



SISTEM DC90

Research, Consulting, Engineering and Technology Transfer, EARETHQUAKE ENGINEERING INNOVATION CENTER BELGRADE,
E-mail: dc90@Eunet.yu www.dc90.co.yu, Vele Nigrinove 1, tel/fax:381 11 2835-235, 2836-044, PIB 100132505, Matični broj: 17330314,
Raiffeisenbank: 265-1100310000653-30.

Destination :

**CANADA
HYDRO-QUEBEC
CENTRALE BEAUHARNOIS
80 BOUL. EDGAR-HEBERT**

**C.P. 36 MELOCHEVILLE, QC,
J6N 3C1
A/S: PIERRE MUNGER**

EXPORTER:

**SISTEM DC 90, d.o.o.
PUKOVNIKA PURICA 1, BELGRADE,
SERBIA**

Appel d'offres 4502455244

Number pcs: 10

**COMMERCIAL NAME: STEEL
ANCOR- CONNECTOR**

**TECHNICAL NAME :DAMPER-
CONNECTOR DC 90 SET**

" CANADA HQ L " TYPE

Btto: 17,00 kg

Ntto: 16,00 kg

168 pcs.

Documentation about quality assurance

Belgrade, 2010, july

Contents

C. Documentation about quality assurance:

1. Material Documentation

Attests for all built-in materials with mechanical characteristics including:

Metal pipes and

Welding electrodes

2. Documentation with proof of welder's qualification

Assurance of a valid completed welding exam-test

3. A statement from a responsible technical person about the control of all phases during manufacture.

4. Documentation about testing of the finished product with all the necessary diagrams and comments including:

-force-displacement diagram (histereses diagram)

5. Photo documentation

Trade name:

Metal Anchor-connector

Technical Name:

Damper-connector DC 90 sets („Canada HQ L“type)

CUSTOMER ORDER

The Customer (HYDRO-QUEBEC) ordered to conduct the dynamic loading test on type “Kanada HQL ” damper (the absorber of seismic energy developed by “SYSTEM DC90”) according to the Test Program. The testing results of the delivered specimen should meet the quality requirements in the aspect of the energy damping.

TESTING PROCEDURE

The testing is performed by means of AFS Servo-controlled Hydraulic System, Figure 1. The edges of the testing specimen are fixed by the jaw clutches designed for the round specimens, thus the influence of the deformations virtually has no effect on the testing results.



Figure 1. AFS, Servo-controlled Hydraulic System

The maximum range of the system is $\pm 20\text{kN}$. The System works in the following modes:

- Force (energy) control mode,
- Strain control mode,
- Actuator step control mode.

The testing is performed in the displacement control mode (the deformation of the testing specimen). In advance defined testing mode was input in PDP PC program, while the sinuous alteration of dislocation is realized by function generator. The recorded data (the values of the force and actuator step) measured by AFS System are transmitted to PC through A/D converter.

Microsoft EXCEL software has been used to process the obtained measured data. The testing started at 0.5 Hz frequency level, the data acquisition frequency was 100 samples per second.

1. Material Documentation

Attests for all built-in materials with mechanical characteristics including:
Metal pipes and
Welding electrodes



INSPECTION CERTIFICATE 3.1 acc.EN 10204:2004
-uvrjenje o ispitivanju-

CERTIFICATE No. 35066
(uverenje broj)
UGOVOR KUPCA
CONTRACT No. 89-05/2010
(ugovor broj.)
T: HRACE
- EN 10051/1991

PAGE No: 1
(strana br)
DATE OF ISSUE 05/05/2010
(dat.izdavanja)

Transport: HG/9170511151HG

[illegible]

0629010	0147414	298 438	.68	35
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SHEET No Gardla br	CHEMICAL COMPOSITION - HEMELJSKI SASTAV (%)														
	C	Mn	Si	P	S	Al	Cu	Cr	Ni	Mo	Ti	V	Nb	N	Oxy
	X 100		X 1000				X 100				X 1000				X 100
0147414	13	80	10	14	10	38	4	4	2	4	1	2	2	2	27

MATERIAL MASS RADIOACTIVITY DOES NOT EXCEED VALUE OF 100 BG/KG
QUALITY ASSURANCE
ONEZBEZBEZNE KVALITETA

MEMBERS OF CONSORTIUM: KOMGRAP, SISTEM, VALJEVO-PLAN, PIRS, NIK-INŽENJERING, PROJEKT-KOMERC VELJA, RADIJUS, GEO-TEST, BEOING, SZR GRAĐEVINAR

FERROMORAVIA, s.r.o

Tovární 1688, 686 02, Staré Město

DIČ: CZ63480085 IČO: 63480085

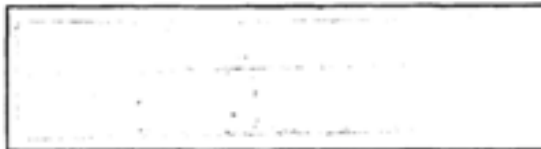
OR: Krajský soud v Brně, spis.zn. C 20789 dne 29.9.1995

Inspekční certifikát**Inspection certificate 3.1**

ČSN EN 10204/3.1

Číslo: /No.:

