Patent in USA No. 10/555,131, from 31.10.2005; patent in Australia No.AU 2003254327A1 from 2004.11.23.
MP 123-97; MP 124-97; MP 125-97; MP 126-97 and P 323/03.

Tested by:

1. Institute IMS, Belgrade, Vojvode Mishicha bul. 43, Serbia.
2. Military-Technical Institute – VTI, Belgrade, Kataniceva 15, Serbia.
3. Institute for earthquake engineering and engineering seismology – IZIIS, Skopje, R. Macedonia.
4. Faculty of civil and geodetic engineering, University of Ljubljana, Jamova 2, Ljubljana

Involvement in domestic and foreign scientific projects:

- Seismic strengthening in seismic areas of Serbia by applying absorbers- Team Leader, the Project was financed by Ministry of Science and Technology of R. Serbia, Institute IMS.
- Reconstruction and modernization of factory for production of structure elements – Project Leader, the Project was financed by Ministry of Science and Technology of R. Serbia, IMS Institute.
- Euro-Mediterranean project "Prohitech"- Earthquake protection of historical objects by reversible technologies, countries participants: Italy, Greece, Portugal, Morocco, Romania,.R. Macedonia, Belgium, Slovenia, Turkey, Israel, Egypt, Algiers.

SISTEM DC90

Research, Consulting, Engineering and Technology Transfer,
INNOVATION CENTER BELGRADE for EARTHQUAKE ENGINEERING,
E-mail: dc90@Eunet.rs, www.dc90.co.rs, Pukovnika Purica 1/29, tel\fax:381 11 3910-868,

Author of the System DC 90: Zoran Petrashkovich, Civil Eng., Academican of SAIN
Members of Consortium for work execution: HK Komgrap-Belgrade, Radijus-Mionica, NIK Engineering-Belgrade, Velja-Belgrade, Delta-Belgrade, Geotest-Belgrade, Pirs-Belgrade, Beoing-Belgrade, Sistem-Valjevo, Gradjevinar-Pozarevac, Petkovich- Soko Banja.
Designers, Researchers and Project Directors in the System: Zarko Petrashkovich, Civil Eng., Svetlana Jankovich-Miladinovich, Civil Eng., Lyubomir Vojvodich, Civil Eng., Mirjana Maksimovich, Civil Eng., Jasenka Momirovich, Civil Eng., Slobodan Stankovich, Civil Eng. Arch., Slavolyub Jovanovich, Civil Eng. Arch., Zoran Andrich, Civil Eng., Igor Dzuklevski, Civil Eng., Miladinovich Zoran, Civil Eng., Jasminka Petrashkovich-Dzuklevski, Civil Eng.
Consultants: Academician Boshko Petrovich, Civil Eng., Ph. D. Ljubomir Tashkov, Civil Eng., Ph. D. Branimir Chorich, Civil Eng., Prof. Dragoslav Shumarac, Civil Eng., Prof. Djordje Ladjinovich, Civil Eng.
Director of System DC 90, Co.Ltd.: Dragana Obrenovich.

OBJECT STRENGTHENING

EXISTING AND NEW MASONRY AND FRAME CONSTRUCTIONS

Markets where System DC 90 is presented:

- **Canada**- Hydroelectric generator Hydroquebec, Montreal, **Algiers**-strengthening of an Ambassador's Residence building in progress, **Azerbaijan –** Palace of the President of the State in Baku city, **Iran**-signed M.O.U. on representation and technology transfer,
- **Greece**-strengthening analysis of objects damaged by last Athens earthquake, **Greece and Cyprus** – several contacts with Greece representatives related to protection of churches, **Macedonia**- research, design and signed representation contract, **Romania**-cooperation on laboratory experiments in scope of "Prohitech" project, **Slovenia**- design, research and promotion, Ljubljana – 12 tower with 12 floors built without concrete frames conceptual solution done,
- **Serbian Orthodox Monastery Chilandar in Holy Mt. Athos, Greece** – technology donation offer for monastery restoration,
- **Armenia** – strengthening design of 12 storey RC frame structure object, brandy distillery, ideal design, **Georgia and Kazakhstan** – the System promotion,
- **Monte Negro** – application in new masonry objects, Budva, Mediteran hotel, conceptual solution done, **R. of Srpska** (Banja Luka) System promotion, **Eastern Serbia** – completed objects and a Territorial Representative for protection of historical objects, Exhibition in Pozarevac DIT and realized a large number of contacts in the region, strengthening of a church in Zajechar, **Colubara district** – mass rehabilitation of 350 objects, **Belgrade** – application in new masonry objects and a big industrial objects, foundations of Press Co. "Borba", Belgrade, **Pozhega**- ideal solutions for 209 objects among which and a church from 1807th year, memorial of M. Obrenovich.

  Vrshac – System promotion, contacted for an object in the city and a tower on the hill, **Mladenovac** – application of outdoor object strengthening, **Golubac** – sport hall, **Rudnik and Kopaonik Mountains** - RC frame objects strengthening done **Vranje- Golubac** - Primary school, the main project of the adaptation of school, sports hall-**Golubac** - Project documentation, Construction of the system engineering, **Klenje Klenje**-house culture, the main project of renovation and adaptation of existing roof structures using technology odizanja construction hidrouličkim brakes, **Krusevac**-Department Store Deva-research, studies, design and delivery of dampers.

Strengthening of masonry object of Ambassador's Residency in Algiers.

AWARDS:

- "Award for successful professional work and achieved results", IMS Institute, on the occasion of IMS Institute's Day, 27th of December 1990th year, Belgrade.
- "Charter for outstanding devotion in work", IMS Institute, 29th of December 1992nd year, Belgrade.
- "Award for outstanding devotion in work", IMS Institute, 17th of December 1993rd year, Belgrade.
- "Award for successful scientific-innovative and creative work in the Institute", IMS Institute, 23rd of December 1994th year, Belgrade.
- "Award for successful scientific-innovative and creative work in the Institute", IMS Institute, 21st of December 1995th year, Belgrade.
- "Silver medal for structure of rigid horizontal planes made of prefabricated slabs and vertical planes with energy absorber", Belgrade 16.10.1996., YU EUREKA '96, 16.10.1996. Belgrade.
- "Medaille d'or avec mention pour l'invention" - System DC 90, **Brusseles EUREKA '97**, Bruxelles, 11.11.1997.
- "Medaille d'or pour l'invention" - Flexible mould for cofferere ceiling production , **Brusseles EUREKA '97**, Bruxelles, 11.11.1997.
- "Brussels Mayer's Award '97" for helping protection of historical monuments.
- "NAGRADA SOYUZPATENT", ROSSIA.
- « PRIX » - Institut National d' Inventique lasi ROUMANIE.
- "Award for two golden medals in Brussels, Eureka '97 manifestation", IMS Institute, 26th of December 1997th year, Belgrade.
- "Certificate of merit for outstanding achievement in development and advancement of inventorship, innovation application and development of Organization of Belgrade Inventor's Association", Association of inventors and authors of technical improvements of Belgrade, Belgrade, 10.04.1998.
- "Medal with picture of Nikola Tesla" for outstanding achievement in development and advancement of inventorship, innovation application and development of Organization of Belgrade Inventor's Association", Association of inventors and authors of technical improvements of Belgrade, Belgrade, 10.04.1998.
- "Golden medallion" Inventions, Technical Advancement, New Products and Youth's Creativity Show, Makinova, Skopye, 20 -24.10.1998.
- "Letter of thanks for successful participation", Tesla-fest '99, Novi Sad, 12-16th of October 1999th year.
- "Award for acknowledged patents: MP-123/97, MP-124/97, MP-125/97, MP-126/97", IMS Institute, 28th of December 1999th year.
- "Annual award for invention", Belgrade Economy Chamber, Belgrade, 2001.
- "Golden medal Tesla-Pupin", for outstanding results in stimulus, development and affirmation of inventorship, for application of innovations and for special contribution to development and advancement of Yugoslav Inventor's Union", Yugoslav Inventor's Union, Belgrade 12.10.2002.
- "Golden medallion" Inventions, technical advancement, new products and youth's creativity show, Makinova, Skopye, 20 -24.10.1998.
- "Golden medallion and Great Golden Medal with picture of Nikola Tesla without competition" – for invention of "System of seismic strengthening of objects – System DC 90", Association of inventors and authors of technical improvements of Belgrade, Belgrade 09.05.2003.
- "City of Belgrade Award for invention in 2003." Belgrade City Parliament, Belgrade, 18.04.2004.
- "Genius Cup Award" from Association of Hungarian Inventors, "25th Inventorship Show", Belgrade, 2005th year.
- "Genius Cup Award" at the IFIA "Genius 2006" Inventors exposition, Budapest, 2006th year.
- Diploma of the Hungarian Association of innovators 16.sept. 2007.god
- "Special plaque and medals with the portrait of Nikola Tesla" Union of inventors and authors of technical improvements of Belgrade, 30.11.2007.god.
- "Golden Plaque" to find the most dumpers, Union of inventors and authors of technical improvements, Belgrade 09.05.2008.god
- Certificate of the Hungarian Association of innovators 22.06.2008.god.
- Bachelor of Commerce Chambers of the City of Belgrade for the most successful innovation-invention of seismic security System DC 90 to achieve in 2007/2008., granted 19.02.2009.
- Certificate of Serbian Association of innovators, the exhibition INOS 2009th, granted 18.04.2009. For the protection system seismic earthquake System DC-90.
- Recognition of the Republic of Serbian Association of innovators, the exhibition INOS 2009th, granted 18.04.2009. For protection System of seismic shocks System DC-90
- "Gold Medallion and Big gold medal with the portrait of Nikola Tesla", the patent system solutions metal hysteresiss dampers for the construction of the new wall and the system of metal hysteresiss dampers concrete without beam systems., Union inventors and authors of technical improvements, Belgrade 22.05.2009

