TYPE TEST REPORT FOR OPGW 09A36z-48M (6609)

Client: TERNA
Date: 9th – 12th March, 2009
Drum tested: W-07585-S (for test 3.12) and W-07590-X (for the rest of tests)

The following Composite Fiber Optic Ground Wire (OPGW) cable type tests have been carried out in accordance with the specifications referred:

	Tests on wires before stranding	**Standard**	**Date**
1.1	Visual aspect, Diameter, section	IEC 61232	Mar 10th 2009
1.2	Mechanical properties of wires	IEC 61232	Mar 10th 2009
1.3	Torsion test of the AS wires	IEC 61232	Mar 10th 2009
1.4	Electrical Resistance	IEC 61232	Mar 10th 2009
1.5	Aluminium thickness AS wires	IEC 61232	Mar 10th 2009
1.6	Hardness of aluminium coating	ISO 6507	Mar 4th 2009
	Tests on wires after stranding		
2.1	Visual aspect, Diameter, section	IEC 61232/ EN 50182	Mar 10th 2009
2.2	Mechanical properties of wires	IEC 61232/ EN 50182	Mar 10th 2009
2.3	Torsion test of the AS wires	IEC 61232/ EN 50182	Mar 10th 2009
2.4	Electrical Resistance	IEC 61232/ EN 50182	Mar 10th 2009
2.5	Aluminium thickness AS wires	IEC 61232/ EN 50182	Mar 10th 2009
2.6	Hardness of aluminium coating	ISO 6507	Mar 4th 2009
	Tests on completed cable		
3.1	Cable performance, formation…	CEI EN 50182	Mar 9th 2009
3.2	Mass verification	CEI EN 50182	Mar 9th 2009
3.3	Ultimate tensile strength	CEI EN 50182	Mar 11th 2009
3.4	Q-test	UX LC 3907	Mar 11th 2009
3.5	Stress-strain test	CEI EN 50182	Mar 11th 2009
3.7	Internal self-damping	CIGRE No. 62	To be done at NES
3.8	Aeolian vibrations	UX LC 3907	To be done at NES
3.9	Mechanical cycles simulating thermal excursions	UX LC 3907	To be done at NES
3.10	Sheave test	IEC 60794-4-1	Mar 9th 2009
3.11	Wire unwrapping	UX LC 3907	Mar 11th 2009
3.12	Attenuation linearity	IEC 60793 C1C	Mar 9th 2009
3.13	Temperature cycles	IEC 794-1-F1	Mar 9-12th 2009

Tests 1.6 and 2.6 are carried out at the laboratories of the Centre de Disseny d'Aliatges Lleugers i Tractaments de Superficie, Universidad Politecnica de Catalunya, Avda. Victor Balaguer, s/n, 08800 Vilanova y la Geltrú, Barcelona, by Eng. Josep A. Picas. Annex A accounts for the Hardness of aluminium coating report before (1.6) and after (2.6) stranding issued by the Centre de Disseny d'Aliatges Lleugers i Tractaments de Superficie from the Universidad Politecnica de Catalunya.

Tests 3.7 to 3.9 shall be carried out at Nuova Electtromeccanica Sud S.p.a.

All the other tests have been performed at Prysmian Telecom Cables y Sistemas, Ctra. C-15 Km-2, Pol. Ind. Masia d'en Notari-PRYSMIAN, 08800 Vilanova y la Geltrú, Barcelona, España, by Dr. J. Martin-Regalado, from Prysmian Cables y Sistemas, and have been witnessed by Ing. Piero Berardi and Ing. Matteo Mannino from TERNA S.p.a.

The results for the entire above mentioned test have been found satisfactory as per the following attached reports.

Ing. Matteo Mannino from TERNA
Dr. J. Martin-Regalado, from Prysmian Cables y Sistemas

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Visual Aspect, Wire Diameter and Section before stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232**
Objective: To verify the visual aspect, diameter and section of the wires.
Instruments: Vernier MITUOTOYO

TEST SETUP AND PROCEDURE:
The visual aspect of the wires is examined by bare eye. The diameter of the AS wires is obtained from the average of two measurements. The section is calculated from the average diameter

PASS/FAIL:
The values shall be in accordance with the cable specifications. Diameter: 2.07±0.04 mm

RESULT:
The wire surface of all wires is regular, free from imperfections and defects. The average diameter of the wires is 2.07±0.01mm. The following table summarizes the results:

Sample	1st [mm]	2nd [mm]	Average [mm]	Surface [mm^2]	Pass
1	2.07	2.07	2.07	3.365	OK
2	2.06	2.07	2.07	3.349	OK
3	2.08	2.08	2.08	3.398	OK
4	2.07	2.07	2.07	3.365	OK
5	2.08	2.08	2.08	3.398	OK
6	2.07	2.08	2.08	3.382	OK
7	2.07	2.07	2.07	3.365	OK
8	2.08	2.08	2.08	3.398	OK
9	2.07	2.07	2.07	3.365	OK
10	2.07	2.08	2.08	3.382	OK
11	2.06	2.07	2.07	3.349	OK
12	2.07	2.06	2.07	3.349	OK
13	2.07	2.07	2.07	3.365	OK

CONCLUSION:
The wires met the requirements for the Test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Elongation and Tensile strength test on wires before stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232**
Aim: To determine the tensile properties of the wires as raw material
Instruments: TENSILE MACHINE SHIMADZU AUTOGRAPH AGI50KN

TEST SETUP AND PROCEDURE:
All AS wires samples before armoring are prepared for the test. The samples are installed between the jaws of the vertical test machine. An external gauge 250mm long is attached to the test specimen. The samples are initially loaded to 30 Kg. The load is continuously increased at a constant rate to determine the load at 1% strain (AS wires only), **L@1%**, the tensile strength, $\mathbf{T_S}$, and the elongation at break, **s**.

