

DOCUMENTARIES ON THE DEVELOPMENT AND APPLICATION OF SEISMIC VIBRATIONS CONTROL TECHNIQUES

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SUMMARY

This paper summarizes the main features and so far obtained results of the Project MUSICA ("MUltimediale per lo sviluppo di Sistemi Innovativi per Costruzioni Antisismiche", namely "Multimedia for the Development of Innovative Systems for Anti-Seismic Constructions"). Activities for MUSICA were jointly undertaken by the Italian Agency for New Technology, Energy and the Environment (ENEA) and some other partners associated to the Italian Working Group on Seismic Isolation (GLIS) in 2000. The project objectives are to contribute to information and training on the modern passive control techniques of seismic vibrations through a better, modern use of media. Activities consist in the development of a series of films and documentaries, of various durations and for different viewers, on manufacturing, R&D and applications of the aforesaid techniques, namely seismic isolation, passive energy dissipation, hydraulic coupling by means of shock transmitters, systems formed by shape memory alloy devices, "active sewing" method for masonry buildings, etc. Some of these films and documentaries are addressed to designers and representatives of the Institutions and others to the ordinary public.

INTRODUCTION

Since 1988, large efforts have been devoted by the Italian Agency for New Technology, Energy and the Environment (ENEA – "Ente per le Nuove tecnologie, l'Energia e l'Ambiente") to the development, validation and application of modern seismic vibration control (SVC) techniques, namely [1-3]:

- seismic isolation (SI);
- passive energy dissipation (ED);
- provisional hydraulic coupling (HC) by means of shock transmitters (STs);
- coupling of structures using shape memory alloy (SMA) devices;
- and more recently, semi-active control (SAC) of vibrations.

The work of ENEA has been performed taking advantage of both international and national collaborations. To be stressed are those in progress in the framework of the activities of the Italian Working Group on Seismic Isolation (GLIS – "Gruppo di Lavoro Isolamento Sismico") at national level

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and in those of Task Group 5 on Seismic Isolation of Structures (TG5) of the European Association for Earthquake Engineering (EAEE) and, more recently, the Anti-Seismic Systems International Society (ASSISi) at international level [3, 4].

In addition to performing the aforesaid R&D and coordination work, ENEA, together with other GLIS members, is devoting particular attention to information and training. Information is being addressed not only to specialists, but also to designers, representatives of the national, regional and local Institutions and the ordinary public, as well. Thus, the used information / training tools are not only publications and organization of meetings for experts, but also organization of conferences addressed to non-experts, students and the ordinary public, as well as publication of articles in magazines and newspapers and talks at radios and TVs.

In May 2000, to further contribute to information and training on the SVC techniques towards all the above-mentioned parties through a better use of media (so as to also more incisively contribute to the promotion of a wider application of the SVC techniques), ENEA and other GLIS Partners undertook the Project MUSICA ("MUltimediale per lo sviluppo di Sistemi Innovativi per Costruzioni Antisismiche", namely "Multimedia for the Development of Innovative Systems for Anti-Seismic Constructions"). This consists in the development of a series of films and documentaries of various durations and different viewers on manufacturing, R&D and application of the SVC techniques [5].

1. THE FILM DIRECTOR AND PRODUCTION COMPANY

MUSICA has been jointly developed by ENEA and GLIS in cooperation with the Film Company Giotto Film of Borgo Trevi (Perugia, Italy). It takes advantage of the skill of the Film Director Enrico Bellani, who had already directed the motion-picture "Il Cantiere dell'Utopia" (The Yard of Utopia) on the restoration of the Upper Basilica of St. Francis at Assisi after the large damage caused by the 1997-98 Marche and Umbria earthquakes, by also filming the installation of SMA devices and innovative STs [1]. This film was shown by the Italian national TV "RAI UNO" on the day of the re-consecration of the Basilica (November 28, 1999). Its English version was proposed by ENEA, with the agreement of "RAI UNO", to the SEISMOS Documentary Awards at the 12th European Conference on Earthquake Engineering in London in 2002, where it was selected by ballot of delegates as the overall winner.