137264



Předmět / Object	COLD-DRAWN ROUND STEEL BAR 014.00	
Rozměr / Dimensions	014.00 h9 3000+100-0	
Jakost / Quality	S355J2G3C	
Dle norem / Standart	EN 10278	N 10277-2
Objednávka / Order No.	41099220/00302	
Zakázka č. / Internal Order No.	9920022236	
Dodací list č. / Advice note	809001020	5908003123
Auto / Truck No.	CZ 4T30970 2T38668	
Množství / Total	0,000	
Váha / Totalweight	1,020	T

Mechanické vlastnosti / Mechanical values		(MPa=1 N/mm ²)
Vzorek č. / Probe No.	2071550	Hodnota / Value
Rp02 (MPa)	Yield point	524,0000
Rm (MPa)	Tensile strenght	672,0000
A5(%)	Allongation	13,0000

Chemické složení / Chemical Composition		
Tavba č. / Cast No.	30318	Hodnota / Value
(Tavbová analýza - Cast Analysis)		
C%		0,1600
P%		0,0150
S%		0,0090
Mn%		1,3200
Si%		0,3600
Cu%		0,0900
Al%		0,0240
Ti %		0,0027
CEQ %		0,4000

Vyřízení zakázky vyhovuje stanoveným požadavkům.

Dodržena radioizotopická aktivita taveb. vzorku - max. 100 BQ/KG.

We hereby certify that material describe above complies with the terms of the contract.

The radioisotopic activity of melting sample is compliance - max. 100 BQ/KG.

Staré Město

08.09.2008

FERROMORAVIA s.r.o.
Tovární 1688
686 02 Staré Město**FERRO**

atestace





U. S. Steel Serbia, d.o.o.
Gornjaka 12, 11200 Smederevo
Serbia
Tel: +381-20-228118
+381-20-221819

INSPECTION CERTIFICATE 3.1 acc EN 10204:2004
- uverenje o ispitivanju -

CERTIFICATE No: 89643
(uverenje broj)

CONTRACT No. 43/83-2887
(ugovor broj.)

T: CR
- EN 10131 /1992

PAGE No: 2
(strana br)
DATE OF ISSUE 26/04/2007
(dat. izdavanja)

Transport: PA983393138PA

PRODUCT: COLD ROLLED COILS
(proizvod)
DIMENSIONS: 1,200 X 1000 X
(dimenzije, mm)
QUALITY: DC 01 / EN 10130/91+A1/98
(kvalitet)
Net Weight (kg): 8310

MECHANICAL PROPERTIES - MEH. TEH. OSOBINE									
COIL No, PACK No, lotur br., paket br.	HEAT No, Serija br.	Re	Rm	Re/Elon gati	Cold bend test	Erich iev.	Hardness (tvrdopa)	r	n
		2	2	on	8				
		N/mm	N/mm	X	100	mm	HRB HRF HR30T		

464769 828928 233 334 8,75 42

Y

CHEMICAL COMPOSITION - HEMIJSKI SASTAV (%)														
HEAT No, Serija br	C	Mn	Si	P	S	Al	Cu	Cr	Ni	Mo	Ti	V	Nb	N
	X 100					X 1000			X 100				X 1000	
828928	0	30	7	7	4	34	2	1	1	<1	<1	<1	<1	4

We hereby declare that above mentioned products were manufactured in accordance with specifications and contract requirements.

QUALITY ASSURANCE
OBEZBEDJENJE KVALITETA

120-10-13
11664

 IGM-TRADE Ilja i dr.DOO Profile and Pipe factory Industrijska 2 1430 Kavadarci R.Macedonia	Сертификат 2.2	ФМ 7.2/02
	Certificate 2.2	EN 10204:2004
	Нарачка број/Order No.	Пратка број/Delivery No 1112*63
	Купувач/ Buyer JEEP COMMERCE BEOGRAD, SRBIJA	
DATE:26.08.2008 1430 KAVADARCI, R.MACEDONIA		DATE:09.04.2010 1430 KAVADARCI, R.MACEDONIA
Опис на производот/Product description CFR(C)HS, Cold formed	Обележување/Marking	Стандард/Standard EN10219 ; EN 10217
Маркирање на производот/Product marking S235JR. EN 10219/1+2 ; EN 10217	Материјал/Material S235JR	

Испорака/Delivery:

Ознака Marking	Димензии(mm) Dimensions(mm)	Кол./теж. Lot/Weight	Материјал Base material	Стандард Standard	Шаржа Heat No.
	120x120x5. / 12000mm	32pcs/4915kg	S235JR	EN10219	266558
	Fi 21.3x2.3 / 6000mm	271pcs/1760kg	S235JR	EN10217	355518
	Fi 21.3x2.5 / 6000mm	424pcs/3145kg	S235JR	EN10219	146470
	Fi 26x2.8 / 6000mm	97pcs/1305kg	S235JR	EN10217	145626
	Fi 26.9x2.8 / 6000mm	79pcs/900kg	S235JR	EN10217	145626
	Fi 33.7x3.0 / 6000mm	169pcs/2200kg	S235JR	EN10217	723856
	Fi 48x2.5 / 6000mm	91pcs/1575kg	S235JR	EN10217	146470
	120x60x5.0 / 6000mm	24pcs/2160kg	S235JR	EN10219	721886
	120x80x5.0 / 6000mm	20pcs/1720kg	S235JR	EN10219	721886
	Zp 100x1.8/6000mm	240pcs/4135kg	S235JR	EN10219	986819
	18x18x1.5/6000mm	300pcs/1305kg	S235JR	EN10219	917910