Strengthening of frame RC object in Krushevac city.

PRESENTATION AT STANDS AT INTERNATIONAL AND DOMESTIC SCIENTIFIC MEETINGS AND HELD LECTURES

Arhens, FIB Symposium 2003

Zhablyak Mt., 2006 - Construction, Science and Practice - GNP.

Lecture in Engineer's Chamber in Ljubljana

Skopje, 2005 – International conference for earthquake engineering EE-21C.

Skopje, 2004 – International conference for earthquake engineering.

Vrnyachka Banya, 2004, 2006 – Yugoslav association of constructor engineers, 12th Congress.

Iran, 2005, First international fair of anti-seismic building in Tehran.

LECTURES:

1. Engineer's Chamber of Serbia – Belgrade, 2005, Seismic strengthening of objects.
2. Engineer's Chamber of Serbia – Vranye, 2006, Seismic strengthening of objects.
3. IZIIS, Skopje, 2003, 2004, System DC 90.
4. Bureau for protection of monuments of Belgrade city, 2006, Strengthening of structures of historic objects (structures made of stone, brick and wood).
5. Bureau for protection of monuments of R. Serbia, 2006, Strengthening of structures of historic objects (structures made of stone, brick and wood).
6. Civil engineering faculty in Belgrade, 1998, System DC 90 awarded in Brussels.
7. Engineer's Chamber of Slovenia, Ljubljana, 2004.

SYSTEM DC 90

TECHNOLOGY FOR SEISMIC STRENGTHENING AND PROTECTION OF MASONRY AND FRAME STRUCTURES

Structure

System DC 90 comprises a number of structural elements which strengthen brittle walls and make them ductile and tough, which make floor slabs and ceilings stiff and capable to transmit the load in their own plane, and which integrate foundations, connect them by foundation collars, and make them stronger to accept horizontal displacements and enlarged vertical loads. The technology is a ***Brussels Eureka'97 Gold Winner for Invention*** as well as other numerous international awards.

Vertical elements – walls

These elements are strengthened by vertical stiffening elements (bracing) that connect horizontal slabs and foundation. Vertical stiffening elements (bars) consist of vertical ties, which are being pre-stressed, while the other elements of the bars are diagonals with seismic energy absorber and horizontals as parts of the stiff floor slabs. Walls strengthened in this way become ductile and capable to accept the alternative horizontal dynamic displacements**.**

Horizontal elements

If they are not stiff in their own plane, floor slabs and ceilings are being strengthened in one of the following two ways:

- Impregnation with a thin, lightly reinforced, concrete slab, or
- Incorporation of horizontal bracings that are connected with vertical stiffening elements.

Foundations

Foundation structure is confined with foundation collar, which is connected by anchors and in which the vertical stiffening elements are anchored.

Technology

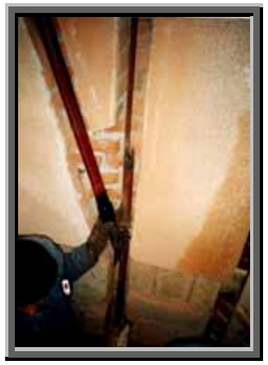
Technology of retrofit and seismic strengthening is based on activities done on outer side of facade walls and in simpler cases it does not even require removing of tenants**.**

Techno-economical parameters

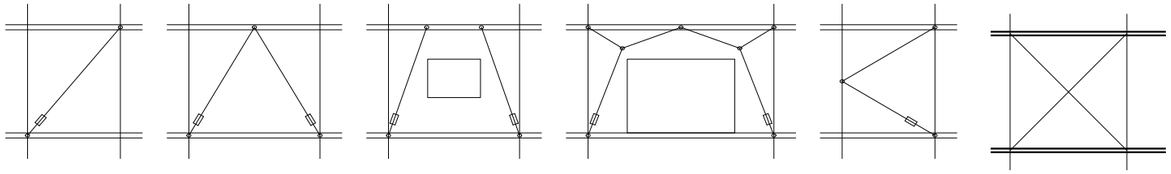
Recent application and experience with the technology in Kolubara region, where 1998. earthquake damaged over 24.000 structures, out of which 11.600 were heavily damaged, give us the following results:

1. Time necessary for strengthening structure of a family residential house, area of about **150 m^2**, is reduced to **only ten days.**

2. Price of rehabilitation by applying System DC 90, compared to traditional methods by applying horizontal and vertical belt-courses or by applying reinforced-concrete vertical belt-courses, is **two and a half times less.**



SYSTEM DC 90 - TYPES OF VERTICAL BRACING



"D" "A" "P" "Po" "K" "X"

Look of bracings applied for reconstruction of reinforced-concrete frame of department store “Deva” in Krusevac city.

Portal type «A» Portal type «P» Connection detail

System DC 90 aplication possibilities on objects in Algeria damaged in 2003. earthquake.

Vertical bracings on damaged objects in Algeria. Absorber application, Montenegro.

Damper testing.

Wall model testing.

SYSTEM DC 90 DEVICE TESTING IN INSTITUTE FOR EARTHQUAKE ENGINEERING AND ENGINEERING SEISMOLOGY, IZIIS, SKOPJE

Model of the wall of hydro-generator "Beauharnois" in 1:3 ratio on vybro-platform

Applying damper model in ratio according to forces 1:27 on a wall model R=1:3.

Machine hall of "Beauharnois" hydro-generator in Quebec, Canada.

Applied damper model in ratio 1:27 to a wall model on a vybro-platform in Skopje.

Damper of “Canada” type in real ratio for application on "Beauharnois" hydro-generator.

Model of three samples for model research in Skopje.

SYSTEM DC 90 DEVICE TESTING IN MILITARY-TECHNICAL INSTITUTE (VTI) IN BELGRADE, SERBIA FOR OBJECT OF HYDRO-GENERATOR IN QUEBEC, CANADA

The testing was done in VTI dynamic laboratories, on the following equipment:servohydraulic loading frame MTS500kN.

Damper during the testing

Subject and program of testing:

Four samples were tested, two of type "Mionica+" and two of "Canada" type.

Dampers before the testing.

Program of testing included five testing:
1. Damper Mionica+ to displacement increase on all the 20 cycles and decrease after reaching maximum displacement ± 4mm. l=200mm, ε=±4/200=±2%. Frequency was 1Hz.
2. The same damper Mionica+ from test 1, after the break, with aim the post-collapse behavior to be seen for Δl= ±4-6mm. For frequency of 1Hz.
3. Damper Mionica+^{2}.

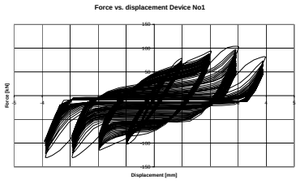
Testing to cyclic load, 1Hz, constant displacement ±25mm, i.e. strain ε=±25/100=±1.25%.