2. GLIS PARTNERS

In addition to ENEA, the major Partners of MUSICA (namely those providing the largest technical contribution and funding) are the following Institutions and companies, which are all represented in GLIS:

- ALGA, a manufacturing company of SVC and other devices at Milan;
- ENEL.HYDRO-ISMES, a worldwide renowned company which, among others, owns and operates excellent laboratories for dynamic tests at Seriate (Bergamo);
- FIP Industriale, a manufacturing company of SVC and other devices at Selvazzano (Padova);
- "Impresa Generale di Restauro Pouchain", a company specialized in the restoration of cultural heritage, at Giustiniana (Rome);
- INSO, a building design company specialized in the design and construction of large public buildings, located in Florence;
- the Italian National Seismic Survey (SSN "Servizio Sismico Nazionale") of the Presidency of the Ministries Council, Rome;
- the Joint Research Center (JRC) of the European Commission (EC) at Ispra (Varese);
- TIS, a manufacturing company of SVC and other devices located in Rome;
- the University of Basilicata at Potenza, which, among others, owns a very advanced laboratory for seismic tests and has excellent experience in the development of SVC systems.

In addition to these main Partners, the Project has also been funded (with lower contributions) by the following Institutions and companies, some of which are represented in GLIS:

- IERP ("Istituto per l'Edilizia Residenziale Pubblica") of Perugia Province, namely the Public Building Institute for residential houses in this Province, which, among others, erected three adjacent isolated apartment houses at Città di Castello (Perugia) in the years 2001-2003;
- "Impresa Lunghi", a building company located at Santa Maria degli Angeli (Perugia), which erected the aforesaid buildings and was previously involved in the restoration of the Upper Basilica of St. Francis at Assisi;

- "Studio Mancinelli", a design office at Fabriano (Ancona), which is performing the first retrofit of an Italian building by means of SI and subfoundation;
- "Tekno In", an engineering company at Rome specialized at designing structures provided with SVC systems;
- the University of Ancona;
- the University of Catania;
- the Third University of Rome;
- Forell / Elsesser Engineers, Inc., San Francisco, California, USA.

The activities of the MUSICA Project are coordinated by a Coordination Committee, formed by one representative for each of the aforesaid major Partners.

3. FILMING ACTIVITIES

Several structures provided with SVC systems (bridges, viaducts, strategic, public and residential buildings and industrial plants), including the most important in Italy and some also in the San Francisco area and Turkey, were filmed, together with the production processes of the devices and their testing in the Italian Laboratories. In addition, some conventionally founded structures of interest of SSN, provided with seismic monitoring systems, were filmed.

Filming activities began in May 2000 and were completed in June 2001. Filmed documentation (55 hours) contains comments of concerned experts, owners, or residents, recorded on site while filming laboratories, factories or structures. During montage, use was also made of pictures taken from previous films, such as "Il Cantiere dell'Utopia" and documentaries shot during important tests in the past.

The filmed test laboratories, engineering and research centers, manufacturing companies and structures provided with SVC systems are outlined below. Some recent filmed applications of the various systems are also shown by Figures 1-16.

3.1 Test laboratories and engineering and research centers working at SVC systems

Filmed were the following test laboratories and engineering and research centers, where SVC systems and structure mock-ups provided with them have been tested using specific equipment (E), shaking tables (T) and the pseudo-dynamic method (PSDM):

- ALGA (Montebello, Pavia Province, Lombardia Region) (E);
- ENEA (Casaccia Center, Rome Province, Lazio Region) (T);
- ENEL.HYDRO-ISMES (Seriate, Bergamo Province, Lombardia Region) (E and T);
- FIP Industriale (Selvazzano, Padova Province, Veneto Region) (E);
- JRC, ELSA Laboratories (Ispra, Varese Province, Lombardia Region) (E and PSDM);
- TIS (Civita Castellana, Viterbo Province, Lazio Region) (E);
- University of Basilicata (Potenza, Basilicata Region) (E, T and PSDM);
- University of Bologna and ENEA at Montecuccolino (Bologna, Emila-Romagna Region) (E).

