance izrezane iz toplotnoizolacijskih plošč iz XPS kvalitete 400-L (d = 120 mm) in XPS 700-L (d = 100 mm). Preiskave so potekale v servo-hidravličnem stroju, deformacije preskušanca pa smo merili s pomočjo LVDT merilcev. Preskušanec za strižne preiskave je bil sestavljen iz dveh XPS blokov, ki sta bila prilepljena na sistem treh vzporednih jeklenih plošč, od katerih je bila srednja pomična, zunanji plošči pa fiksni (slika 5).

Dobljen odziv XPS-a pri tlačnih preiskavah lahko razdelimo na tri karakteristična območja: i) elastično (do deformacije 2–3%), ii) plastično (do deformacije ~75%) in iii) utrditev (pri zelo stisnjenih stanjih). Izkazalo se je, da je tlačna napetost pri 10% tlačni deformaciji, ki jo v svojih katalogih kot deklarirano tlačno trdnost navajajo proizvajalci XPS, vedno v plastičnem območju. Pri cikličnih strižnih preiskavah smo preskušance izmenično obremenili do izbrane deformacije, jih nato razbremenili do sile 0 ter nato obremenili v nasprotni smeri. Strižni odziv napetost – deformacija kaže bistveno manjšo duktilnost XPS-a v primerjavi z obnašanjem v tlaku, v globokem nelinearnem stanju je izrazit tudi padec nosilnosti. Prve poškodbe (meja elastičnosti) v strigu se pojavijo prej pri tlačno močnejšem (700-L) kot pri tlačno šibkejšem XPS (400-L). Tovrstni ciklični testi XPS plošč v svetu doslej še niso bili izvedeni. V prispevku B. Azinovića je prikazano, kako smo izmerjene rezultate uporabili za analizo pasivnih hiš pri potresu (uporabljeni računski podatki so prikazani na sliki 6).

BEHAVIOUR OF XPS UNDER COMPRESSIVE AND SHEAR LOAD

SUMMARY

Within the project also laboratory tests of the compressive and shear behaviour of extruded polystyrene XPS boards were performed in the testing Laboratory of Civil and Geodetic Engineering Faculty at the University of Ljubljana. The tests were determined according to the standards SIST EN 826: 1997 (behaviour in compression) and SIST EN 12090: 1999 (behaviour in shear). The test specimens were blocks cut out from the XPS boards of quality 400-L (d = 120 mm) and 700-L (d = 100 mm). For the tests a servo-hydraulic testing machine was used while the deformations of the XPS specimen were monitored by means of LVDTs. The test specimen for the shear tests consisted of two XPS blocks glued on the system of 3 parallel steel plates where the middle one was movable and the outer plates were fixed (Figure 5).

The obtained compressive response of the XPS can be divided into 3 characteristic regions: i) elastic (up to deformation ~ 2-3%), ii) plastic (up to deformation ~75%) and hardening part. The tests have shown that the compressive stress measured at the level of compressive deformation equal to 10% (which is commonly declared compressive strength value) always lies in the plastic region. In most cases of shear monotonic test the failure within the XPS occurred. In the case of cyclic shear tests the testing procedure was similar to that used in the monotonic tests, but with additional unloading-reloading cycles at selected level of deformation. Comparing the stress – strain response of the XPS in compression and in shear, it can be seen that the obtained shear ductility capacity is smaller, and that strength degradation is evident in the deep nonlinear range of behaviour. In shear the first damage (yield) was detected in compressively stronger XPS specimen (700-L) before than in the case of compressively weaker XPS (400-L). Such cyclic test of XPS boards has not been performed elsewhere before. In the following contribution of B. Azinović it is shown how the obtained characteristics have been used for analysis of passive houses in seismic areas (used structural model and material data are presented in Figure 6).

UPORABNOST REZULTATOV

Z eksperimenti so bile določene karakteristike XPS, ki so bistvene za potresne analize stavb temeljenih na XPS. Tlačne trdnosti so podobne deklariranim vrednostim v katalogu proizvajalca, doseženi moduli elastičnosti pa so nekoliko nižji. Izmerjene strižne karakteristike, ki jih proizvajalec do sedaj ni navajal, znašajo 0.14 (0.22) MPa (trdnost) oz. 4.5 (7.5) MPa (modul) za XPS 400-L (700-L).

KLJUČNE BESEDE

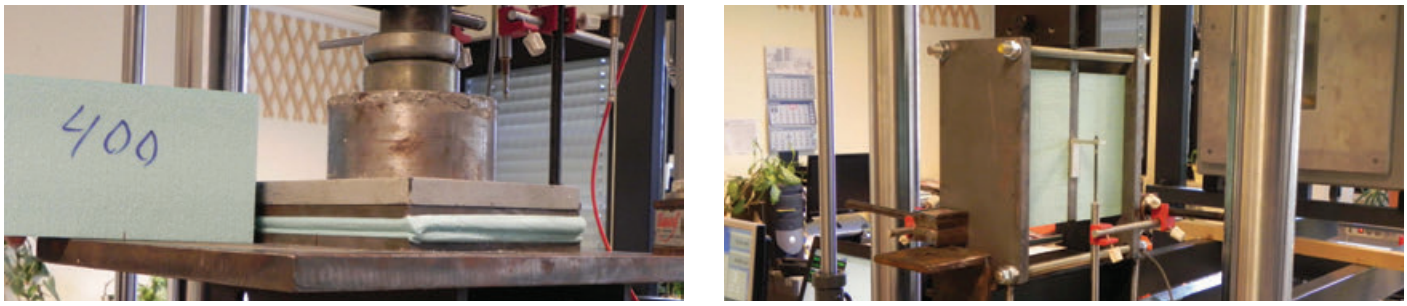
Ekstrudiran polistiren (XPS), temeljenje na toplotni izolaciji, tlačna/strižna trdnost, potresni odziv.