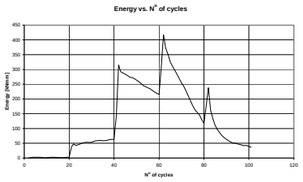
4. Damper Canada, testing to cyclic load – 1Hz, for constant displacement ±2mm, ε=±2/250=±0.8%.
5. Damper Canada to cyclic load for permanent increase of displacement, while keeping approximately the same amplitude of the force.

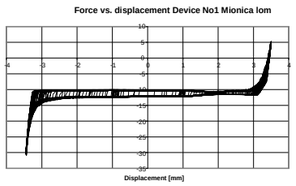
Dampers after the testing:

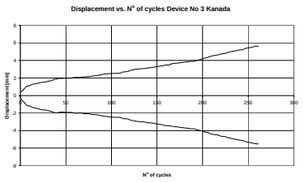
Damper with anchoring part at new masonry structures.

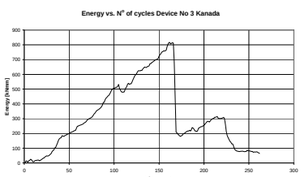
Three-part damper with a wrist for application out of object wall.

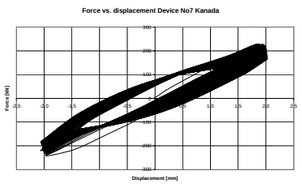


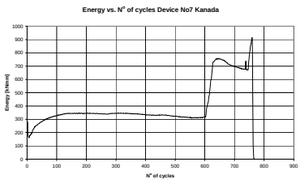






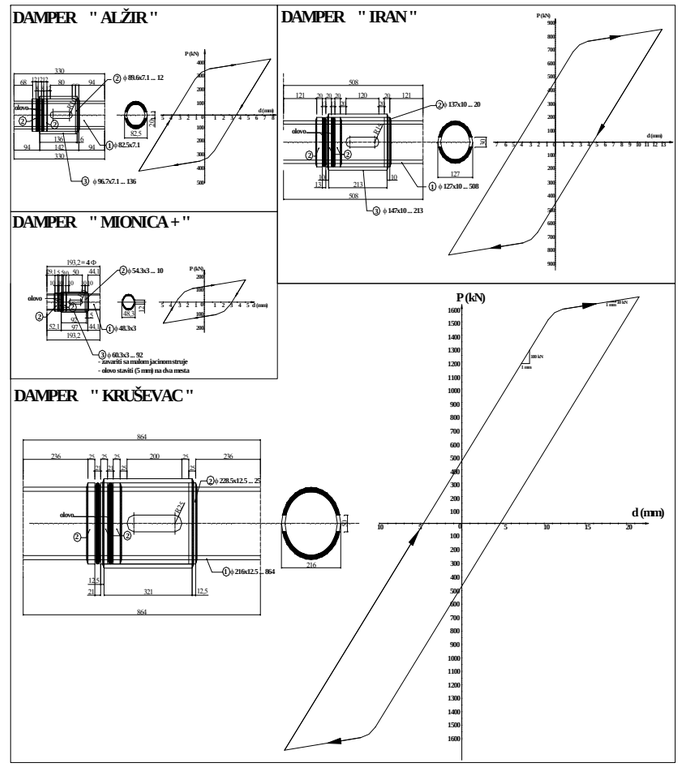






SYSTEM DC 90 – DAMPERS - ABSORBERS OF SEISMIC ENERGY

DAMPERS		F	ΔF	F-ΔF	s_V(F-ΔF)	s_VF	Δ
No.	Name	cm^2	cm^2	cm^2	kN	kN	mm
1	*Kruševac*	78.41	12.50	65.91	1581.89	1881.89	1 – 21
2	*Iran*	36.76	6.00	30.76	738.16	882.16	1 – 13
3	*Alžir*	16.82	2.84	13.98	335.48	403.64	1 – 8
4	*Mionica +*	4.14	0.72	3.42	81.99	99.27	1 - 5



Facts defining damper:

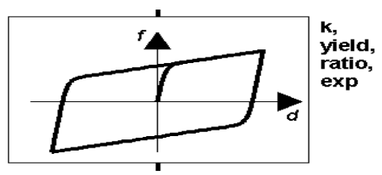


Fig.1.

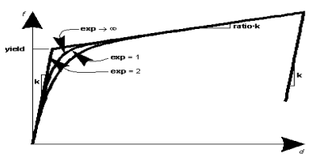


Fig.2.

- Stiffness of elements- (given in the sketch, upper right); limit of elasticity – yield (given in the sketch, upper right); relation of stiffness in elastic zone and after it – ratio k; exponent by which the diagram is approximated – exp.

Testing done by: IMS Institute (Belgrade), Military-Technical Institute (Belgrade), IZIIS Institute (Skopje, R. Macedonia).

General Consultant: Academician Ph.D. Boshko Petrovich.

PROTECTION OF CULTURAL AND BUILDING HERITAGE

Delivery of 41 dumpers type Algiers, Mionica and Ø30 for the Embassy of Finland in Algiers.

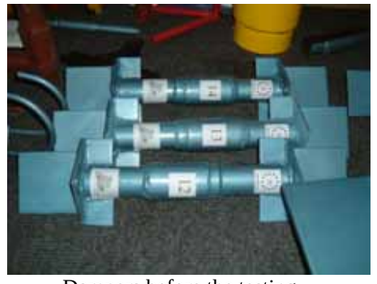
Protection of historical objects by application of DC 90 technology is based on using long-lasting materials and disassembling possibility. The built-in steel mass of elements doesn't change the existing form, but is built inside the walls of the object.

On pictures shown is a 14th century church with objects of high cultural, historical and building heritage value in R. Macedonia and in Algiers, whose protection is in progress.

RESEARCH IN SCOPE OF EURO-MEDITERRANEAN PROJECT "PROHITECH" AT FACULTY OF CIVIL AND GEODETIC ENGINEERING, UNIVERSITY OF LJUBLJANA, JAMOVA 2, LJUBLJANA

Prior to trip to Ljubljana with damper models (12) for testing in scope of "Prohitech" project.

A damper before the testing.



Dampers before the testing.

Damper histeresis.

Damper during the testing, 1-5Hz.

Damper after the break in process of the testing.

Compensator of displacement during the testing (0.001Hz) in Ljubljana.

Four-storey house in Lig in process of strengthening.

Appearance of vertical bracings type “upside-down P” on four-storey object in Lig.

Connection detail of diagonal with damper and vertical bracing, in Lj. Lazich object.

Visible damage of J.Sreten’s object in Lig.

Vertical bracing on Lj. Lazic’s object in Lig.

Welding of damper connection with vertical bracing on an experimental object of Lj. Lazic.

Appearance of vertical corner bracings on object predicted for destruction of Lj. Achimovich in Lig.

Appearance of vertical corner bracings on object predicted for destruction of Lj. Achimovich in Lig.

Setting vertical anchors in parochial home in Lig.

SYSTEM DC 90 DAMPERS ASSORTMENT

1. Damper for RC frame structures to be built in places of plastic hinge in frame-structure building beams. The diagram of the damper is decided according to reinforcement diameter (Ø 12 - Ø 30).

2. Type "Mionica+", V=110kN, D=48.3*3mm, L=400 mm.
- Rigidity K=128.712,87 kN/m
- Yield limit = 120 kN
- Yield ratio in elastical zone and after it K=0,07769
- Exponent which approximises diagram, exp.=2.

3. Type “X-1”, V=65kN
"Bracing X" damper for section of crossed diagonals of "X" bracing. It's needed characteristics are to be decided in design.

4. Type "Iran", V=750kN, D=127*10mm, L=600mm
Damper devloped for Iran market's needs. It's characteristics are used from testing diagram.

5. Type "Alzir", V=350kN, D=67.7*7.1mm, L=600 mm.
Damper devloped for Algiers market's needs. (Ambassador Residency). It's characteristics are used from testing diagram.

6. Type "Krushevac", V=1.600kN, D=216*10mm, L=600 mm.
Damper applied in Krushevac city departement store's RC frame structure.

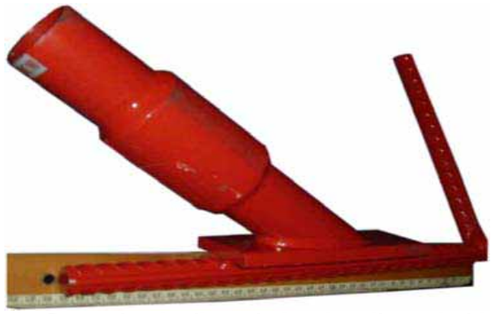
Technical description of strengthening and protection of existing and new objects by applying Sistem DC 90 technology with orientation prices and duration of the activities.