Хемиски состав/Chemical composition %

Шаржа. Heat No.	10 ⁻² C	10 ⁻² Si	10 ⁻² Mn	10 ⁻² P	10 ⁻² S	10 ⁻² Al	10 ⁻² N	10 ⁻² Cr	10 ⁻² Ti	10 ⁻² Ni
266558	13	2	45	12	8	35	4			
355518	15	2	43	10	12	46	7			
146470	14	2	44	14	14	32	5			
145626	13	2	47	13	11	44	5			
723856	13	2	53	20	10	40	8			
713643	12	2	50	11	11	46	7			
986819	10	2	42	20	12	43	6.8			
917910	9.5	3	43	15	8	48	6.6			

Механичко/технолошки карактеристики/ Mechanical/technological properties:

Test na istegaije/Tensile test

Ознака/Marking	Шаржа Heat No.	R _m [N/mm ²]	R _m [N/mm ²]	A [%]	Бр. на тест		
	266558	286	409	31.3	1		
	355518	307	443	31.0	1		
	146470	280	406	31.5	1		
	145626	295	417	32.5	1		
	723856	298	412	30.0	1		
	713643	288	412	32.0	1		
	986819	298	414	30	2		
	917910	340	408	30	1		



TEM DC 90
 center for thermodynamic, humecting
 (testing) & thermodynamic calculations

elektrode-jesenice



ELEKTRODE JESENICE, d.d.
 Čvrsta posredstva d. o. o. z. o. o.
 Tel: +386 (0)4 594 19 00
 Fax: +386 (0)4 594 14 40
 E-mail: elektrode@jesenice.si
 www.jesenice.si

Kupnik / Buyer / Customer
 RUTENIA
 PLE ROMANOVICIA 9/4
 3 8000 BEOGRAD
 SRBIJA

Potrdilo o kvaliteti / Werkzeugeignis /
 Test report
 1010 204 8.2
 Datum / Date / Tag
 19.10.2010
 1010 204 8.2
 Datum / Date / Tag

Ime / Name / Produkt
 Elektrode Jesenice
 Datum / Date / Tag
 19.10.2010

Mehaničke lastnosti / Mechanical Eigenschaften / Mechanical properties							CONTINUA VARI	
Ime / Name	Proizvajalec / Manufacturer	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production
770110	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0
770111	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0
770112	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0
770113	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0

Kemijska analiza / Chemische Zusammensetzung / Chemical Composition									
Ime / Name	Proizvajalec / Manufacturer	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production	Proizvodnja / Production
770110	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0
770111	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0
770112	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0
770113	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0	1.000.0

slj

2.Documentation with proof of welder's qualification
Assurance of a valid completed welding exam-test

11127 BEOGRAD, Grčica Milenka 67, tel: 011/2851-079, fax: 2850-648, e-mail: zzz@bitayu.net www.zzz.co.yu

UVERENJE O STRUČNOJ OSPOSOBLJENOSTI ZAVARIVAČA Welder Approval Test Certificate

Oznaka: EN 287-1:2004 141 T BW 5 S t6.0 D060 H-L045 ss nb
Designation:

Proizvođačka WPS (ako je primenljiva):
Manufacturer's WPS (if applicable):

Ime i prezime zavarivača: ZORAN (Slavoljub) NIKOLIĆ
Welder's name:

Identifikacija: 0903977770017
Identification:

Datum i mesto rođenja: 09.03.1977. Valjevo
Date and place of birth:

Poslodavac: ND INŽENJERING COMPANY,d.o.o.,Beograd
Employer:

Pravilo / standard: EN 287-1:2004
Code / Testing Standard:

Broj: 696/08
Number:

Žig zavarivača:
Welder's brand:
Isprava identifikacije:
Method of identification:

Fotografija
(ako se zahteva)
Photograph
(if required)

Poznavanje struke: Nije ispitano
Job knowledge: Not tested

	Podaci o Ispitnom uzorku Weld test details	Područje odobrenja Range of approval
Postupak zavarivanja / Welding process	141	141
Lim ili cev / Plate or pipe	T	T,P
Tip spoja / Joint type	BW	BW,FW
Grupa(o) osnovnog materijala / Parent metal group(s)	S	1.1,1.2,1.3,1.4,2,3,4,5,6,7,9,11
Dodatni materijal/Oznaka / Filler metal type/Designation	S	S,M
Zaštitni gas / Shielding gas	EN439-11	EN439-11
Pomoćni materijal / Auxiliaries	-	-
Debljina materijala (mm) / Test piece thickness (mm)	6	3 mm do 12 mm
Spojini prečnik cevi (mm) / Pipe outside diameter (mm)	63	>= 25 mm
Položaj zavarivanja / Welding position	H-L045	H-L045,PA,PC,PF,PE,PB,PD
Žigljenje/podicačka // Gouging / backing	ss,nb	ss nb,ss mb,bs FW:s,l,m

Vrsta ispitivanja Type of test	IZVRŠENO PRIHVATLJIVO Performed and acceptable	NE ZAHTEVA Not required
Vizuelno / Visual	X	-
Radiografija / Radiography	X	-
MP - PT / MT - PT	-	X
Makrostrukturno / Macro	-	X
Prelomom / Fracture	-	X
Savijanjem / Bend	-	X
Dodatna ispitivanja* / Additional tests*	-	X

*) Priloži poseban list, ako je potrebno / Append separate sheet if require

Produženje uverenja od strane Ispitnog tela za 2 godine.
Prolongation for approval by examiner or examination body for following 2 years

Datum Date	Potpis Signature	Funkcija Position or title

Ispitno telo: Zavod za Zavarivanje a.d. Beograd
Examination body:

Ispitivač / Examiner:  
Vladimir Vuković, dipl. ing. Vladimir Lilić, dipl. ing.