Pictures taken from documentaries shot during tests performed in past years have been combined to those concerning the aforesaid filming activities, in particular as far as those of ENEL.HYDRO-ISMES and the University of Basilicata are concerned.

3.2 Italian manufacturing companies of SVC systems

Filmed were the factories of the following manufacturers of SVC devices of the aforesaid various kinds (SI, ED, HC and SMA devices), by focusing on production and qualification:

- ALGA (Montebello) (SI, ED and HC devices);
- FIP Industriale (Selvazzano) (SI, ED, HC and SMA devices);
- Metalgomma (Monzambano, Mantova Province, Lombardia Region) (SI rubber devices);
- TIS (Civita Castellana) (SI, ED, HC and SMA devices).

3.3 Applications of the SVC systems to Italian bridges and viaducts

Filmed were the following Italian bridges and viaducts, provided with elastic-plastic ED devices (EPDs)

and / or other ED device types, combined (except for the first structure) with STs, all manufactured in Italy:

- the "Somplago" viaduct (Carnia, Udine Province, Friuli Region), provided with EPDs conceived by Dr. R. Medeot, which was the first Italian application of SVC devices (1975) and survived the Friuli earthquake in 1976 (while all other bridges in the same area collapsed);
- the "Ponte nelle Alpi" (Belluno Province, Veneto Region) and "Ponte Giulio" bridges (Maniago, Udine Province), which are again relatively old applications to new constructions;
- a more recent viaduct equipped again with ED and HC devices near Urbino (Pesaro Province, Marche Region);
- the "Coltano" viaduct, on the Cecina Livorno freeway (Tuscany Region), which is probably the longest viaduct in the world (more than 9 km) being provided with SVC devices;
- viaducts of the Napoli-Bari freeway near Vallata (Avellino, Campania Region), which had been retrofitted with the aforesaid SVC devices;
- a new viaduct during construction of the Florence-Livorno highway near Livorno, during installation of the SVC devices.

3.4 Applications of the SVC systems to new Italian strategic or industrial large buildings

Filmed were the following new strategic or industrial large Italian buildings mostly provided with SVC systems manufactured in Italy:

- two buildings of the New Fire Management Center at Naples (Campania Region), which were the first Italian application (beginning of the years '80s) of the SVC techniques and were provided with HC devices, sliding devices (SDs) and rubber bearings (RBs) (these buildings had been designed prior the 1980 Campano-Lucano earthquake and the use of the aforesaid SVC techniques, thanks to Prof. F.M. Mazzolani, allowed for avoiding large design modification in spite of the seismic reclassification of the Naples area after such an earthquake);
- the five isolated buildings of the TELECOM Italia (former SIP) national telephone company at Ancona (Marche Region), owned by SEAT and designed by Dr. G.C. Giuliani, which are the first Italian application of base SI (beginning of years '90s), were equipped with High Damping Rubber Bearings (HDRBs) and were provided by ENEL (National Electricity Board) with a seismic monitoring system that recorded the March 1998 aftershock of Marche and Umbria earthquake (in the films use has also been made of some pictures shot in 1990 during impressive forced- and free-vibration tests, the latter to 110 mm base displacement [6]);
- a base isolated building of the Italian Navy at Ancona, to be used for emergency management during natural disasters, including earthquakes, which was equipped again with HDRBs;
- the two twin towers of the Administration Center of ENEL at Naples, each consisting of a central core suspended at the top from the two external towers and was provided with EPDs to limit its rotation;
- an isolated medical center in the Navy Base of Augusta (Siracusa Province, Sicily Region), which is the first example (beginning of years '90s) of application of SI to an Italian medical structure, being provided with HDRBs;
- two non-isolated hospitals in the Tuscany Region, at Cecina (Livorno Province) and Pisa, erected by INSO, having a modular structure which may be easily provided with base or floor SI, as demonstrated by specific numerical and experimental studies carried out by INSO in cooperation with Studio Antonucci (Ancona) and ENEA.