A. EXISTING OBJECTS

Strengthening of a three-storey masonry building in Ljig.

1. System DC 90 strengthening of EXISTING MASONRY OBJECT in aim of stiffening to horizontal influences (wind and earthquake), acceleration of building procedure, costs decrease and enduring lasting period of the object means

production of vertical bracings which are made of steel verticals and diagonals with absorber, anchored in foundation collars that spreads partly or completely around the object foundation, depending on quality of foundation collars of the object. The bracings can be visible or built inside the wall mass and then cemented by fine-granulated mortar with addition of super-plastificators. In case ceiling is not rigid, it should be strengthened by other systems (by bracings or light reinforced-concrete slab), which is not the matter of this point. The number of bracings is decided by design as well as need for their connection. In this way strengthened masonry object is sufficiently tightened and toughened that can accept new horizontal quakes and loads. The exploitation time of the object, considering that steel elements are protected from corrosion, can be endured to last as long as the material out of which the object is made from (stone or brick and mortar) because System DC 90 strengthening gives ductility, compactness and durability to the walls. All the works are to be done according to YUS and EC standards.



Connection detail: vertical anchor-diagonal with damper.

Price of strengthening depends on object structure condition (walls, foundations and ceiling) and moves in scope of 30-45 EUR/m2 of gross object surface.

An object damaged by 1998th Mionica earthquake.

The exact price can be decided after detailed recording, research and strengthening design in System DC 90. Recording of the object is done by ortho-photo method using 50 x 50 cm markers.Strengthening time is decided related to real time needed for strengthening of a one storey object P=150m2 of gross surface, which is 10 days.

Wall model testing in IMS Institute.

Object strengthening in Slovac village - Laykovac.

S. Radivojevich's object strengthening in Mionica village.

Rehabilitated and strengthened house is Komanica village.

Strengthened object considerably damaged by earthquake and predicted for destruction.

Strengthening object with ground-floor-bracing stone finish.

Ground-floor object with stone basement in Mionica village.

Strengthened object in Laykovac village.

Strengthened object in Krchmar village.

House of R. Markovich from Mionica village during preparations for experimental forced-vibrations testing.

Map of Colubara district's seismic risk.

Specialists team from Institute for Earthquake Engineering and Engineering Seismology – IZIIS, Skopje, with associates during forced-vibrations object testing in Mionica village.

Gathering in laboratory of the Institute for Material and Structure Research - IMS, Belgrade, during testing of two-storey wall strengthened by System DC 90 technology due to Mediterranean Countries Ministry Conference in 2003rd year in Belgrade.

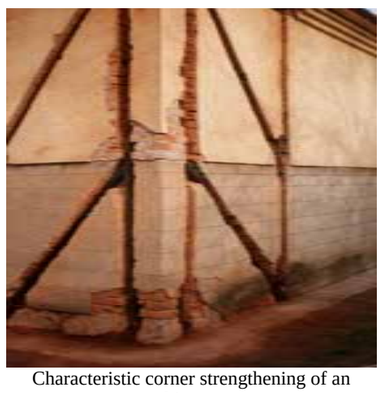
Considerably damaged object with diagonal cracks and wall division.

Iran donation damper delivery in 2004th. year.

Vertical bracing in considerably damaged stone walls in Jurjevac village.

Diagonals with dampers and anchors for strengthening new masonry objects.

Crossed diagonal cracks on an object in Mionica.

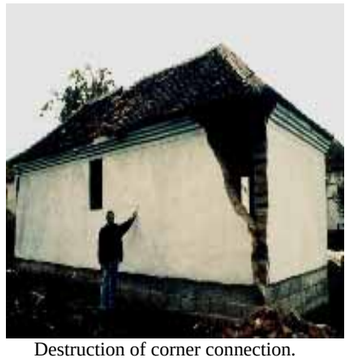


Characteristic corner strengthening of an object.

Damper testing to dynamic load in frequent range 1-10Hz in Military-Technical Institute VTI, Zarkovo, Belgrade and damper work-check to low-cycle fatigue in post-elastic field.

Vertical bracing cemented with fine granulated concrete.

Part of laboratory equipment for quasi-dynamic testing of two storey wall model in IMS Institute, Belgrade.



Destruction of corner connection.

Wall model testing in IMS Institute.

2. System DC 90 strengthening of A FRAME RC OBJECT in aim of stiffening to horizontal influences (wind and earthquake), acceleration of building procedure and costs decrease means

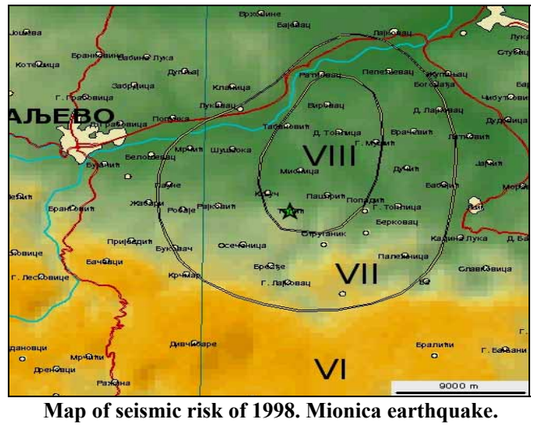
production of vertical bracings consisting of verticals- RC (reinforced concrete) columns reinforced with steel elements if necessary, and steel diagonals with System DC 90 dampers anchored in foundation structure of the object. If the existing structure is not capable to accept the additional load, the strengthening is done by enlarging dimensions of contact surface or by mega-braids, depending on foundation building procedure. The bracing can be visible or built inside the wall mass and then cemented by fine-granulated mortar with addition of super-plastificators. In case ceiling is not rigid, it should be strengthened by other systems (by bracings or light reinforced-concrete slab), which is not the matter of this point. The number of bracings is decided by design as well as need for their connection. In this way strengthened masonry object is sufficiently tightened and toughened that can easily accept new horizontal quakes and loads. The exploitation time of the object, considering that elements are protected from corrosion and fire, can be endured to last as long as the material out of which the object is made from (concrete and steel reinforcement) because System DC 90 gives ductility and compactness to the object. All the works are to be done according to YUS and EC standards.

Length-wise damper section.

Price of the strengthening depends on object structure condition (walls, foundations and ceiling) and moves in scope of 20-30 EUR/m2 of gross object surface. The exact price can be decided after detailed recording, research and strengthening design in System DC 90. Recording of object is done by ortho-photo method using 50 x 50 cm markers. Strengthening time is decided related to real time needed for strengthening of a frame structure object of around P=1250m2 of gross surface, which is 25 days.

Vertical bracing type"II" for reinforced-concrete or masonry objects.

A damper series for RC frame constructions before delivery.



Map of seismic risk of 1998. Mionica earthquake.

Technology solutions rely on System DC 90 patents: USA patent No. 10/555,131; P48040; MP 123-97; MP 124-97; MP 125-97; MP 126-97 i P 323/03.

B. NEW OBJECTS

3. System DC 90 strengthening of NEW MASONRY OBJECT in aim of stiffening to horizontal influences (wind and earthquake), acceleration of building procedure and costs decrease means:
production of vertical bracings which are made of RC columns as verticals and diagonals with absorber, anchored in foundation collars. Bracings are built inside the wall mass and they exclude the need for RC walls and considerably decrease the amount of concrete and steel reinforcement. The number of bracings is decided by design. In this way strengthened masonry object is sufficiently tightened and toughened that can easily accept new horizontal quakes and loads. The exploitation time of the object, considering that steel elements are protected from corrosion, can be endured to last as long as the material out of which the object is made from (stone or brick and mortar) because System DC 90 gives ductility and compactness to the object. The strengthening means delivery of diagonals with dampers and anchors which are to be built inside the walls during building. Connection of the diagonal with columns and frames is done over anchors which are welded to the diagonal on both sides. All the works are to be done according to YUS and EC standards.
Price of strengthening depends on geometry of object structure (walls, foundations and the ceiling) and moves in scope of 8-12 EUR/m2 of gross object surface. The exact price can be decided after design in System DC 90.

Absorber application at new masonry objects in Podgorici.