PASS/FAIL:
The pass criteria for the tensile properties of the wires are summarized in the following table:

Type	T_S [Kg/mm^2]	S [%]	L@1% [Kg/mm^2]
AS 20.3%IACS	136.6	1.5	122.3

RESULT:
The following table summarizes the results:

# sample	T_S [Kg/mm^2]	S [%]	L 1% [Kg/mm^2]	Pass
1	169	2.49	146	OK
2	165	2.25	144	OK
3	169	2.08	147	OK
4	171	2.22	148	OK
5	169	2.36	146	OK
6	165	2.19	143	OK
7	172	2.61	148	OK
8	161	2.40	140	OK
9	167	2.56	144	OK
10	165	1.82	143	OK
11	164	2.59	142	OK
12	168	2.07	144	OK
13	167	2.16	146	OK

CONCLUSION:
The wires met the requirements for the test according to IEC standard

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Torsion test on wires before stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232**
Objective: To verify the mechanical properties of the AS wires.
Instruments: Machine for torsion test on wires

TEST SETUP AND PROCEDURE:
All AS wire samples before armoring are prepared for the test. Each specimen, 207mm long, is gripped at its ends in the vises of the torsion machine, one of which is free to move. The sample is twisted by rotating one of the vises at 60 turns/min until fracture is observed. The number of twists at fracture is recorded.

PASS/FAIL:
The wire shall withstand without fracture not less than 20 twists in a length equivalent to 100 times the nominal diameter of the wire.

RESULT:
The following table summarizes the results:

# sample	Number of torsions	Pass
1	59	OK
2	57	OK
3	56	OK
4	57	OK
5	57	OK
6	55	OK
7	55	OK
8	54	OK
9	57	OK
10	56	OK
11	59	OK
12	57	OK
13	57	OK

CONCLUSION:
The wires met the requirements for the test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Electrical resistance of the wires before stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232**
Objective: To verify the resistance and resistivity of the wires.
Instruments: Thomson Bridge, Micro-ohmmeter RESISTOMAT 2302

TEST SETUP AND PROCEDURE:
All AS wire samples before armoring are prepared for the test.. Each wire sample is installed in one arm of the Thomson bridge. The DC resistance per unit length is measured using a micro-ohmmeter on a sample length of 1.0 m. The temperature of the measurement is taken in order to correct the value at room temperature (20ºC) according to the following formula:

$$R_{20ºC} = R_T / [1+0.0036(T-20)].$$

PASS/FAIL:
The resistivity of the wires shall not exceed the nominal value:

Type	Resistivity [Ω·mm2/Km.]
AS 20.3% IACS	84.80

RESULT:
The following table summarizes the results:

# sample	T [ºC]	R@T [Ω/Km]	R@20ºC [Ω/Km]	Resistivity [Ω·mm^2/Km.]	Pass
1	23.2	23.27	23.00	77.42	OK
2	23.2	23.35	23.08	77.31	OK
3	23.2	23.84	23.57	80.08	OK
4	23.2	23.72	23.45	78.92	OK
5	23.3	23.80	23.52	79.92	OK
6	23.4	23.34	23.06	77.97	OK
7	23.4	23.91	23.62	79.49	OK
8	23.4	22.73	22.46	76.30	OK
9	23.4	23.62	23.33	78.53	OK
10	23.4	24.28	23.99	81.11	OK
11	23.4	23.29	23.01	77.06	OK
12	23.4	23.73	23.44	78.51	OK
13	23.4	23.34	23.06	77.60	OK

CONCLUSION:
The wires met the requirements for the test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Aluminium thickness of the AS wires before stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232**
Objective: To verify the aluminium thickness of the AS wires.
Instruments: Thicknessmeter DELTASCOPE MP-30

TEST SETUP AND PROCEDURE:
All AS wire samples before armoring are prepared for the test. The aluminium thickness is measured at three different points on each sample using a magnetic induction thicknessmeter.

PASS/FAIL:
The average aluminium thickness shall exceed 10% of the nominal wire radius (103 microns)

RESULT:
The following table summarizes the results:

# sample	#1	#2	#3	Average [μm]	Pass
1	175	172	162	170	OK
2	112	115	129	119	OK
3	115	121	173	136	OK
4	124	119	118	120	OK
5	161	154	149	155	OK
6	184	157	139	160	OK
7	116	136	141	131	OK
8	132	156	135	141	OK
9	152	168	174	165	OK
10	152	130	134	139	OK
11	123	124	123	123	OK
12	168	169	175	171	OK
13	122	122	122	122	OK

CONCLUSION:
The wires met the requirements for the test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Hardness of the Aluminium coating of the AS wires before stranding**
Laboratory: UNIVERSITAT POLITECNICA DE CATALUNYA
Test Standard: **CEI 7-11 / ISO 6507**
Objective: To verify the hardness of the aluminium coating of the AS wires.