Datum izdavanja: 28.05.2008.

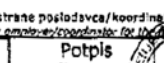
Date of issue:

Mesto: Beograd

Location:

Uverenje važi do: 26.05.2010.

Validity of approval until:

Datum Date	Potpis Signature	Funkcija Position or title
28.05.2008.		INŽENJER BEGRAD-75

08-722-11



ČLAN MEĐUNARODNOG INSTITUTA ZA ZAVARIVANJE
MEMBRE DE L'INSTITUT INTERNATIONAL DE SOUDURE
MEMBER OF THE INTERNATIONAL INSTITUTE OF WELDING

3. A statement from a responsible technical person about the control of all phases during manufacture.

Descriptions for manufacturing processes of Damper types **HQL** and **HQM**

1. Aquisition and transportation of all materials; steel tubes and tin, lead, paints, packaging polystirl etc.
2. Marking, measuring, and cutting the material to fit the dimensions within the required tolerance for each element separately in accordance with technical specifications and normatives.
3. Cleaning, degreasing, removing of corrosion and precise machine processing of parts and surfaces up to the required tolerances and geometry.
4. Placing of element assembly in tools. Geomerty control.
5. Placing of element assembly in tools. Geometry control. Connecting and securing of elements. Repeated control of geometry via modern elecctronic measuring devices with 0.01 mm precision.
6. Welding by CO2 process.
7. Thermic processing of weld by regime. Gradual heating of materials followed by release. Whole process lasts 6,00 hours.
8. Painting of elements with coatings, thoroughly and finally with a total of 3 layers.
9. Packing and labeling into smaller packages and then into packages for aerial transport.
10. Delivery to the Nikola Tesla airport-Belgrade

I hereby state that I have performed the integral control of.

-materials,
-processes,
-geometry and
-final control

Sistem DC 90-Radijus Mionica, Serbia

CEO

Radivojević Slobodan, mechanical.eng.

4. Documentation about testing of the finished product with all the necessary diagrams and comments including:
 -force-displacement diagram (histereses diagram)