4. System DC 90 strengthening of NEW FRAME RC OBJECT in aim of stiffening to horizontal influences (wind and earthquake) and acceleration of building procedure and costs decrease means:
production of vertical bracings consisting of verticals- RC columns and steel diagonals with the dampers anchored in foundation structure of the object. The bracing can be visible or built in the wall mass. The number of bracings is decided by design. In this way strengthened masonry object is sufficiently tightened and toughened that can easily accept new horizontal quakes and loads. The exploitation time of the object, considering that steel elements are protected from corrosion, can be endured to last as long as the material out of which the object is made from (concrete and steel reinforcement) because System DC 90gives ductility and compactness to the object. The strengthening means delivery of diagonals with dampers and anchors which are to be built inside the walls during the building. Connection of the diagonal with columns and frames is done over anchors which are welded to the diagonal on both sides. All the works are to be done according to YUS and EC standards.

Price of strengthening depends on geometry of object structure (walls, foundations and the ceiling) and moves in scope of 8-12 EUR/m2 of gross object surface. The exact price can be decided after design in System DC 90.

A model of X-bracing during testing and a vertical bracing at new masonry objects.

An industrial object strengthening.

Special notes:

- System DC 90 strengthening works are done by trained and licensed members of System DC 90 Consortium, with consultation of Author of the System and Regional Representative i.e. Project Director.
- The necessary testing should be done by renowned Institutes from the country and abroad (IZIIS – Institute for earthquake engineering and engineering seismology – IZIIS, Skopje, F.Y.R. Macedonia; Military-Technical Institute – VTI, Belgrade and other participants of Euro-Mediterranean project PROHITECH from twelve countries from Europe and Mediterranean).
- System DC 90 Co.Ltd. is a participant of PROHITECH project in experimental group WP 6 for protection of cultural and historical objects that suffer from earthquake actions.
- System DC 90 technology is protected by USA patent.
- There are numerous references of application of the technology in masonry and frame RC structures as well as laboratory and field testing in the objects.

REHABILITATION OF 350 OBJECTS IN KOLUBARA REGION DURING AUTUMN 2002.

Cutting the sidewalk by diamond saw for digging the foundation collar.

Cutting a stone wall by diamond saw for setting the vertical bracing.

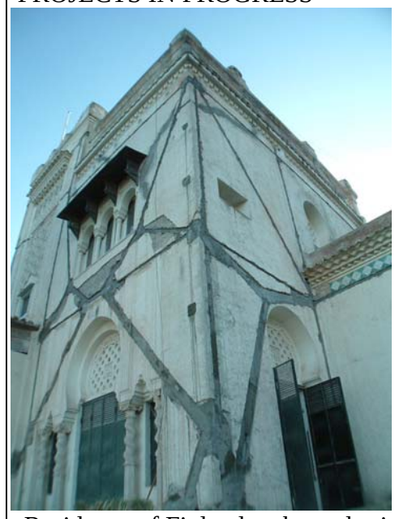
Dug reinforced-concrete foundation collar around an object.

Taking out the stone elements from the wall cut by diamond saw.

Appearance of formed vertical bracing on experiment house of Lj. Lazich in Lig.

Appearance of vertical bracing, P+1 type, on a house considerably damaged in Lig.

PROJECTS IN PROGRESS



Residence of Finland ambassador in Algeria Angle stiffening with presentation of horizontal bars and compensators of shrinking

Residence of Finland ambassador in Algeria
Vertical supporting of tower with compensators of shrinking in summit– anchorage and absorbers at the bottom- anchor

Seven objects in Algeria in the phase of researching and projecting
1.Bridge on Oued Chelef Road District, MEKHAKTIA, 1920

2.Railway Bridge, Oued Chelef, ARIF, 1940

Gymnasium Feroukhi, Miliana, 1909

4.Museum Emir Abdelkader, Miliana, 1730

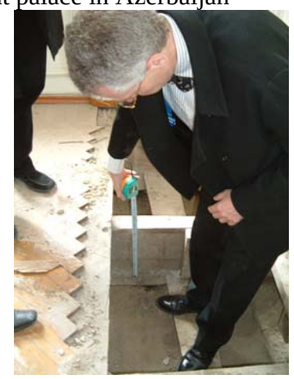
5.Museum Manufackture of arms, Miliana, 1837

6.Lycée Cadat, Miliana, 1986,

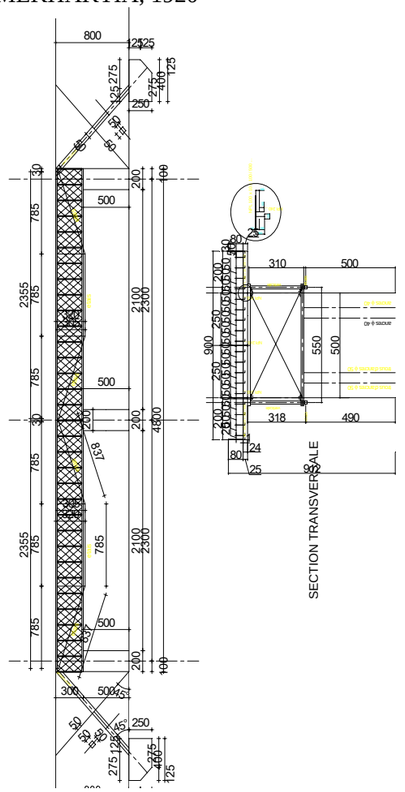
7.Bridge across frontier Ain Defla-Media, 1877

Baku- Residence of a president
The phase of Damper producing.
Terminate projecting and researching

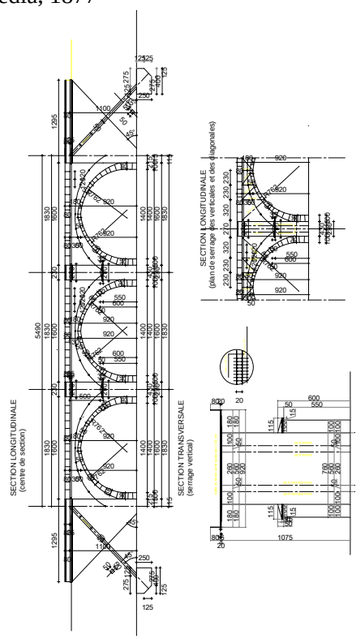
Examining of floor structure on the president palace in Azerbaijan



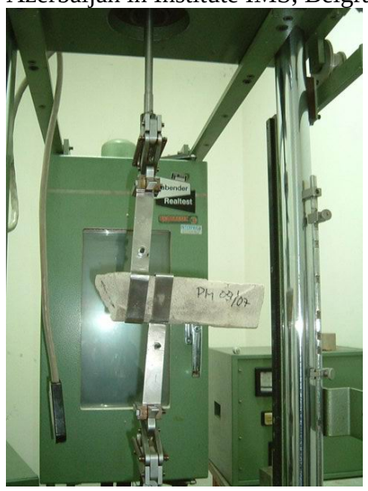
1.Bridge on Oued Chelef Road District, MEKHAKTIA, 1920



7. Bridge across frontier Ain Defla-Media, 1877



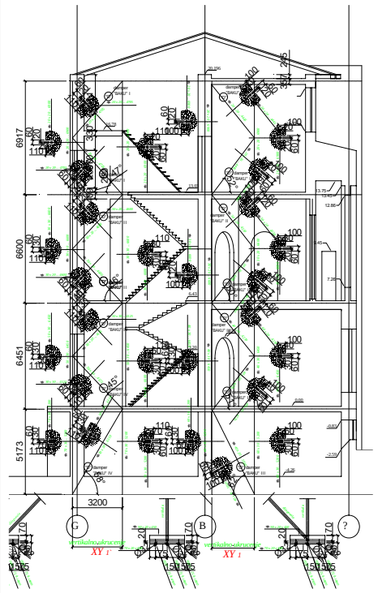
Examining on sliding of the patterns of connection mortar and stone on the walls of president residence in Baku-Azerbaijan in Institute IMS, Belgrade