TEST SETUP AND PROCEDURE:
Few AS wire samples before armoring, 7.5cm long each, are taken for the test. The wires are delivered to the laboratory of the University to measure the hardness of the aluminium coating according to the ISO 6507.

PASS/FAIL:
The micro-hardness value shall exceed 35.

RESULT:
The following table summarizes the results:

# sample	#1	#2	#3	Average	Pass
1	53	53	53	53	OK
2	53	55	53	54	OK
3	56	54	54	55	OK
4	54	55	54	54	OK
5	58	57	56	57	OK
6	57	56	56	56	OK
7	52	50	53	52	OK
8	57	60	60	59	OK
9	54	54	53	54	OK
10	53	53	52	53	OK
11	54	54	55	54	OK
12	55	56	57	56	OK
13	59	56	58	58	OK

CONCLUSION:
The wires met the requirements for the test according to the ISO standard

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Visual Aspect, Wire Diameter and Section after stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232 / EN 50182**
Objective: To verify the visual aspect, diameter and section of the wires.
Instruments: Vernier MITUOTOYO

TEST SETUP AND PROCEDURE:
The visual aspect of the wires is examined by bare eye. The diameter of the AS wires is obtained from the average of two measurements. The section is calculated from the average diameter

PASS/FAIL:
The values shall be in accordance with the cable specifications. Diameter: 2.07±0.04 mm

RESULT:
The wire surface of all wires is regular, free from imperfections and defects. The average diameter of the wires is 2.07±0.01mm. The following table summarizes the results:

Sample	1st [mm]	2nd [mm]	Average [mm]	Surface [mm^2]	Pass
1	2.07	2.08	2.08	3.382	OK
2	2.07	2.08	2.08	3.382	OK
3	2.08	2.08	2.08	3.398	OK
4	2.08	2.07	2.08	3.382	OK
5	2.07	2.07	2.07	3.365	OK
6	2.07	2.08	2.08	3.382	OK
7	2.07	2.08	2.08	3.382	OK
8	2.07	2.08	2.08	3.382	OK
9	2.08	2.08	2.08	3.398	OK
10	2.07	2.07	2.07	3.365	OK
11	2.07	2.08	2.08	3.382	OK
12	2.07	2.07	2.07	3.365	OK
13	2.06	2.07	2.07	3.349	OK

CONCLUSION:
The wires met the requirements for the Test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Elongation and Tensile strength test on wires after stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232 / EN 50182**
Aim: To determine the tensile properties of the wires as raw material
Instruments: TENSILE MACHINE SHIMADZU AUTOGRAPH AGI50KN

TEST SETUP AND PROCEDURE:
All AS wires samples after armoring are prepared for the test. The samples are installed between the jaws of the vertical test machine. An external gauge 250mm long is attached to the test specimen. The samples are initially loaded to 30 Kg. The load is continuously increased at a constant rate to determine the load at 1% strain (AS wires only), **L@1%**, the tensile strength, $\mathbf{T_S}$, and the elongation at break, **s**.

PASS/FAIL:
The pass criteria for the tensile properties of the wires are summarized in the following table:

Type	T_S [Kg/mm^2]	S [%]	L@1% [Kg/mm^2]
AS 20.3%IACS	129.8	1.0	116.2

RESULT:
The following table summarizes the results:

# sample	T_S [Kg/mm^2]	S [%]	L 1% [Kg/mm^2]	Pass
1	168	2.8	130	OK
2	166	3.4	129	OK
3	163	2.8	126	OK
4	158	2.3	124	OK
5	164	3.3	128	OK
6	164	3.2	127	OK
7	165	3.2	129	OK
8	168	3.1	131	OK
9	165	2.6	128	OK
10	166	2.7	128	OK
11	164	3.1	127	OK
12	166	3.2	126	OK
13	163	3.0	127	OK

CONCLUSION:
The wires met the requirements for the test according to IEC standard

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Torsion test on wires after stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232 / EN 50182**
Objective: To verify the mechanical properties of the AS wires.
Instruments: Machine for torsion test on wires

TEST SETUP AND PROCEDURE:
All AS wire samples after armoring are prepared for the test. Each specimen, 207mm long, is gripped at its ends in the vises of the torsion machine, one of which is free to move. The sample is twisted by rotating one of the vises at 60 turns/min until fracture is observed. The number of twists at fracture is recorded.

PASS/FAIL:
The wire shall withstand without fracture not less than 20 twists in a length equivalent to 100 times the nominal diameter of the wire.