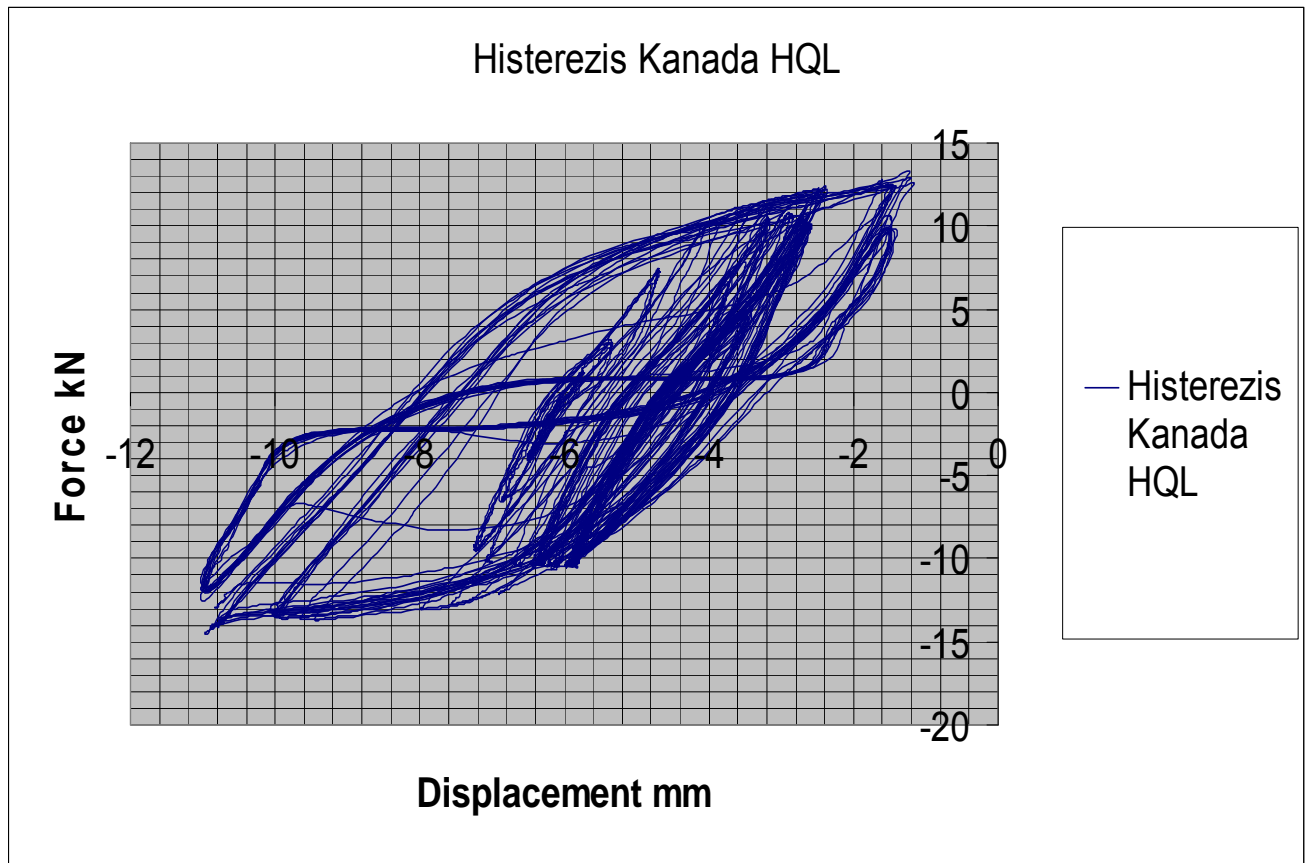


Figure 2. Force vs. displacement (hysteresis), all cycles

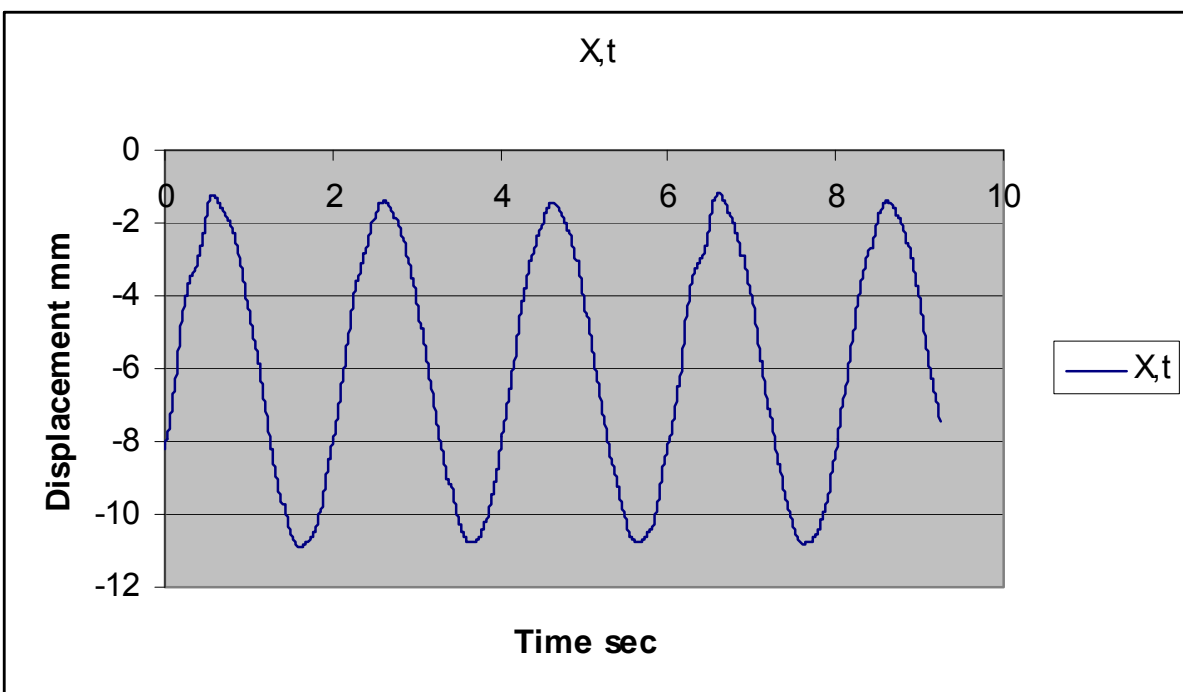


Figure 3. displacement vs. time five cycles (max $x = \pm 5$ mm.)

