The Italian strong motion database: ITACA 1.0

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The main objective of Project S4 (2007-2009 DPC-INGV agreement, http://esse4.mi.ingv.it)) has been to make available through the Internet an updated and improved release of the Italian strong motion database (ITACA), originally developed within project S6, in the framework of the 2004-2006 DPC-INGV agreement. A first release of the alpha version of ITACA was published in the Internet on July 2008, and migrated to a robust system (INGV server) on November 2008. A new significant update of ITACA (beta version) was released on January 2010. The final version of the database, ITACA 1.0, has been released on July 2010 (http://itaca.mi.ingv.it/ItacaNet). A great deal of work has been dedicated to update the information contained in ITACA, that has also led to important changes in the structure of the database.

All the general information relating to the stations (address, housing, coordinates, instrumental history, etc.) and the instrumental characteristics of digital recordings have been reviewed. New information on recording sites (site classification, morphology, peculiar response sites) were included in ITACA and reported in the station monographs and partially in the web-interface. In particular, station data concerning EC8 site classification, topography category, morphological description and fundamental frequency from microtremor measurements have been updated or added. When available, V_{S30} values and S-wave velocity at bedrock have been included. Finally, a short note has been added, when required, at the synthesis page of the station monograph to summarize specific aspects related to the seismic response of the station site or possible effects of soil structure interaction.

Other modifications in the structure of the database are a consequence of the implementation of the tool to perform the dynamic compilation of the station monographs, to allow the storage of additional information relative to the sites (maps, spectral ratios, references, image files, pdf documents, etc.).

The new web version of ITACA is characterized by a new home page (Figure 1), which contains more information than in the beta version (i.e. a section on new data, the description of the project history and many links and utilities) and by three main user-friendly interfaces (Figure 2), one for waveforms, one for stations and one for events, that, through the setting of the search fields, allow to perform queries to look for and download strong motion data.

Figure 1 - ITACA home page

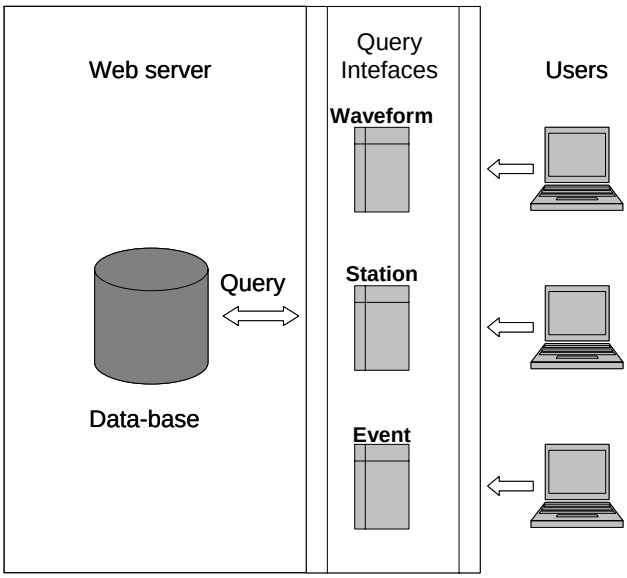

Figure 2 - Structure of the ITACA portal

New search-fields have been added to enable users to explore in detail the contents of the database and the options to download and display data have been expanded to make use of ITACA in a way as flexible as possible. Details on the structure and on the use of the database can be found in the **user-manual** downloadable from the home page of ITACA.

Further utilities have been added, such as the **glossary** of the most used engineering and seismological terms, a user's guide of the database and the manual explaining the station reports, in order to help the site exploration.

A useful engineering tool has been added, **REXELite** (Iervolino et al., 2009), which is a simplified version of the software formerly released in the framework of the RELUIS projects (http://www.reluis.it). This application allows one to search a suitable combination of natural strong motion records compatible with a target spectrum, either based on the Italian Building Code (NTC 08) or the Eurocode 8, or defined by the user. The search can also be associated to magnitude and epicentral distance of the target event.

To keep track of the ITACA users, a **user's registration** has been introduced in the 1.0 release, that is required only for download operations. This is expected to provide useful information for DPC and for the ITACA operating team to understand which are the professions and the objectives of the ITACA users.

Although the waveforms available at the start of Project S4 in the alpha version of ITACA were treated by following the worldwide accepted techniques, aiming to remove low and high frequency noise, the compatibility among acceleration, velocity and displacement waveforms was not guaranteed. For these reasons, a novel approach for processing the ITACA strong-motion records has been devised.