Universal electrical breaker ZWICK in Institute IMS, Belgrade

Prepared sample for examining

Detail of vertical stiffening on President residence in Baku-Azerbaijan

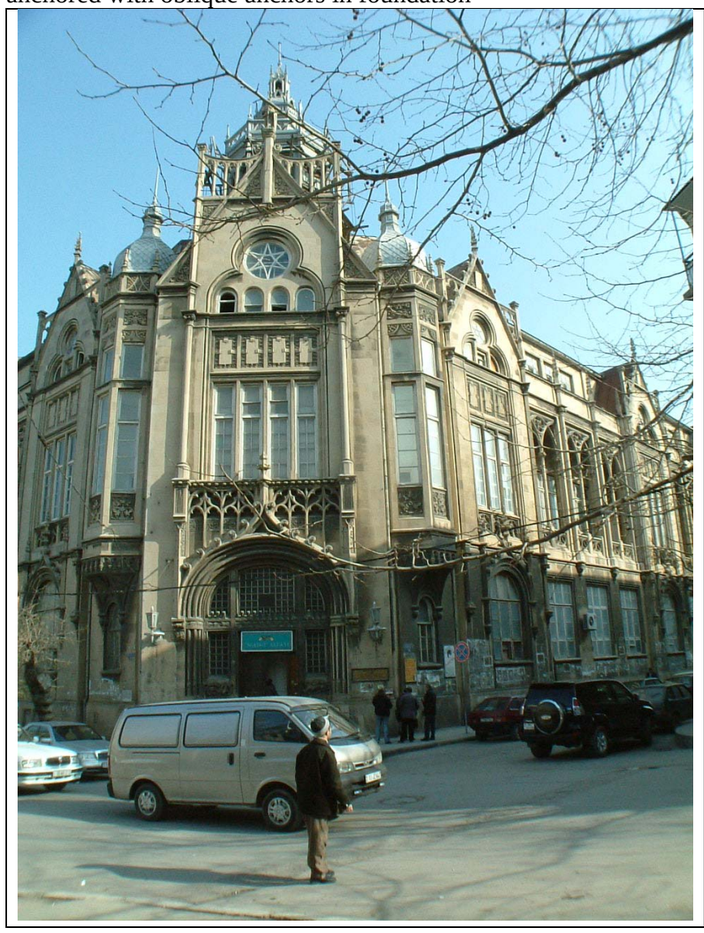


Recording geometry for bridge and school

Object before sanation

Object during sanation

House of a lawyer in Ljig is renovated in a style of old Serbian constructing based on the project of Academician Bozidar Petrovic. Enchancing of construction is done by seven vertical stiffening with Dampers type Mionica anchored with oblique anchors in foundation



Azerbaijan president residence in Baku is enhanced with thirteen vertical stiffening anchored with oblique anchors in the 120 cm thick massive basic walls. There are applied 66 Dampers of type BAKU and they was built in 11 tons of steel elements (0,1% of whole mass of the object). Object is analyzed on district vibrations and unnatural earthquakes in collaboration with IZIIS Institute from Skoplje, Macedonia

Damper of type BAKU 30/60-48 is developed for needs of enhancing of the president residence in Baku, Azerbaijan

Renovation of family home (P=200m^2) in Dobra, on the Danube river, using the vertical stiffening with a stiffened wooden ceiling for horizontal influences

Renovation of a house in wine yard

Bondrug system of a water-mill construction in Dobra.

Sports hall in Golubac (42m x 30m x 17m) . Light steel construction in the system of vertical and horizontal bracings-stiffenings on the location IX degrees MCS

Dynamic testing of damper model at VTI Institute, Belgrade

- the test of “DC90 System” Damper by low-cycle fatigue.
- the three leveled safety work of Damper;

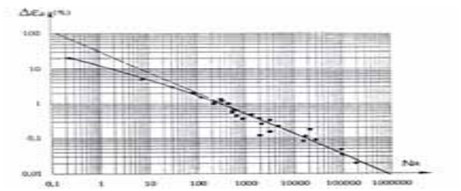
1) work of Damper under deformation control mode up to the final fracture,
2) work of Damper under deformation control mode after the fracture,
3) hysteresis work of the diagonal.

- the elements used for the hysteresis modeling of damper work according to the number of cycles and accumulated strain of the Damper.

(The Damper features are the following**:**

1.The diameter of the cross-section surface reduction is minimum 20%**,**
2.The length of the reduction corresponds to the maximum strain of 5-10%**,**
3.The roughness of “dog bone” element,
4. Elements for local and global buckling (for work in compression, concrete, lead, aluminum plate, and element for sliding),
5. C and γ –material constants

The problem is how to describe hysteresis loop with large displacements and in situation when the acting force is small, because the relation are not more applicable.

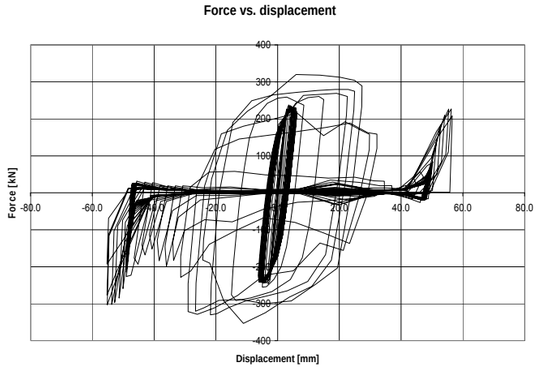


Врло ниско циклични замор (дијагам акумулирана дилатација-број циклуса, Manson-Coffine Law, 1955

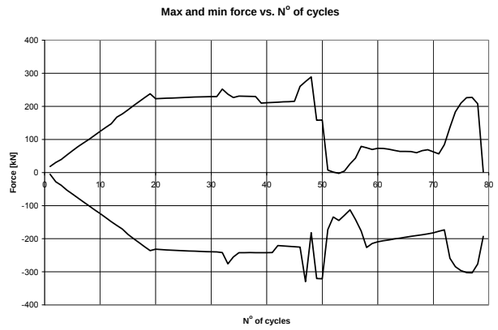
Test of Damper for bridge construction

The following diagrams are presented: “Force vs. displacement” diagram, “Energy vs. Time” diagram, “Displacement and Force vs. Time” diagram.

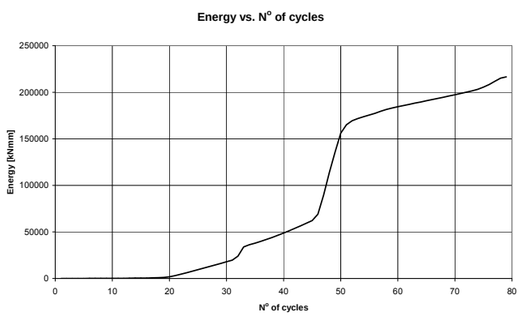
Testing at VTI Institute, Belgrade



Hysteresis Diagram “Force vs. displacement”

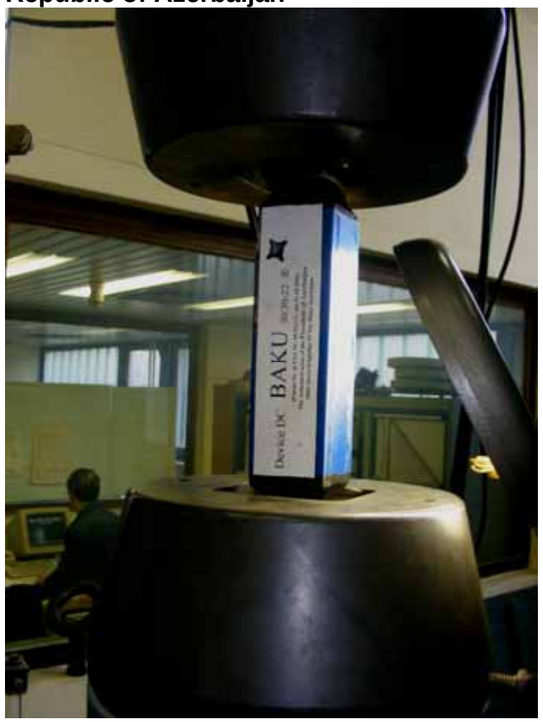


“Force vs. Number of Cycles” diagram



“Energy vs. Number of Cycles” diagram

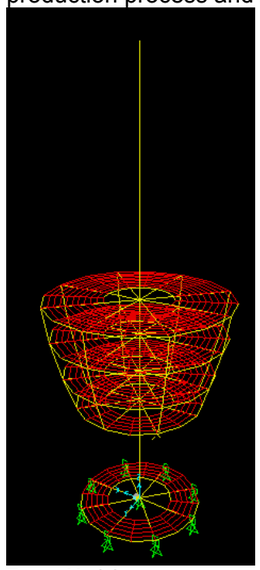
Test of Damper of high durability assigned for the objects of historical value, for example, the building of the President Residence in Baku, Republic of Azerbaijan



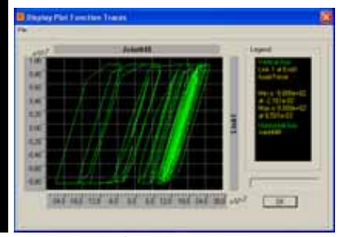
Test of Damper made of stainless steel Cr-Ni assigned for Hydroelectric Power Station in Quebec, Canada

Anti-seismic protection of the 40 meters high “Kura” Tower made of reinforced concrete, Kura River, Azerbaijan

Non-linear dynamic analysis and diagrams of optimization and analysis of vertical linear dampers capable to withstand the high level of bending moments caused by the earthquake tremors.
Photos of Damper equipped with anchors during the production process and right before the shipment.