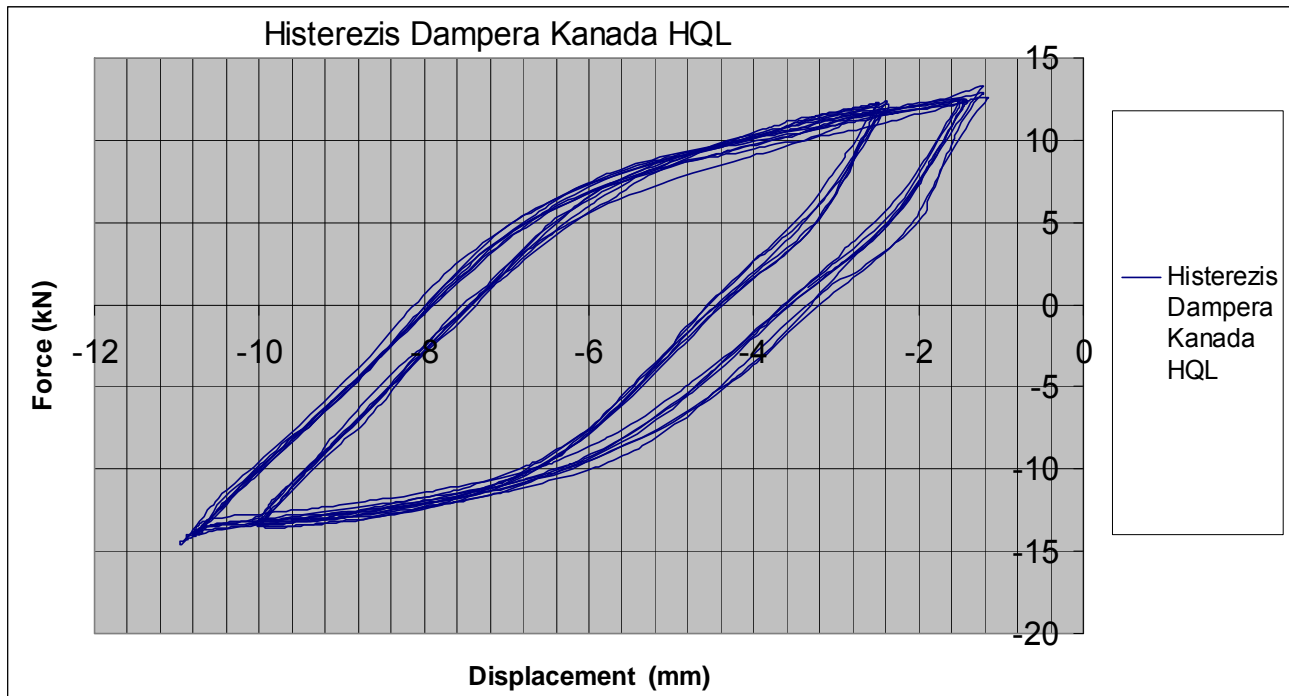


Figure 4. Force vs. displacement (hysteresis), middle cycles

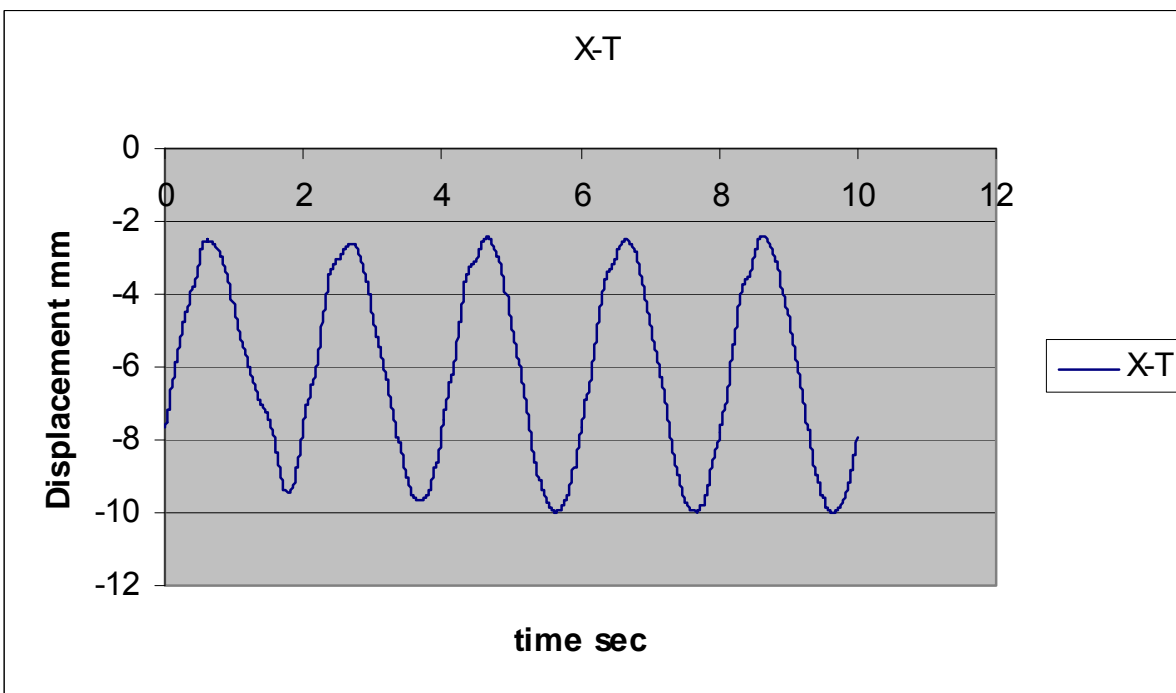


Figure 5. displacement vs. time five cycles (max $x = \pm 3.0\text{mm}$. to $x = \pm 3.5\text{mm}$)

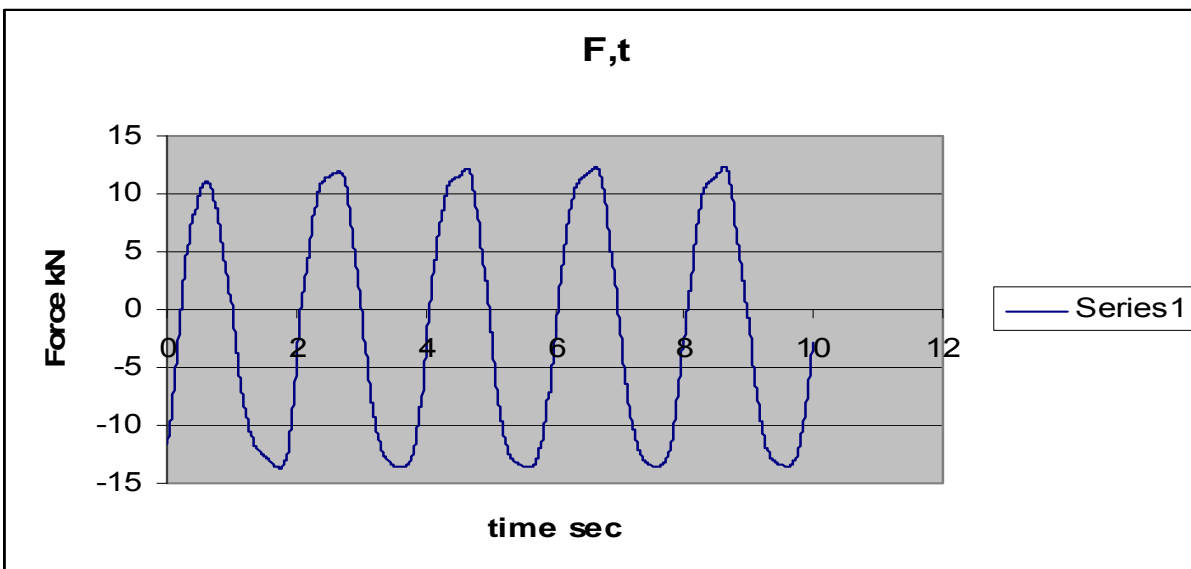


Figure 6. Force vs. time five cycles (max $F=+11$ kN to $F=+12$ kN)