RESULT:
The following table summarizes the results:

# sample	Number of torsions	Pass
1	59	OK
2	59	OK
3	56	OK
4	60	OK
5	61	OK
6	57	OK
7	58	OK
8	51	OK
9	54	OK
10	53	OK
11	54	OK
12	57	OK
13	57	OK

CONCLUSION:
The wires met the requirements for the test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Electrical resistance of the wires after stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232 / EN 50182**
Objective: To verify the resistance and resistivity of the wires.
Instruments: Thomson Bridge, Micro-ohmmeter RESISTOMAT 2302

TEST SETUP AND PROCEDURE:
All AS wire samples after armoring are prepared for the test.. Each wire sample is installed in one arm of the Thomson bridge. The DC resistance per unit length is measured using a micro-ohmmeter on a sample length of 1.0 m. The temperature of the measurement is taken in order to correct the value at room temperature (20ºC) according to the following formula:

$$R_{20ºC} = R_T / [1+0.0036(T-20)].$$

PASS/FAIL:
The resistivity of the wires shall not exceed the nominal value:

Type	Resistivity [Ω·mm2/Km.]
AS 20.3% IACS	84.80

RESULT:
The following table summarizes the results:

# sample	T [ºC]	R@T [Ω/Km]	R@20ºC [Ω/Km]	Resistivity [Ω·mm^2/Km.]	Pass
1	23.4	23.88	23.59	79.78	OK
2	23.4	24.81	24.51	82.88	OK
3	23.4	23.68	23.39	79.49	OK
4	23.4	23.99	23.70	80.14	OK
5	23.4	23.53	23.25	78.23	OK
6	23.5	23.94	23.64	79.95	OK
7	23.5	24.15	23.85	80.65	OK
8	23.6	23.58	23.28	78.72	OK
9	23.6	24.11	23.80	80.88	OK
10	23.6	23.75	23.45	78.90	OK
11	23.6	23.32	23.02	77.85	OK
12	23.6	23.59	23.29	78.37	OK
13	23.6	23.11	22.81	76.41	OK

CONCLUSION:
The wires met the requirements for the test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Aluminium thickness of the AS wires after stranding**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 61232 / EN 50182**
Objective: To verify the aluminium thickness of the AS wires.
Instruments: Thicknessmeter DELTASCOPE MP-30

TEST SETUP AND PROCEDURE:
All AS wire samples after armoring are prepared for the test. The aluminium thickness is measured at three different points on each sample using a magnetic induction thicknessmeter.

PASS/FAIL:
The average aluminium thickness shall exceed 7.5% of the nominal wire radius (78 microns)

RESULT:
The following table summarizes the results:

# sample	#1	#2	#3	Average [μm]	Pass
1	125	145	108	126	OK
2	132	165	153	150	OK
3	144	166	176	162	OK
4	166	169	185	173	OK
5	133	155	122	137	OK
6	127	173	123	141	OK
7	134	131	137	134	OK
8	141	139	161	147	OK
9	149	125	149	141	OK
10	146	157	132	145	OK
11	137	147	143	142	OK
12	137	133	153	141	OK
13	137	143	132	137	OK

CONCLUSION:
The wires met the requirements for the test according to the IEC standard.

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Hardness of the Aluminium coating of the AS wires after stranding**
Laboratory: UNIVERSITAT POLITECNICA DE CATALUNYA
Test Standard: **CEI 7-11 / ISO 6507**
Objective: To verify the hardness of the aluminium coating of the AS wires.

TEST SETUP AND PROCEDURE:
Few AS wire samples after armoring, 7.5cm long each, are taken for the test. The wires are delivered to the laboratory of the University to measure the hardness of the aluminium coating according to the ISO 6507.

PASS/FAIL:
The micro-hardness value shall exceed 35.

RESULT:
The following table summarizes the results:

# sample	#1	#2	#3	Average	Pass
1	51	51	51	51	OK
2	50	46	48	48	OK
3	54	52	51	52	OK
4	53	55	54	54	OK
5	50	49	49	49	OK
6	50	50	48	49	OK
7	50	47	48	48	OK
8	52	51	53	52	OK
9	55	53	54	54	OK
10	47	48	47	47	OK
11	47	49	47	48	OK
12	50	50	49	50	OK
13	57	56	56	56	OK

CONCLUSION:
The wires met the requirements for the test according to the ISO standard

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Cable performance, formation, diameter, section, lay length**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **CEI EN 50182 / UX LC61 / LC3907**
Objective: To verify that the OPGW cable being tested is compliant with the specifications
Instruments: Caliper

TEST SETUP AND PROCEDURE:
A one meter OPGW sample is cut. The cable diameter and lay length are measured. The wires are removed and wire diameter is measured on all samples as well as the aluminium tube. The optical core is removed. The PBT tube and fiber colors are checked.

PASS/FAIL:
The measurements shall be compliant with UX LC61 and LC3907.

RESULTS:
The following table summarizes the results.