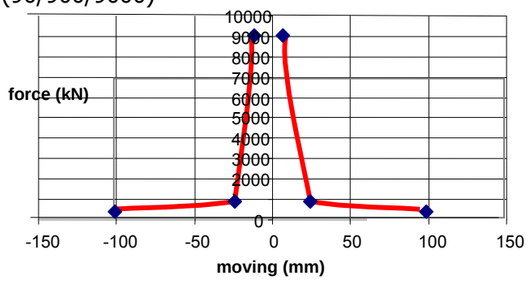
Tower Model.



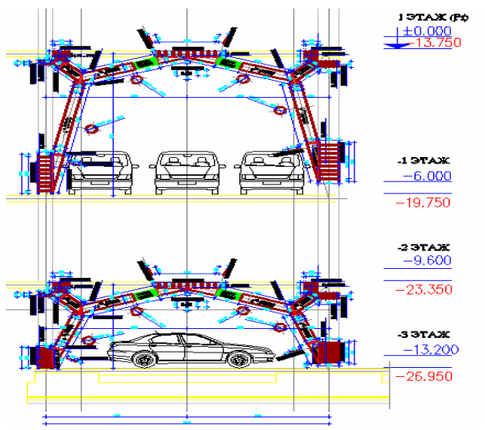
Projected Hysteresis Diagram

Damper “BAKI K 900” P= 900.00 kN, Displacement = +-24.00 / +24 мм.

Model Optimization for Different Values of Forces (90/900/9000)

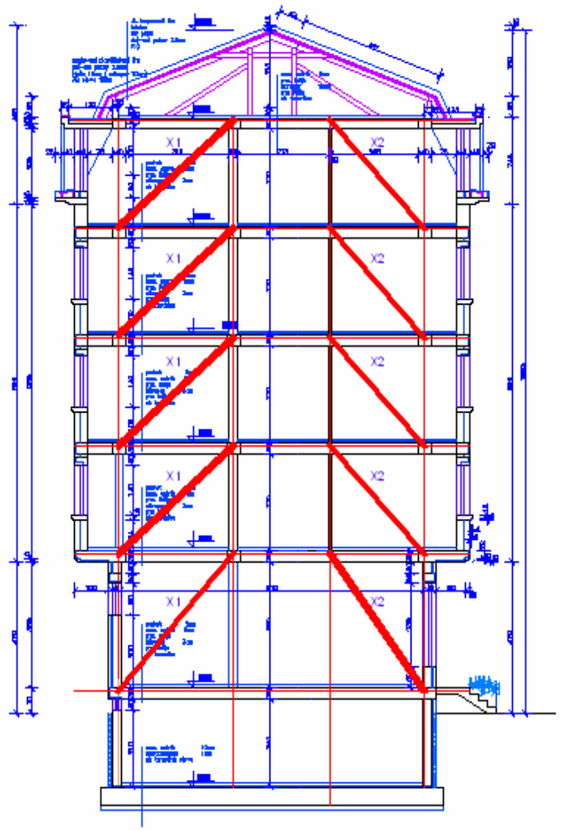


Anti-seismic protection of skeleton construction made of reinforced concrete.
The building of trade center (the span is 8,00m x 8,00m, beamless construction, 65,000.00m2) is strengthen by vertical bracing type “Portal” and by dampers.
Dynamic Analysis of the Model and the appearance of the necessary hysteresis behavior of the damper.
Vertical storey bracing and the diagonal element of the “DC 90” damper before the shipment.

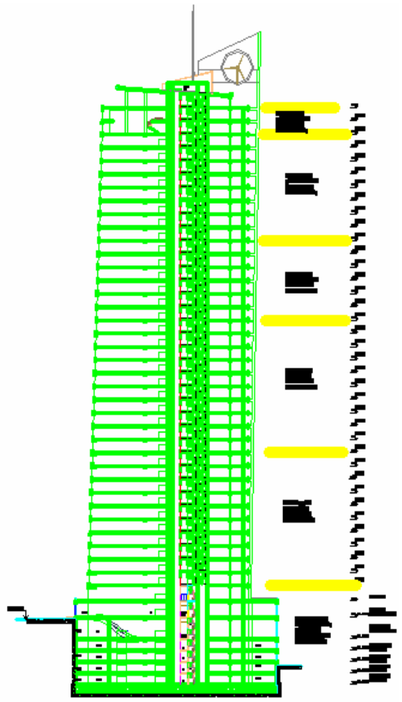


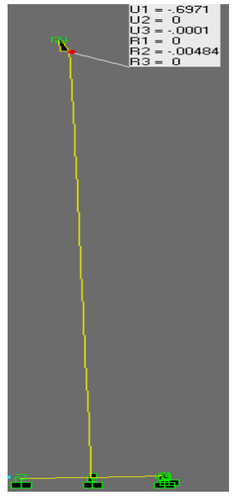
Anti-seismic Protection of new construction made of bricks.
The six-storey building in Bjelina (Republic of Srpska, Bosnia and Herzegovina) is strengthened by vertical bracing built inside the walls that exclude the need for vertical RC slabs capable to withstand the horizontal forces.

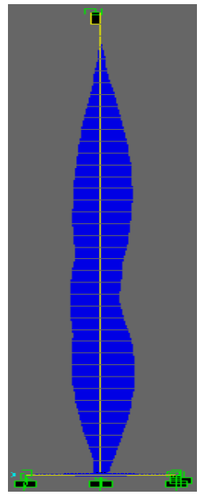
Disposition of bracing, ground plan and cross-section view. Mounting of damper during the building pro



Numeric Dynamic Analysis of new DC 90 systems application in order to provide the 162 m high building in Baku with extra anti-seismic safety.
Model and Analysis Results.







Laboratory of “System DC90” Innovation Centre in organization process.
Location of Innovation Centre in Bolec, Belgrade.
Hydraulic system for model dynamic testing and testing under high levels of Force for quasi dynamic alternative testing of Dampers and DC 90 Systems.
System Features:
The system provides the testing in five dispositions:
1) Vibro platform 800x2400mm is assigned to test the specimen up to 5 tons and up to 10 Hz frequency and dynamic loads in free time record.
2) Axial dynamic testing under push-pull loading conditions, the length of elements is up to 2000mm, the force range is +- 20,00 kN, the frequency is up to 10 Hz, the displacement range is +-15mm,
3) Vertical Model testing of the specimen (dimensions 3000mmx2500mm) by horizontal dynamic loading by the actuator of mentioned dynamic features,
4) Testing of the linear constructions (dimensions 600mmx2000mmx3000mm) by vertical dynamic loading by the vertical actuator of mentioned dynamic features,
5) Quasi dynamic testing of the construction members (dimensions 5000mmx3000mmx1000mm) by alternative push-pull loading in vertical frame by force at range +- 10,000.00 kN.

The participants of the First Innovation Camp:
Dobrica Vasiljević, BSCE.
Emina Kostič, BSCE.
Zeljko Knezevic, BSCE.
NovicA Jancic, BSCE.
Vera Vujovic, BSCE.
Marijana Andjelkovic Trbojevic, BSCE.
Jelena Ostojic, BSCE.
Zoran Perovic, BSCE.
Simon Sedmak, student
Branislav Dlacic, student
Tino Mihajlovik, BSCE., company Digitexx
Saso Atanasovski, BSCE, company Digitexx
MZT – EKA, Macedonia

The lecturers:
Dr. Sedmak Stojan, Professor, certified engineer
Some aspects of material fatigue.
Prof.Dr.Ljubomir Taskov DSCE
Prof.Dr. Lidia Krstevska, DSCE
Laboratory or in-situ experimental methods
of dynamic testing of the objects .
Analysis and presentation of testing results.
Modern trends and approaches to
the problem of historic objects protection.
Prof.Dr.Zlatko Maglaic, DSCE
Dynamics of the constructions and specific aspects
of approach in construction practice.