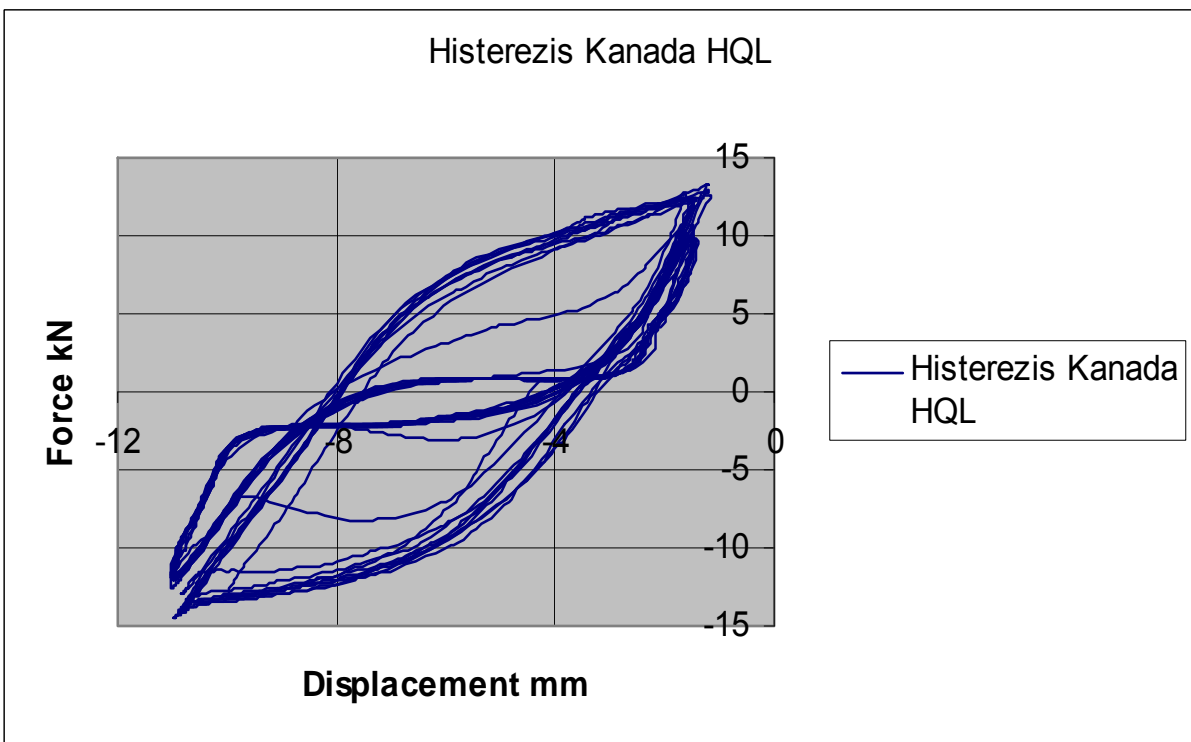


Figure 7. Force vs. displacement (hysteresis), finish cycles

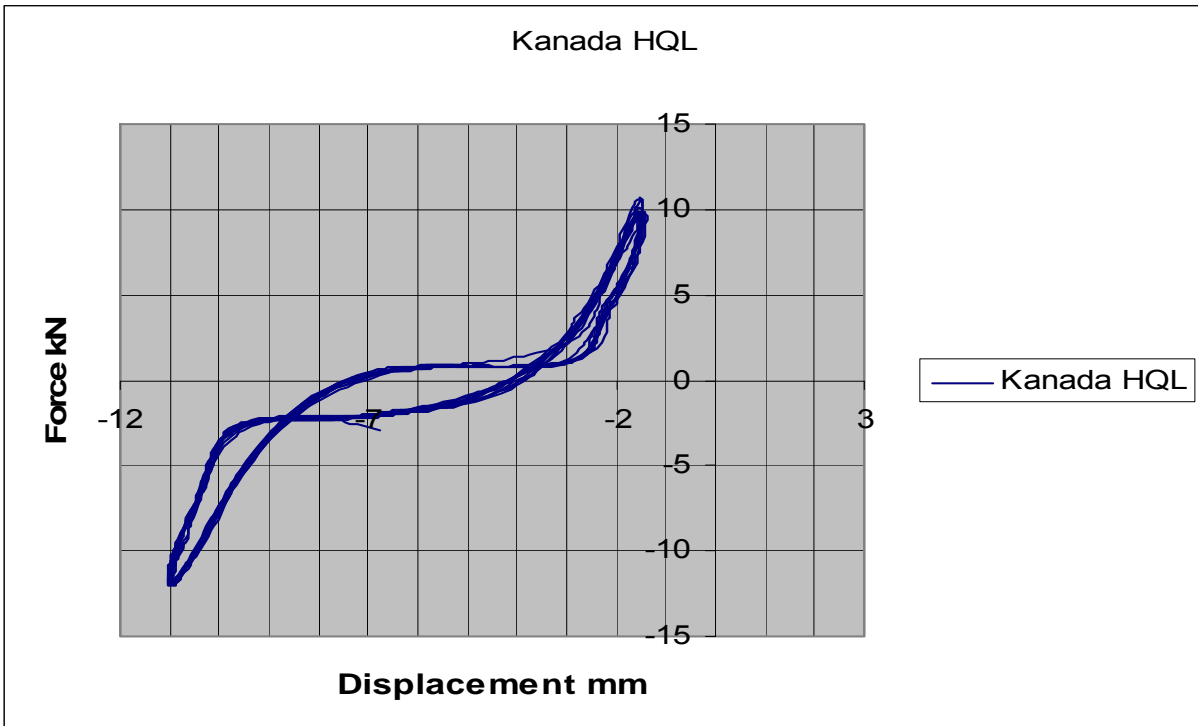


Figure 8. Force vs. displacement (hysteresis), after colaps-control displacement

TESTING RESULTS

The testing results are represented on the following Figures:

- Figure 2. Force vs. displacement (hysteresis), all cycles
- Figure 3. displacement vs. time five cycles (max $x = \pm 5\text{mm}$.)
- Figure 4. Force vs. displacement (hysteresis), middle cycles
- Figure 5. displacement vs. time five cycles (max $x = \pm 3.0\text{mm}$. to $x = \pm 3.5\text{mm}$)
- Figure 6. Force vs. time five cycles (max $F = \pm 11\text{ kN}$ to $F = \pm 12\text{ kN}$)
- Figure 7. Force vs. displacement (hysteresis), after colaps-control displacement

At deformation levels of $\pm 1\text{mm}$, $\pm 2\text{mm}$, $\pm 3\text{mm}$ and 6 cycles of $\pm 4\text{mm}$ the strain force is practically constant that is about 8-10kN (see Figure 2).

Figure 4 indicates work for displacement $\pm 3.5\text{ mm}$ and $\pm 5\text{ mm}$, and Forces between 7 to 12 kN in plastic area.

Figure 7. and 8 indicates that there are two type of hysteresis: before and after the damper fracture. At the beginning of testing, during the first 16 cycles, the hysteresis area is very large (see Figure 9), while starting from 20th cycle till the end of testing the hysteresis area decreases significantly (see Figure 10). The absorbed (damped) energies correlate respectively. Figure 9 confirms the statement. The increase of deformation of damper specimen during the first 16 cycles is followed by the similar growth of the absorbed energy during each particular cycle. After the 18th cycle the absorbed energy vs. number of cycles is linear, but after the 140th cycle the gradient lightly decreases.

Testing of damper was made in side of Inovation Laboratory of Sistem DC90, com.ltd., Belgrade.

Technical characteristics of Dampers Kanada HQL.

Fabrication and delivery of Damper-connector DC 90 sets („Canada HQ L“type) including the total custom export duties and formalities and air freight or carriage costs paid to Buyer address in Montreal.