Parameter	UX LC61/LC3907	Cable data sheet	Measurement
# PBT tubes, color	1, BLUE	1, BLUE	OK
# fibers per tub	48	48	OK
Fiber color code	According to table in Par 2.1	According to table in Par. 2.1	OK
# ACS wires	Not specified	13	13 – OK
∅ ACS wires [mm]	Not specified	2.07±0.04	2.07±0.01 – OK
$\varnothing_{ext}$ Alum. tube [mm]	Tol. = ± 1.5%	6.8 ± 0.1	6.82 – OK
Thickness Al. tube [mm]	Tol. = ± 10%	1.0 ± 0.1	1.0 – OK
∅ cable [mm]	$\leq 10.5\ ^{+1}_{-1.5}$	10.9	10.92 – OK
Lay lenght	10 to 16	Not specified	15 – OK
Electrical resistance [Ω/Km]	< 1.2	< 0.91	0.83 – OK

CONCLUSION:
The cable is full compliant with the cable data sheet and Table UX LC61.

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Mass verification**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**CEI EN 50182 / UX LC61 / LC3907**
Objective:	To verify the weight and of the OPGW cable.
Instruments:	Scale PRECISA 300C-300D

TEST SETUP AND PROCEDURE:
The cable mass per unit length is measured on an OPGW 1.0 meter long sample using a calibrated scale.

PASS/FAIL:
The values shall be in accordance with Tabella UX LC61 (<0.4 Kg/m) and cable data sheet (361Kg/Km) with tolerance ±2%

RESULT:
The cable mass per unit length is 365 Kg/Km.

CONCLUSION:
The cable met the requirements for test according to the cable data sheet and Tabella UX LC61.

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Ultimate Tensile Strength**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**CEI EN 50182**
Aim:	To measure the failing load of the cable.
Instruments:	TENSILE EQUIPMENT J. BOT EG&G CD400

TEST SETUP AND PROCEDURE:
The OPGW cable sample submitted to stress-strain test is installed in a hydraulically activated horizontal test machine. The cable length under test (between dead-end assembly loading points) is 16.0 m. The dead-end assembly have reference NES 8.22.10.003. Cable load is uniformly increased up to the failing load and the Ultimate Tensile Strength (UTS) recorded.

PASS/FAIL:
Cable failure shall not occur below the specified tensile strength (54.2 KN = 5525 Kgf).

RESULTS:
Fig. 1 shows cable load vs. time for the test. The cable failure occurs at 7360 Kgf (72.2 KN), that is 133% of the RTS value.

CONCLUSION:
The cable met the requirements for the test according to the CEI standard.

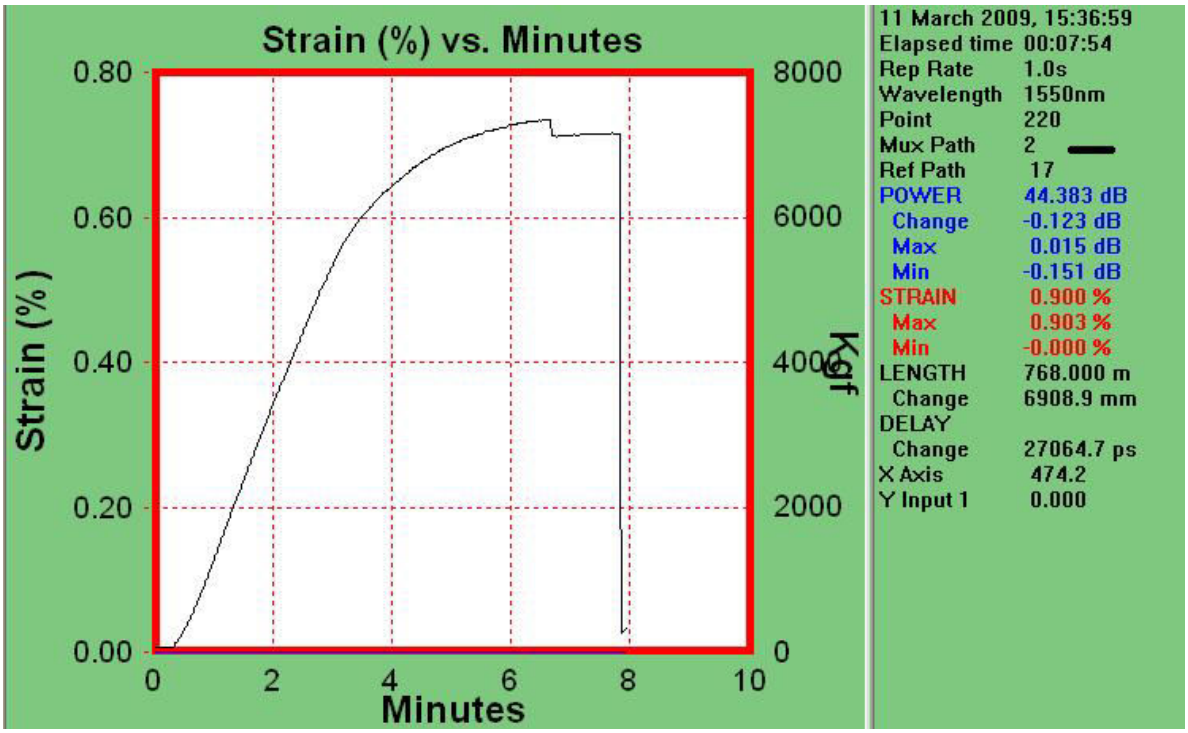


Fig. 1.- Cable load vs. time for Tensile test

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Q-test**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**UX LC 3907**
Aim:	To verify the optical properties of the cable up to 70% of the RTS with all fittings installed.
Instruments:	TENSILE EQUIPMENT J. BOT, EG&G CD400