Within the bounds of the First Innovation Camp the participants visited the archaeological excavations at Vincha locality nearby Belgrade

The visit to the Incubator Centre of the Technological / engineering Institutes of Belgrade City impressed the participants of the First Innovation Camp favourably.

Some program events were held in Dobra settlement at 150km distance from Belgrade.

Recreation activities within the
First Innovation Camp program

SISTEM DC90

Opening of the Laboratory for Model Dynamic Testing in Bolech

Scientific production Centre "DC90 SYSTEM", Belgrade

In honour of twentieth anniversary of the first patent application (П -2381/89 dated 15.12.1989) the Laboratory for Model Dynamic Testing in Bolech was opened at 23.09.2009.
The ceremony of grand opening of the Laboratory for Model Dynamic Testing was attended by a great number of guests – more than 150 of domestic and foreign experts from Macedonia, Montenegro, Bosnia and Herzegovina and Serbia as well as the representatives of the institutes, faculties, ministries, Commerce chamber, innovative and research .
The golden awards for valuable contribution in innovative development and support were presented to:
Dr. Radoslav Cerovich, Prof.,
Dr.Dragoslav Shumarac, Prof.,
Dr.Lidiya Krstevska, Prof.,
Dr.Stoyan Sedmak, Prof.,
Dr. Milosh Katich, Academician,
Dobrica Vasilyevich, BSCE

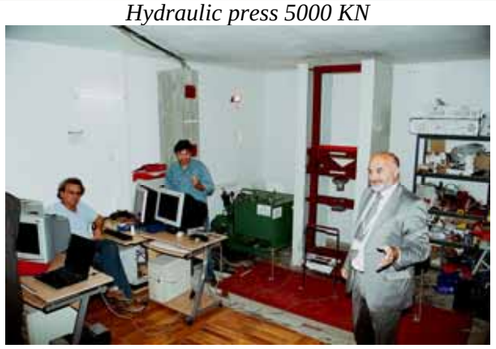
The dynamic testing of the diagonal damper ("VOKZAL" Type) designed for framework truss systems was conducted by quasi loading. The testing was carried out in frame equipped with presses at +-5000 кN Force level and maximum 535mm level of displacement.
The operation of the vibro platform equipment designed for dynamic testing as well as resonance condition of different constructions were presented.

The ceremony of grand opening of the Laboratory for Model Dynamic Testing was attended by a great number of guests

"VOKZAL" Type *Damper Testing*

Vibro platform and models at testing

Hydraulic press 5000 KN



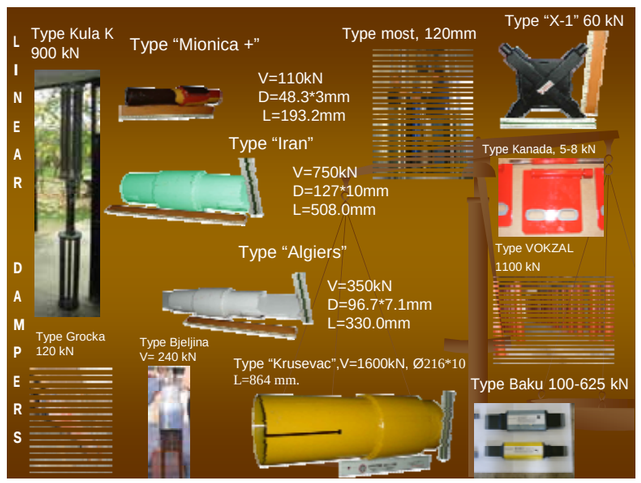
Experimental Data analysis was conducted by means of software.

The laboratory serves the purpose of firsthand acquaintance with knowledge domain or assimilation of experience as well as continuation of innovation process in sphere of earthquake stability of the construction structures.
Every researcher has an opportunity to implement or test his ideas by means of models in Innovation Centre Laboratory, as well as to experience the state of the art construction systems and original seismic stability control devices based on innovations , such as metal hysteresis dampers, high elastic dampers, tuned mass system, ACLS and so on (Seismic Isolators, Velocity Dependent Devices, Displacement Dependent Devices, Rigid Connection Devices).

In its operation the laboratory enjoy the support of expert team of IZIIS Institute from Skopje:
Dr. Lyubomir Tashkov, Professor, certified construction engineer, IZIIS Institute, Skopje, Macedonia
Dr. Lydia Krstevska, Professor, certified construction engineer, Skopje, Macedonia (dynamic problems)
Dr. Stoyan Sedmak, Professor, certified engineer, Metallurgical Technology Institute, Belgrade (fatigue problems and failure mechanics).

The laboratory capacity is opened for both domestic and foreign researches and innovators. As a result of testing, research and application the following range of dampers are available at the moment:
Damper, Type KULA K (900 kN). The damper is mounted vertically at the spot where high column or tower base join the foundation. It is very effective in case of great tightening torque when the construction is built on the problem ground.
Damper, Type Grocka (120-250 kN) The damper is mounted in masonry structures. There is no need to use the rigid diaphragm walls made of reinforced concrete if the structures strengthened and reinforced this way. The use of damper gives the chance of combination with skeleton system (reinforced wall + skeleton). Otherwise it is impossible to combine the non-strengthened masonry structures with skeleton structures because of great difference in horizontal rigidity of the structures.
Damper, Type Mionica+ is used for the purpose o sanitization of the masonry structures subjected to the earthquake. This type of damper is used in Kolubara region on a mass scale, especially in Mionica settlement.
Damper, Type Iran, is developed as a donation for the purpose of the reconstruction the objects subjected to the earthquake in Bam city in Iran. The damper is developed for the construction made of brick earth.
Damper, Type Algeria. is developed and used at the reconstruction the Finland Ambassador residence in Algeria. The modified version of the damper will be used on a mass scale in Ayn Delpha and Vilai Shlef regions.

Damper, Type Krushevac is used at reconstruction of the Deva trade center in Krushevac thanks to the contribution of Dobrica Vasilyevich, one of the collaborators and pioneers of the damper adoption in Serbian construction .
Damper, Type Bridge, is developed to solve the problem of interconnection between the main pillars and girders in bridge constructions. The damper gives an opportunity to provide relatively big controlled displacements up to 120 mm.
Damper, Type X1 is developed as a first model of double-axes action in IMS Institute. It was used during the construction of the additional storey in Kiyevo-Knezevac.
Damper, Type Canada HQL and HQM is developed in cooperation with Canadian experts to strengthen the walls of turbine room.
Damper, Type Vokzal is developed for the purpose of the construction of the large trade centre (70.000 m^2) in Baku, 8.00 m bays and 6.00 m storey height.
Damper, Types Baku 1-8, it is a range of modified dampers for strengthening the historical objects. They were originally developed in cooperation with Serbas company, Baku, for the purpose of the Azerbaijan President residence reconstruction.
At the present moment we research and develop the new metal hysteresis dampers for the construction needs (vibro- protection, strengthening and seismic stability).



First summer innovation camp

Belgrade 22-27.09.2009

INNOVATIONS AND SEISMIC STABILITY OF THE CONSTRUCTION STRUCTURES ANTISEISMIC DEVICES 2009

The first innovation and research camp **Innovation and safety 2009** at the first place serves the purpose of firsthand acquaintance of the students, engineers and experts with the innovation process in the domain of earthquake stability of the construction structures.

The selection of the candidates for the participation was made by the members of the authors' team that includes::

Dr. Dragoslav Shumarac, Prof., certified construction engineer, Construction Institute, Belgrade, Serbia
Dr. Lyubomir Tashkov,Prof., certified construction engineer ,IZIIS, Skopje, Macedonia
Dr. Lydia Krstevska, Prof., certified construction engineer Skopje, Macedonia
Dr. StoyanSedmak, Prof., certified construction engineer, Metallurgical Technology Institute Belgrade, Serbia
Dr. Zlatko Maglaich, Prof., certified construction engineer, Construction Institute, Sarajevo, Bosnia and Herzegovina
Gordana Danilovich-Grkovich, Incubator Centre of the Technological / engineering Institutes of Belgrade City, Serbia
Zoran Petrashkovich, certified construction engineer, member of SAIN (Serbian Academy of Invention), Belgrade, Serbia

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Famous experts and professors lectured on their professional domain. The participant had an opportunity to take part in experimental testing.

The participants of the First innovation camp could see the results of DC90 System application on the objects all over the world. .