Each set includes the following:

- Damper,
- Steel plate,
- Connector: 16mm diameter, 2mm tread.

(All the members are joined by welding and appear as integrality).

Damper-connector DC 90 („Canada HQ L“type) is fabricated according to the following technical specifications:

- a) Initial force of plastic (non-elastic) work varies from 7.92 kN to 8.32 kN.
- b) Plastic work zone is ± 4 to 5 mm.
- c) Maksimum force – Damper-connector capacity is about 14.4 kN.

5. Photo documentation



Figure 9. View of Damper type “Canada” (absorber of seismic energy).

DELIVERED SPECIMEN

To conduct a test the customer delivered the type “Canada” damper (the absorber of seismic energy developed by “SYSTEM DC90”).

The view of the delivered damper specimen (the absorber of seismic energy) is represented on Figure 9. and Figure 10.



Figure 10. View of Damper type “Canada” (absorber of seismic energy).

Accumulated dilatation

Δl_u	$ \Delta \varepsilon_u $	n_{cyc}	$\Sigma \Delta \varepsilon_u $
<i>mm</i>			
± 0.5	0.005	5	0.02
± 1	0.01	2	0.04
± 2	0.02	6	0.24
± 3	0.03	10	0.60
± 4	0.04	5	0.40
± 5	0.05	5	0.50
	Σ	33	1.80

$$|\Delta \varepsilon_i| = \left| \frac{\Delta l_i}{l} \right| - \text{accumulated dilatation during a semi-cycle}$$

Where a cycle,

l – is the length of the test specimen of 100 mm and

n_{cyc} – is the number of cycles.

Total accumulated dilatation is 1,80 during **33 loading cycles** on a length of 100 mm on a dog bone Damper DC 90 type HQL. Post-collapse capacity)even after the construction degradation, when it can no longer take pull loading. More **than 400 cycles** with control deformation.

5. CONCLUSION

The objective of the testing was to investigate the quality of the specimen in aspect of energy damping as well as to check the calculated domain of usage of the damper.

Recommended area of use of the tested damper is up to ± 5 mm.

It is also important that this damper has a high material plasticity reserve (post-collapse capacity) even after the construction degradation, when it can no longer take pull loading. More than 400 cycles.
Belgrade, 2010, july

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