ISSUES AND ITS SIGNIFICANCE

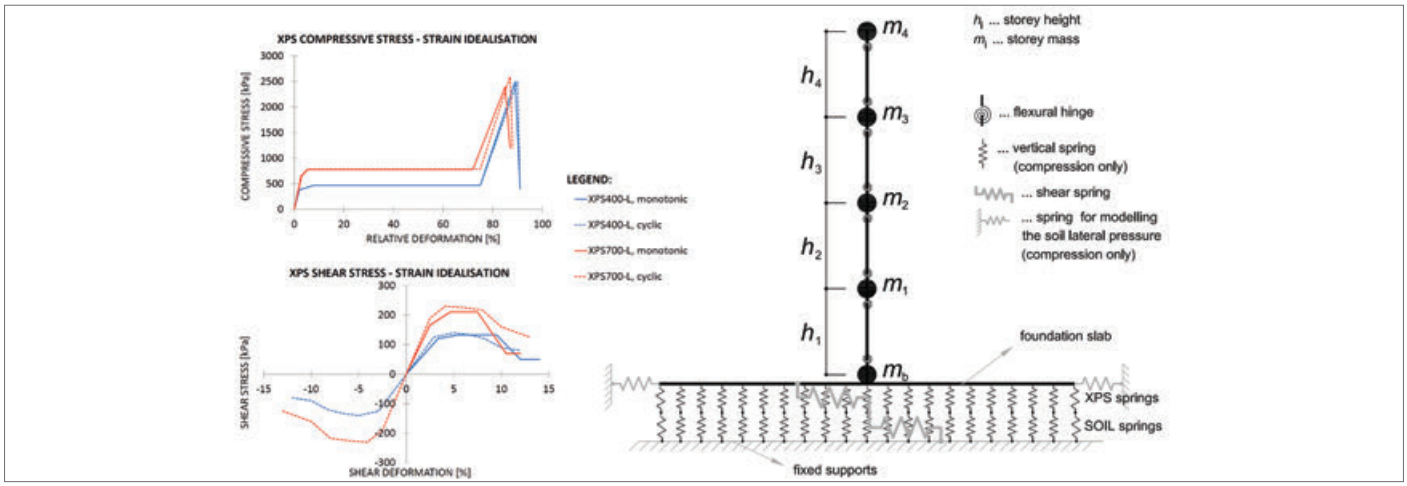
The characteristics of XPS which are essential for the seismic analysis of buildings founded on XPS boards have been experimentally determined. The measured compressive strengths are similar to the declared values from the producers' catalogues, while the obtained values of elastic moduli are slightly lower. Measured shear characteristics which have not been provided by the producers till now are 0.14 (0.22) MPa (strength) and 4.5 (7.5) MPa (modulus) for XPS 400-L (700-L).

KEY WORDS

Extruded polystyrene (XPS), foundation on thermal insulation, compressive/shear strength, seismic response.



Slika 5: Vzorec XPS pred in na koncu tlačne preiskave (levo) in preskušanec za strižno preiskavo nameščen v preskuševalnem stroju (desno). [Bokan-Bosiljkov, 2013a]
Figure 5: XPS specimen before and at the end of the compressive test (left) and XPS shear test setup (right). [Bokan-Bosiljkov, 2013a]



Slika 6: Idealizirani diagrami napetost – deformacija vzorcev XPS 400-L in 700-L in poenostavljen numerični model (4-etažne) stavbe temeljene na XPS.

Figure 6: Idealised stress – deformation diagrams of the XPS 400-L and 700-L specimens and simplified numerical model of a (4-storey) building founded on XPS.

David Koren

PREISKAVE TRENJA IZBRANIH SKLOPOV IZ XPS

SLIDING RESISTANCE OF XPS FOUNDATION SETS

POVZETEK

V okviru eksperimentalnih raziskav izvedenih v Konstrukcijsko-prometnem laboratoriju na UL FGG so bile opravljene tudi preiskave trenja na sklopih, ki se uporabljajo na stiku konstrukcije s temeljnimi tlemi. Ti testi niso standardizirani in so bili za potrebe preiskav zasnovani posebej [Bokan-Bosiljkov, 2013b]. Testirani sklopi so bili sestavljeni iz ene ali dveh XPS plošč, betonske plošče, z/brez hidroizolacije (HI) ali polietilenske folije (PE) med izbranimi sloji. Sklopi s HI

SUMMARY

In order to estimate the coefficients of friction between the different constituent elements in TI foundation set shear tests were carried out in the testing Laboratory of Civil and Geodetic Engineering Faculty at the University of Ljubljana. These tests have not been standardised yet and they were for the need of our experiment specially developed [Bokan-Bosiljkov, 2013b]. Various TI foundation sets were analysed – composed of one or two XPS boards, concrete slab, with/without a waterproofing insulation (HI)