Referring to Paolucci et al. (2010) for details on the procedure, its basic steps are the following:

- baseline correction (constant detrending);
- application of a cosine taper, based on the visual inspection of the record (typically between 2% and 5% of the total record length); records identified as late-triggered are not tapered;
- visual inspection of the Fourier spectrum to select the band-pass frequency range (Figure 3); whenever feasible, the same range is selected for the 3-components;
- application of a 2nd order acausal frequency-domain Butterworth filter to the acceleration time-series;
- double-integration to obtain displacement time series;
- linear detrending of displacement; double-differentiation to get the corrected acceleration

Particular attention was paid to identify the late-triggered records, typically on the S-phase, that form a large portion of analogue records in the ITACA database, from small-to-medium magnitude earthquakes.

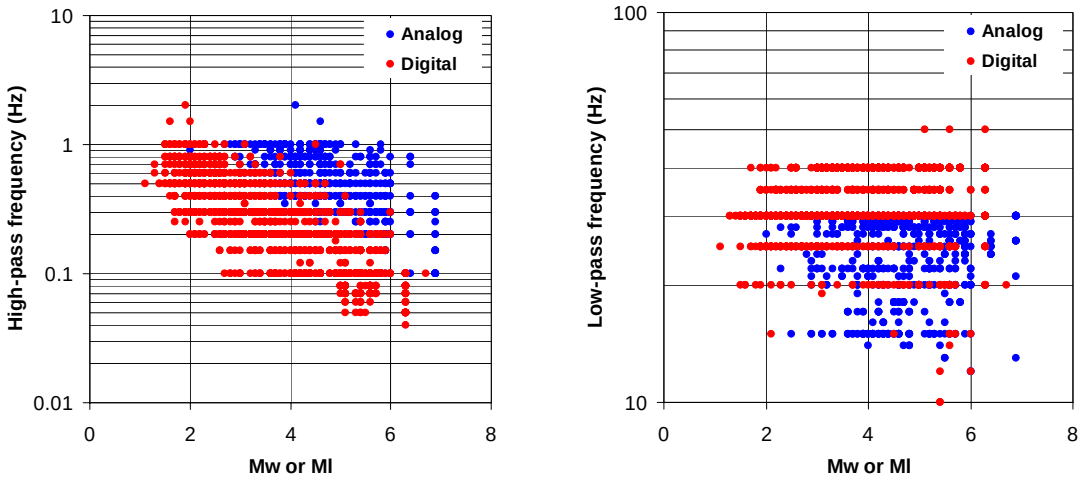

Figure 3 - ITACA data set: Frequencies filtering (Ns component) plotted as a function of magnitude

Compared to the alpha version, the ITACA data set has been updated by 1110 accelerograms recorded by the Accelerometric National Network (RAN), in the period 2005-2007, from 740 events and 369 stations.

In addition, about 300 strong motion data recorded by three local networks were included, i.e., the Strong Motion Network of Northern Italy, Rete Accelerometrica dell'Italia Settentrionale, *RAIS* http://rais.mi.ingv.it/, the Seismic Network of the Basilicata region, *BAS*, and the Seismic Network of the Autonomous Province of Trento, *PVTR*). Moreover 30 records relative to temporary stations and networks (analogue and digital), either installed in the framework of Project SISMOVALP (*INTERREG IIIB Alpine Space Programme 2001-06*, network *SVALP*) or during the post-earthquake emergency phase, namely the Gemona (GMN) station, installed by ING during the 1976 Friuli seismic sequence, and the 4 stations installed by INGV-MI during the L'Aquila seismic sequence (MI01-02-03-05). In addition, waveforms recorded during the L'Aquila seismic sequence, including the mainshock, by the accelerometer installed at Aquila Castello station (AQU) (http://mednet.rm.ingv.it) are also present.

In conclusion, the published version 1.0 of the new Italian strong-motion database ITACA (Italian ACcelerometric Archive, http://itaca.mi.ingv.it) includes to date (December 2010) 3955 three-component waveforms: 3562 of them were recorded during 1802 earthquakes with a maximum moment magnitude of 6.9 (the 1980 Irpinia earthquake) in the period 1972–2007. The most recent records comes from the recent M_w5.4 2008 Parma and from the M_w6.3 2009 L'Aquila earthquakes and related $M_w > 4$ aftershocks. A total of 723 analog and digital stations are present in ITACA, 399 of which have provided accelerometric data. The stations

mainly belong to the National Accelerometric Network (RAN, *Rete Accelerometrica Nazionale*), now operated by the Italian Department of Civil Protection (DPC).

Reference

Paolucci R, Pacor F, Puglia R, Ameri G, Cauzzi C and Massa M (2010) Record processing in ITACA, the new Italian strong-motion database. In Akkar et al. (eds.), Earthquake Data in Engineering Seismology, Chapter 8, Geotechnical, Geological and Earthquake Engineering Series, Vol 14, Springer.