3.5 Applications of the SVC systems to other important Italian new and retrofitted public buildings Filmed were also the following further important Italian public buildings, which were provided, during construction or rehabilitation, of SVC systems manufactured in Italy:

- five new buildings of University of Basilicata, erected in the middle of the years '90s, provided with HDRBs (they were subjected to on site-tests and equipped with a seismic monitoring system);
- the "Gentile Fermi" school at Fabriano (Ancona Province), a historic monument damaged by the 1997-98 Marche and Umbria earthquakes, which was being seismically improved by means of viscoelastic ED devices (Figure 1).
- the "La Vista" and "Domiziano Viola" schools at Potenza, which were being retrofitted by means of dissipative braces provided with EPDs (Figure 2);



Figure 1: Visco-elastic dampers installed in the Gentile Fermi school at Fabriano (a rare example of rationalist architecture), during seismic improvement works (filmed in 2001).

Figure 2: Dissipative braces installed in the Domiziano Viola school at Potenza, during seismic improvement works (filmed in June 2000).





Figure 3: SI system (RBs) of the new Emergency Management Center of San Francisco, California, USA (filmed in July 2000).



Figure 4: Works for cutting the foundations of the Berkeley Civic Center, for the insertion of RBs (filmed in July 2000).

3.5 Examples of application of the SVC systems in other countries

The following structures of different kinds applying the SVC techniques, both for their new construction and for their retrofit, were filmed with the support of Forell / Elsesser in the San Francisco area (California, USA), in order to provide a few examples of what has been and is being done in countries other than Italy:

- the new Emergency Management Center of San Francisco (Figure 3), a new very strategic reinforced concrete (r.c.) construction which was base isolated by means of RBs to ensure its protection to extremely violent earthquakes (to 8.3 magnitude);
- the Berkeley Civic Center (Figure 4), an important public and historic r.c. structure, which was being retrofitted during our filming activities by cutting the existing foundations and installing RBs;

- the San Francisco City Hall (Figure 5), an important public and historic masonry structure damaged by the 1989 Loma Prieta earthquake, the retrofit of which by cutting the structure foundations and inserting RBs had been recently completed;
- the San Francisco Asian Art Museum (Figure 6), a mixed masonry and steel structure which was being retrofitted during our filming activities, again by cutting the foundations and inserting RBs;
- the Market Street Branch of Wells Fargo Bank, which had been seismically rehabilitated using dissipative braces similar to those used in the Potenza schools;
- a three story apartment house at Marina, San Francisco, which was seismically retrofitted by means friction pendulum SVC system after the 1989 Loma Prieta earthquake that had broken its foundation columns.

3.6 The presence of Italian manufacturing industry abroad

To provide a few examples of the presence of the Italian industry abroad (in terms of both completed applications and projects), some structures provided with SVC devices manufactured in Italy or for which application proposals had been submitted by Italian manufacturers were filmed in both the USA (San Francisco area) and Turkey. With regard to the US structures, filming activities concerned:

- the Carquinez Bridge, which was filmed during the installation of Italian STs;
- the Marine County Civic Center Hall of Justice of San Rafael, which had to be seismically retrofitted by means of Italian STs;
- the main bridges and viaducts of the San Francisco Bay area (Bay Bridge, Golden Gate Bridge, San Rafael Bridge), for retrofitting which with SVC systems proposals had been submitted by Italian manufacturers.