TEST SETUP AND PROCEDURE:
An OPGW cable sample is installed in a hydraulically activated horizontal test machine. The cable length under test (between dead-end assembly loading points) is 22.0 m. The dead-end assemblies have reference NES 8.22.10.003. The suspension clamp is AGS type with reference NES 8.21.10.003. The arrangement of the suspension is such that at 70%RTS , the output angle is 20º both sides..
All 48 fibers are spliced in series for attenuation measurements. The optical length for the test is 1056 meters (48x22m). The attenuation measurement is performed continuously during the test by source and powermeter.
Cable load is raised in intervals of 10% RTS up to 70% RTS (3870 Kgf). The load is then released.

PASS/FAIL:
Optical attenuation changes shall not exceed 0,1 dB/Km tested fiber @ 1550 nm up to 60% RTS. Optical attenuation changes in the range 60% to 70% RTS shall be reversible after the load is released.

RESULT:
Fig. 2 shows the Load cycle vs. time for the test. The attenuation change never exceeded 0.03 dB/Km up to 70% RTS.

CONCLUSION:
The cable met the requirements for the test according to TERNA specifications.

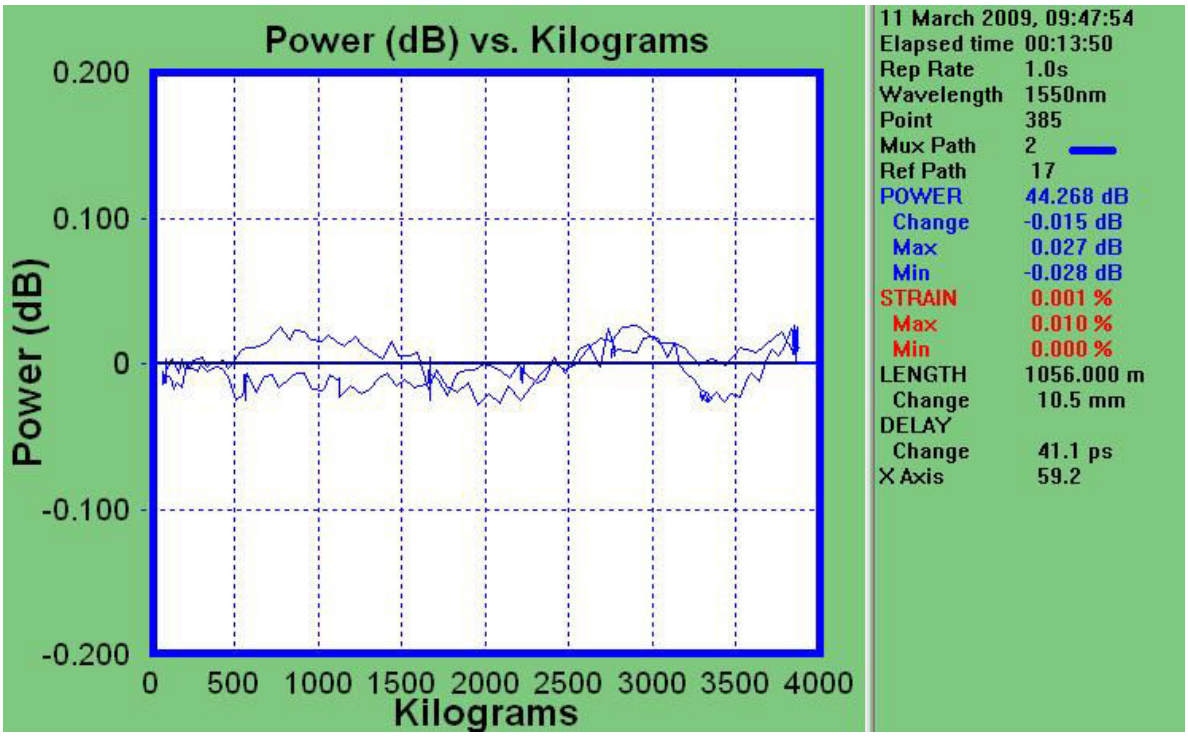


Fig. 2.- Attenuation change vs. Load for Q-test

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Stress strain test**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**CEI EN 50182**
Aim:	To check the modulus of elasticity of the cable.
Instruments:	TENSILE EQUIPMENT J. BOT EG&G CD400

TEST SETUP AND PROCEDURE:

An OPGW cable sample is installed in a hydraulically activated horizontal test machine. The cable length under test (between dead-end assembly loading points) is 16.0 m. The dead-end assembly are new (unused) with reference NES 8.22.10.003. Ambient temperature is recorded before and after the test.

An external fiber sensor (length = 10m) is attached to the cable for strain measurements. For information purposes, all 48 fibers are spliced in series for attenuation measurements. The optical length for the test is 768 meters (48x16m), which are performed continuously during the test by source and powermeter.

