The Preliminary Study of Seismic Microsonation and Seismic Hazard Assessment for Urban Areas of Gori (Georgia)

Z. Gogoladze, M. Moscatelli, D. Albarello, N. Tsereteli, S. Giallini Ivane Javakhishvili Tbilisi State University, M. Nodia Insitute of Geophysics Institute of Environmental Geology and Geoengineering of the Italian National Research Council Email: zurab.gogoladze.3@gmail.com

Abstract

Seismic risk is a crucial issue for South Caucasus, which is the main gateway between Asia and Europe. The goal of this work is to propose new methods and criteria for defining an overall approach aimed at assessing and mitigating seismic risk in Georgia.

This abstract presents the results of preliminary study of seismic microzonation of the city of Gori (Georgia) that was done in the frame of CNR (National Research Council of Italy) project - Preliminary study for the assessment of seismic risk in strategic cities of"Georgia". The city of Gori is the central of Shida Kartli region (Mkhare) and is located on both sides of Liachvi and Mtkvari rivers, in the 135 km² around the Gori fortress .

The seismic microzonation map of level 1 of Gori was carried out in the light of 1) 30 13.5 1885 1030 three-component velocimeter (http:// EOLOGICAL CROSS SECTION $f_0 = 7.06 Hz$ already available data (i.e., topographic map and boreholes data), 2) results of new 601.294 Landslide www.tromino.it). Measurements Alluvial deposits Joint inversion of T22 and MASW Rugby Stadium Flysch and tertiary molass geological surveys and iii) geophysical measurements (i.e., MASW and noise were analysed using both Grilla and Boreholes projecte onto A-A' section Vs, Vp velocity profiles and resonance interfaces measurements processed with HVSR technique). So we have done seismic free field Geopsy software. Geological-Technical Map (GTM) is the results of the codification of geological map in according to the technical representation investigations full of the city and over the most strategic buildings and important parts of At each point, it was computed HVSR evaluating the ratio between the horizontal and the vertical component of ambient vibration measured at the same station by averaging them on 50-s-long time standards developed by the Italian Department of Civil Protection. windows into which each trace was subdivided. A first order baseline correction and a 5 % cosine taper was applied to each window, and the Fourier spectra were calculated and smoothed using the Konno Gori : the city hall, the hospital, the Rugby stadium, Castel of Gori and museums and and Ohmachi algorithm (with b = 40); the windows exhibiting large amplitude transients were excluded manually. The geometrical mean of horizontal components was used to compute HVSR. As ground motion di-The Geological-Technical Map for Seismic Microzonation (GTM_SM) contains all the basic information (geological, geocentral square. Our preliminary results highlights the presence of both stable zones rectionality can be viewed as an indication of strong topographic site effects, in order to investigate preferential directions of the amplification (i.e., polarization of ground motion), HVSR ratios were computed by romorphological, lithotechnical, geotechnical and hydrogeological characteristics) derived from existing maps and documents to susceptible to local amplifications and unstable zones susceptible to geological instability. tating the horizontal component between 0° and 180° (directional or polar HVSR). define the subsoil model and develop the Map of Seismically Homogenous Microzones (Level 1). The map must also list all Our results are directed to establish the set of actions aimed at risk mitigation before the previous information, the most significant litostratigraphic ratios and the most representative litotechnical sections. initial onset of the emergency, and to the management of emergency once the seismic The units of the Geologic Bedrock are to be defined through:

event has occurred. The products obtained will constitute the basic elements of an integrated system aimed at reducing the risk and improving the overall safety of people Sratification, if existing (i.e.: stratified, non-stratified); and infrastructure in Georgia. Degree of fracturing or alteration (expert qualitative evaluation)

Geological Overview

The geological bedrock of the study area consists of Flysch and tertiary molasse, made of alternating sandstone and marls layers, covered by Quaternary deposits. These latter are made of alluvium deposits consisting mainly of silty-gravels and loams deposits. In the Eastern part of Gori is also possible find conglomerates of Pleistocene fluvial terraces. Bedrock flysch outcrops near the Gori Fortress and toward South and East of Gori downtown.

From a morphologic viewpoint, there are also steep slopes formed by rock falls (such as northwest of the Gori Fortress).



Figure 1 - Flysch formation cropping out on the western side of the area





Plan view of the available and new measurements.

Red grids locate the study area

Stratigraphic information were obtained from 20 available borehole data, whose information have been translate from Russian to English language.

Moreover, despite the difficulties due to the heavily urbanized area, a large amount of geophysical data were gathered during the project. They consist of data of: (i) 55 noise single-station and (ii) 6

MASW (Multichannel Analysis of Surface Waves) measurements.

In particular, the first ones provide results in terms of: HVSR (Horizontal to Vertical Spectral Ratio) curves; rotational HVSR and single spectra from single station measurements; while the second one in terms of dispersion curves that can be combined with ellipticity of Rayleigh waves.









Data processing

Active seismic surveys were performed close to strategic buildings and places, such as Militar Hospital, Gori Fortress, Museum of Stalin, Rugby stadium, University, and in the remaining part of the city.

Each noise measurement was about 40 minutes, with a sampling set at 128 Hz using a Tromino, a compact



Results

The noise measurements allowed the realization of a detailed f0 and f1 natural frequencies map of the area. HVSR curves individuate a broadband peak around 7 Hz at the top of the Gori Fortress, while a 5 Hz

sec to 2000 m/sec.

bank of river it varies 400 m/sec- 410 m/sec, 470 m/sec, Rugby Stadium 601 m/sec.

The Map of Seismically Homogeneous Microzones of Gori (Figure 16) has been achieved on geological, geomorphological and geophysical surveys and lithostratigraphic data (borehole data). The analysis of the data made it possible to establish the absence of stable areas in scricto sensu, and the prevalence of stable areas susceptible to local amplifications and areas susceptible to instability. In detail, in Figure 17 are reported three different types of stable zones prone to instability, codified and identified in Gori following the procedure recommended in the Guidelines for Seismic Microzonation (SM Working Group, 2015).

Stabile zones prone to local amplification:

Microzones where flysch outcroppings are present. It is codified as granular cemented bedrock, stratified, fractured or alterate bedrock; Microzone characterized by the presence of recent alluvial deposits;

Microzone characterized by the presence of conglomerate deposits of Quaternary fluvial terraces; Zones prone instability:

In Gori, on the basis of preliminary investigations and of available information, it is been also detected an area prone to insyability (code 30412099), at Northen aide if hill where Gori fortress is situated (as reported | in geological and geotechnical map)

- peak may be distinguished in the city centre. In the north part of the downtown (out of the investigated map), a deep interface with a peak between 1 - 1.5 Hz is indi-
- MASW results with joint inversion with ellipticity allowed also the evaluation of the 5 different velocity models. The show surface shear wave velocities (Vs) ranging from 200 m/
- According to Eurocode8 norms is evaluated Vs30 : and at the
- On the Castle of Gori 669 m/sec, Stalini museum which is located in the centre of Gori Vs30 = 545m/sec Gori University