Figure 5: San Francisco City Hall, seismically retrofitted by cutting the foundations and inserting RBs (filmed in July 2000).



Figure 6: Asian Art Museum, during retrofit with RBs (filmed in July 2002).



Figure 7: Bolu viaduct of the Istanbul – Ankara freeway, provided with EPDs, which survived the 1999 earthquakes (filmed in May 2000).



Figure 8a: View of the village of Mevale di Visso (Macerata) after the restoration performed to repair the serious damage caused by the Valnerina earthquake in 1979.



Figure 8b: Mevale di Visso, as destroyed again by the 1997-98 Marche and Umbria eartquakes, for which a feasibility study was performed for its reconstruction with SI (filmed in 2000).



Figure 9a: SMA devices being installed between the tympana and roof of the Upper Basilica of St. Francis at Assisi, during the restoration works of the Basilica in 1999.



Figure 9b: STs installed inside the Upper Basilica of St. Francis to strengthen its lateral walls, during the restoration works of the Basilica in 1999.

With regard to Turkey, the filming activities concerned the viaducts near Bolu of the Istanbul – Ankara freeway (Figure 7), equipped with EPDs and other SVC devices manufactured in Italy, which had been

struck by the August and November 1999 earthquakes: they are the first structure in the world which did not collapse in spite of being located in the epicentral zone of a very violent earthquake and in spite of the fact that the earthquakes largely exceeded the design values [6].

3.7 The new bounds of research and application of SVC systems: (a) cultural heritage

In order to stress the new bounds of research and application of the SVC techniques, filming activities also concerned three key application fields for ensuring the success of such techniques in Italy: cultural heritage, ordinary apartment buildings and industrial plants. All filmed structures were provided with SVC devices manufactured in Italy. With regard to cultural heritage, filmed were:

- the village of Mevale di Visso (Macerata Province, Marche Region see Figure 8), which was destroyed by the 1997-98 Marche and Umbria earthquakes (similar to previous events) and will be at least partly reconstructed using the original masonry materials and SI, according to the excellent results of a feasibility study committed to ENEA by the Marche Technical and Scientific Committee [1, 3, 7];
- "Il Cenacolo", a foundation of "Impresa Pouchain" for restoring activities, at Giustiniana, near Rome;
- the Upper Basilica of St. Francis at Assisi (Perugia Province, Umbria Region see Figure 9), which is the first cultural heritage construction that was retrofitted with SMA devices, in 1999, and as mentioned, had also been filmed by the film director E. Bellani in that year, during the installation of such devices and innovative STs (the latter had been developed in the framework of the EC-funded REEDS Project) [1, 2, 6];
- the bell tower of the St. Giorgio in Trignano church (San Martino in Rio, Reggio Emilia Province, Emilia-Romagna Region- see Figure 10), severely damaged by the 1996 Reggio Emilia and Modena earthquake (by cutting it into two pieces), which was also retrofitted using SMA devices in 1999 (it was the pilot application of the EC-funded ISTECH Project, aimed at developing SMA devices for the protection of cultural heritage [6]);



Figure 10: Bell Tower of the Church of St. Giorgio at Trignano (St. Martino in Rio, Reggio Emilia) which was severely damaged by the 1996 Reggio Emilia and Modena earthquake and was seismically retrofitted in 1999 by means of 4 vertical ties, each in series with a SMA device (filmed in 2000).

- the St. Feliciano Cathedral at Foligno (Perugia Province), severely damaged by the 1997-98 Marche and Umbria earthquakes (similar to the Upper Basilica of st. Francis), again an application of SMA devices, which was filmed in 2000 during their installation (Figure 11);
- the church of St. Giovanni Battista at Apagni (Figure 12) and that of Santa Lucia at Aggi (Perugia Province), which were considered for rehabilitation by sub-founding them and using SI in the framework of the PROSEESM Project [1, 4, 7];
- the Basilica of Santa Maria di Collemaggio at L'Aquila, which is the most important example of romanesque style in the Abruzzo Region and was seismically improved using special non-invasive EPDs (Figure 13);
- the worldwide famous Bronzes of Riace, which have been seismically isolated using multistage HDRBs in the Museum of Reggio Calabria (Calabria Region);
- the Vesta Temple in Rome, which had been seismically improved using a special strengthening system;
- the "Fori Imperiali" at Rome, which were filmed to also include the issue of protection of cultural heritage from traffic-induced vibrations.