The following load cycles is performed (the rate of loading is such that the time to reach 30%RTS is 1< t [min]< 2)

- Load initially 5% RTS and set gages at zero.
- Increase the load until 30% RTS and hold during 30 min. Release to initial load.
- Increase the load until 50% RTS and hold during 60 min. Release to initial load.
- Increase the load until 70% RTS and hold during 60 min. Release to initial load.
- Increase the load until 85% RTS and hold during 60 min. Release to initial load.
- Raise cable load until 100% RTS is reached

The cable modulus shall be determined from the data relative to the range after releasing the load from 70% RTS

PASS/FAIL:

The modulus of the cable shall be in accordance with the cable data sheet: 121.1 KN/mm^2, considering a cable cross-area of 62.0 mm^2.

RESULT:

Fig. 3.1 shows the Strain vs. Load for the test. Temperature before and during the test was 22-23ºC. The data for the modulus calculation is taken from the release part of the curve after reaching 70% and 85% RTS. Details of the calculation and the final result is shown in Fig. 3.2. The average cable modulus is 120 KN/mm^2 in good agreement with that declared in cable data sheet.

CONCLUSION:

The cable met the requirements for the test according to the CEI standard and TERNA specifications.

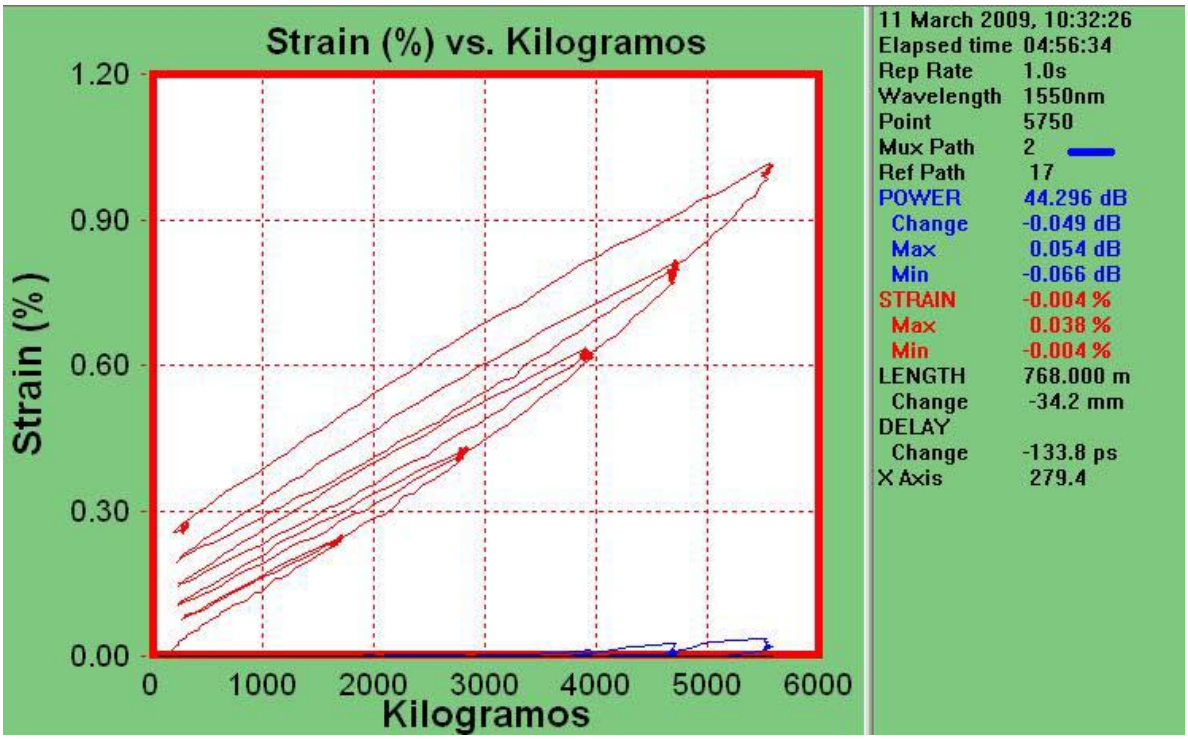


Fig. 3.1.- Cable strain versus cable load during stress strain test

OPGW 09A36z-48M

Return 70% RTS / Return 85% RTS

Load	Strain cable	Load	Strain cable
3050.2	0.537	4107.2	0.742
2905.6	0.516	3956.2	0.723
2745.0	0.500	3796.2	0.707
2606.2	0.481	3642.0	0.686
2472.2	0.461	3487.2	0.670
2325.4	0.441	3345.6	0.648
2193.2	0.428	3203.4	0.631
2060.6	0.410	3063.0	0.612
1927.2	0.393	2928.0	0.598
1805.6	0.377	2794.6	0.577
1678.6	0.360	2658.8	0.562
1565.4	0.343	2527.2	0.541
1448.4	0.324	2404.2	0.526
1336.0	0.309	2283.8	0.509
1223.4	0.295	2156.6	0.494
1116.2	0.280	2030.6	0.470
1010.4	0.265	1916.2	0.458
907.0	0.248	1800.4	0.441
810.8	0.238	1687.2	0.425
720.0	0.222	1580.6	0.410
628.8	0.212	1467.2	0.397