3.8 The new bounds of research and application of SVC systems: (b) ordinary apartment buildings

Filming activities concerned the still very few Italian apartment buildings which were provided with SVC techniques at that time, with the purpose of stimulating a wide extension of the number of applications in this field, following the example of Japanese and now, also Chinese. More precisely, filmed were:

- a r.c. apartment house at Squillace (Catanzaro, Calabria Region), base-isolated by means of HDRBs, which had also been subjected to forced vibration tests and provided with a seismic monitoring system (this house withstood a moderate earthquake shortly after its construction, without suffering any damage, contrary to a twin non-isolated house, which was slightly damaged) [6];
- three r.c. isolated apartment buildings at the Navy Base of Augusta, isolated by means of HDRBs, which were erected, together with the already mentioned medical center, just after an earthquake that had caused significant damage to Augusta;
- a masonry apartment building at Sigillo (Perugia Province) and two similar buildings in Rome, provided with an innovative strengthening system, the so-called "Active Sewing Method for Masonry" (CAM "Cucitura Attiva delle Murature" [8]), which were filmed during and after the seismic / static improvement works (Figure 14).



Figure 11: Cathedral of St. Feliciano at Foligno (Perugia), damaged by the 1997-98 Marche and Umbria earthquakes and seismically improved in 2000 with SMA devices (a = façade; b = sketch of the intervention; c = installation of the devices – filmed in 2000 during insertion of the SMA devices).



The separation of the walls under the action of shear seismic forces.



View of the damages to the internals and frescos.





View of the damages to the internals and frescos.



View of the portal after conventional restoration.

Figure 12: Views of the Church of St. Giovanni Battista at Apagni (Perugia), severely damaged by the 1997-98 Marche and Umbria earthquakes (similar to the Valnerina earthquake in 1979), for which restoration with sub-foundation and seismic isolation has been planned (filmed in 2000).



Figure 13: Façade of the Cathedral of Santa Maria di Collemaggio at L'Aquila, which was seismically improved using innovative EPDs at roof level (filmed in 2000).



Figure 14: Application of the CAM method to the seismic improvement of a masonry apartment building at Sigillo (Perugia) (filmed during the rehabilitation works in December 2000).



Figure 15a: base isolated apartment house erected at Rapolla (Potenza) close to a conventionally founded house (filmed in May 2001).



Figure 15b: HDRB installed (together with SDs) at the base of the apartment house at Rapolla shown in Figure 15a.



Figure 16a: construction of the isolated apartment buildings at Città di Castello, filmed in May 2001.



Figure 16b: HDRB just installed in the isolated apartment buildings at Città di Castello.

- a r.c. isolated apartment building at Rapolla (Potenza Province, see Figure 15) which had also been subjected to on-site tests, together with a twin fixed-base building, with different SI systems, namely HDRBs and a combination of these devices and SDs (pictures of a film shot during these tests have been combined to our shots);
- the already mentioned three adjacent r.c. apartment houses at Città di Castello, which were filmed during installation of HDRBs (see Figure 16) [3];
- a r.c. building at Fabriano, severely damaged by the Marche and Umbria earthquakes of 1997-1998, the retrofitting of which by cutting foundation piles and using SI had already been approved by the Technical Scientific Committee of Marche Region and was later approved by the High Council of Public Works of the Ministry of Constructions (this is the first application of SI combined with subfoundation for retrofitting Italian buildings) [3].

3.9 The new bounds of research and application of SVC systems: (c) industrial plants

Although there were no industrial plants provided with the SVC systems in Italy (there were only some industrial buildings, provided with such devices), filmed were also some industrial facilities, both in the Northern Italy (Friuli) and in the South (Sicily), in particular some high risk chemical plants and components, which are susceptible of a significant improvement of seismic protection, if constructed or retrofitted using SI and / or the other SVC techniques [3].

3.10 Structures provided by SSN with seismic monitoring systems

The following structures, provided with seismic monitoring systems, were filmed in addition to those provided with SVC systems, mentioned above, to also stress the importance of monitoring non-conventional constructions:

- the Institute "F. Momigliano" at "Parco di Villalago" (Piediluco, Terni Province, Umbria Region), which is an historic masonry building;
- the Ponte Cesi bridge of the Terni Perugia highway;
- the main offices of IERP Perugia at Perugia, which is a r.c. building;
- the Zingone r.c. bridge on the Savio River of the Provincial Road n. 138 (Forlì Province, Emilia-Romagna Region).

The pictures related to these shots were included in the short film which was specifically assembled for SSN.

4. FILMS' PRODUCTION

4.1 Trailers and feature film first draft

After the projection of two trailers, in Rome in December 2000 and Perugia at the beginning of 2001, a first draft of the scientific feature film "Esempi di ricerca e applicazioni sulle moderne tecnologie antisismiche" (Examples of research and application of the modern anti-seismic technologies) was shown at Assisi on October 3, 2001, during the 7th International Seminar on Seismic Isolation, Passive Energy Dissipation and Active Control of Vibrations of Structures [4]. It was limited to the R&D on the SVC systems and their applications and consisted of some selected episodes, assessed by mounting the material filmed at experimental laboratories and some important structures; commentaries were exclusively inscreen, provided by the researchers in the laboratories, technicians in the manufacturing industries and designers, mounters, builders, owners or residents in the structures provided with the SVC systems. The pre-mounted material used to produce this feature film was also mostly the base for the assessment of the subsequent various films and documentaries mentioned in Sect. 5.2 [9].

5.2 Short films and motion picture

Both short films and, later, a longer motion-picture, "Le forme della memoria" (The shapes of memory) were mounted. Each of these was produced in two versions, one with commentaries in Italian, the other with commentaries in English. Such commentaries are partly in-screen and partly off-screen. More precisely, nine short films are now available, namely:

• "Le moderne tecnologie antisismiche" (Advanced tested technology for earthquakes), lasting 29 minutes, which is the so-called "institutional" version, produced for ENEA;

- a first slightly different version of the aforesaid short film, lasting again 29 minutes, produced for ENEL.HYDRO;
- a second slightly different version, lasting again 29 minutes, produced for JRC di Ispra;
- "LADIB. Laboratorio Dinamico Industriale dell'Università della Basilicata" (LADIB. Industrial Dynamic Laboratory of the university of Basilicata), lasting 20 minutes, produced for such an University;
- "Sistemi antisismici ALGA" (ALGA anti-seismic systems), lasting 12 minutes, produced for ALGA;
- "Sopravvivere al Sisma" (To survive the earthquake), lasting 33 minutes, produced for FIP Industriale;
- "TIS e le moderne tecnologie anatisismiche" (TIS and the modern anti-seismic technologies), lasting 20 minutes, produced for TIS;
- "L'Osservatorio sismico delle strutture" (The seismic observatory of structures), lasting 20 minutes, produced for SSN;
- "L'ingegnere del restauro" (The engineer of restoration), lasting 20 minutes, produced for "Impresa Generale di Restauro Pouchain".

While the short films are addressed to an educated public, the motion picture is for the ordinary public. For the short films at first the text was written by the MUSICA partners, then appropriate pictures were selected and mounted to illustrate this text; on the contrary, for the motion picture (which was produced later), first pictures were mounted by the film director, then the appropriate text was developed by us to comment it.

It is worthwhile noting that the "institutional" short film "Advanced tested technology for earthquakes" and the film "The shapes of memory" were also proposed to the SEISMOS Documentary Awards at the 12th European Conference on Earthquake Engineering in London in 2002: "Advanced tested technology for earthquakes" was selected by ballot of delegates as the third overall best documentary and as the first in its category ("Earthquake Engineering"). This short film was also shown at numerous national and international conferences and seminars.

5.3 The feature film "Examples of research and application of the moderns anti-seismic technologies"

Recently, the draft of the feature film "Examples of research and application of the moderns anti-seismic technologies" that had been presented at the Assisi Seminar in 2001was reworked by ENEA, within a new contract with Giotto Film, which was also partly founded by the University of Basilicata. The text and selection of pictures were improved and completed; both Italian and English versions were produced. The result is a feature film lasting about 1 hour and 20 minutes, addressed to sufficiently expert viewers, which illustrates the SVC technologies through the following episodes (mostly with in-screen commentaries):

- the isolated residential buildings and the medical structure at the Navy Base of Augusta;
- the application of the SVC systems in the San Francisco area: City Hall; Asian Art Museum; Emergency Management Center; Berkeley Civic Center; Wells Fargo Bank; Carquinez bridge; San Francisco Bay area bridges and viaducts;
- the equipment and research activities of the laboratories of ENEA at the Casaccia Center, University of Bologna at Montecuccolino, ENEL.HYDRO, JRC-Ispra and University of Basilicata;
- the first application of the SVC techniques to Italian bridges and viaducts (Somplago viaduct);
- the application of Italian MASS systems to the Bolu viaduct of the Ankara-Istanbul freeway in Turkey;
- the first Italian building applications of MASS techniques (Fire Center in Naples);
- the first Italian building application of base SI (TELECOM Italia Center at Ancona);
- the first Italian application of ED for retrofitting existing buildings ("La Vista" and "Domiziano Viola" schools at Potenza);
- the worldwide first application of SMA for seismic protection (restoration of the St. Francis Upper Basilica at Assisi);
- the first application of the CAM method for masonry building seismic strengthening (residential building at Sigillo);
- ongoing Italian applications of SVC devices (viaduct near Livorno and residential buildings at Città di Castello, during installation of the devices).

CONCLUSIONS

The main features of the MUSICA Project have been presented. It has been stressed that, as a result of this project, at set of short films ("Advanced tested technology for earthquakes" and further eight short films), a motion-picture ("The shapes of memory") and a feature film ("Examples of research and application of the moderns anti-seismic technologies") have already been produced on the development and application of the SVC techniques. The motion picture should be easily understood by the ordinary public, while the shorts film are more addressed to an educated public and the feature film is devoted to experts.

Further films and documentaries may be produced in the future, in the framework of MUSICA, based on both the already available filmed material (55 hours), as well as new shots on some more recent applications and, if possible, in other countries. Agreements to disseminate the films and documentaries are being reached with TVs and scientific magazines (with the latter for the distribution of CDs).

The authors of this paper are confident that the aforesaid films and documentaries will significantly contribute to a wide information on the SVC techniques, by demonstrating that these techniques are already fully reliable and not costly and that what is only needed now is to widely apply them. The authors are also confident that these films and documentaries will significantly contribute to a wider extension of the application of the SVC techniques not only to important public buildings and bridges and viaducts, but also, as necessary and now fully feasible, to the cultural heritage and especially, the high risk industrial plants and ordinary apartment buildings: this will largely increase the protection of human life, in addition to economy, in seismic countries, in particular Italy.

In Italy, the new seismic code now allows for the free use of the SVC systems and makes such an use more advantageous (i.e. less costly) than before [3]: thus, there are no more obstacles in our country that may hinder the aforesaid rapid and wide extension of the use of the SVC techniques.

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