Strain = A * Stress + B, where

A= 1.316E-04 B= 0.137

A= 1.321E-04 B= 0.206

from which

	1st meas.	2nd meas.	Nominal	Units
E·S	7452	7426	7508.2	KN
Section	62.0	62.0	62.0	mm2
Elast. Coef.	120	120	121.1	KN/mm2

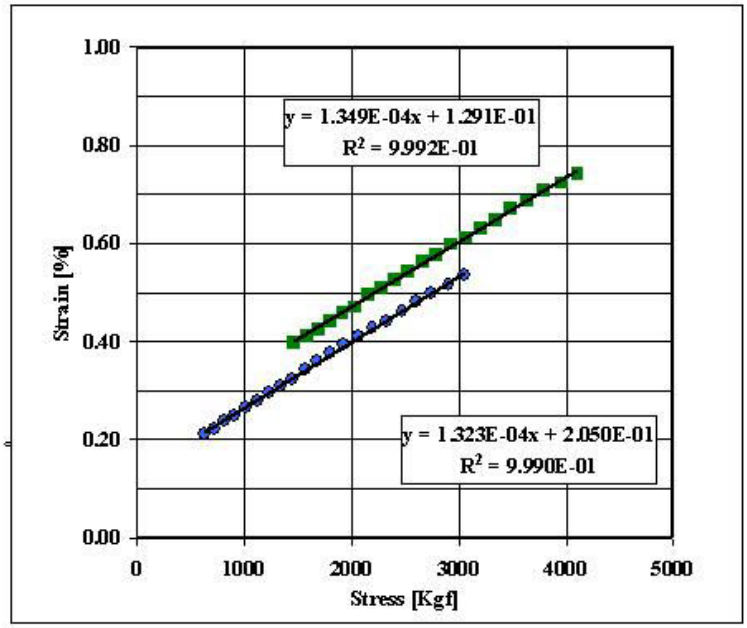


Fig. 3.2.- Calculation of modulus of elasticity test

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Sheave test**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**IEC 60794-4-1 Par. 8.3**
Aim:	To verify that stringing of the OPGW with the recommended sheave size would not damage or degrade the quality of the optical fibers.
Instruments:	TENSILE EQUIPMENT J. BOT SHEAVE MACHINE, CD400

TEST SETUP AND PROCEDURE:

An OPGW sample is installed in a sheave machine. The cable length under test (between deadend assembly loading points) is 18.0 m. All fibers are spliced in series for attenuation measurements. The optical length for the test is 864 meters (48x18m). The attenuation measurements is performed continuously during the test.

The cable sample is pulled forward and backward 10 times through the 780 mm diameter sheave. Other setup parameter values are the pulling tension: 830 Kgf (15% of the RTS); the pulled length: 3.2 meters; and the deflection angle: 30º.

Micrometer readings of the cable diameter are performed at the beginning, mid-point and end of the pulled length after and after the test. After the test is complete, the cable strands are removed and the aluminium pipe diameter is measured at the marked points of the pulled length.

PASS/FAIL:

Optical attenuation changes shall not exceed 0.1 dB/Km tested fiber @1550 nm.

Cable ovality, defined as Ovality=$[\varnothing_{max} - \varnothing_{min}]/[\varnothing_{max} + \varnothing_{min}]$, shall not exceed 10%.

No evidence of damage shall be observed on the parts of the OPGW submitted to test.

RESULT:

Fig. 4 shows the attenuation change (up) and the cable load (down) vs. time for the test. The average load during the test is 890 Kgf. The attenuation change never exceeded 0.04 dB/Km during the test and is reversible after the load is released.

Regarding the deformation of the cable and the aluminium tube, the following tables summarize the results:

#	CABLE DIAMETER.					
	SOUTH		CENTER		NORTH	
	MIN [mm]	MAX [mm]	MIN [mm]	MAX [mm]	MIN [mm]	MAX [mm]
Before	10.89	11.03	10.91	10.97	10.90	10.95
After	10.88	11.06	10.83	11.05	10.88	11.02
Ovality [%]	1%		1%		1%	

#	ALUMINIUM TUBE DIAMETER.					
	SOUTH		CENTER		NORTH	
	MIN [mm]	MAX [mm]	MIN [mm]	MAX [mm]	MIN [mm]	MAX [mm]
After	6.76	6.89	6.73	6.92	6.76	6.91
Ovality [%]	1.0		1.3		1.1	

The averaged cable diameter measured at 890Kg is 10.94 mm. The maximum measured ovality of the cable, $[\varnothing_{max} - \varnothing_{min}]/[\varnothing_{max} + \varnothing_{min}]$, is 1.0% and occurs at center section. The average aluminium tube external diameter outside the tested area is 6.82 mm. After completion of the test, the maximum ovality measured in the aluminium tube, $\text{Ovality}=[\varnothing_{max} - \varnothing_{min}]/[\varnothing_{max} + \varnothing_{min}]$, is 1.3%, at the center section.

CONCLUSION:
The cable met the requirements for the test according to the IEC standard.

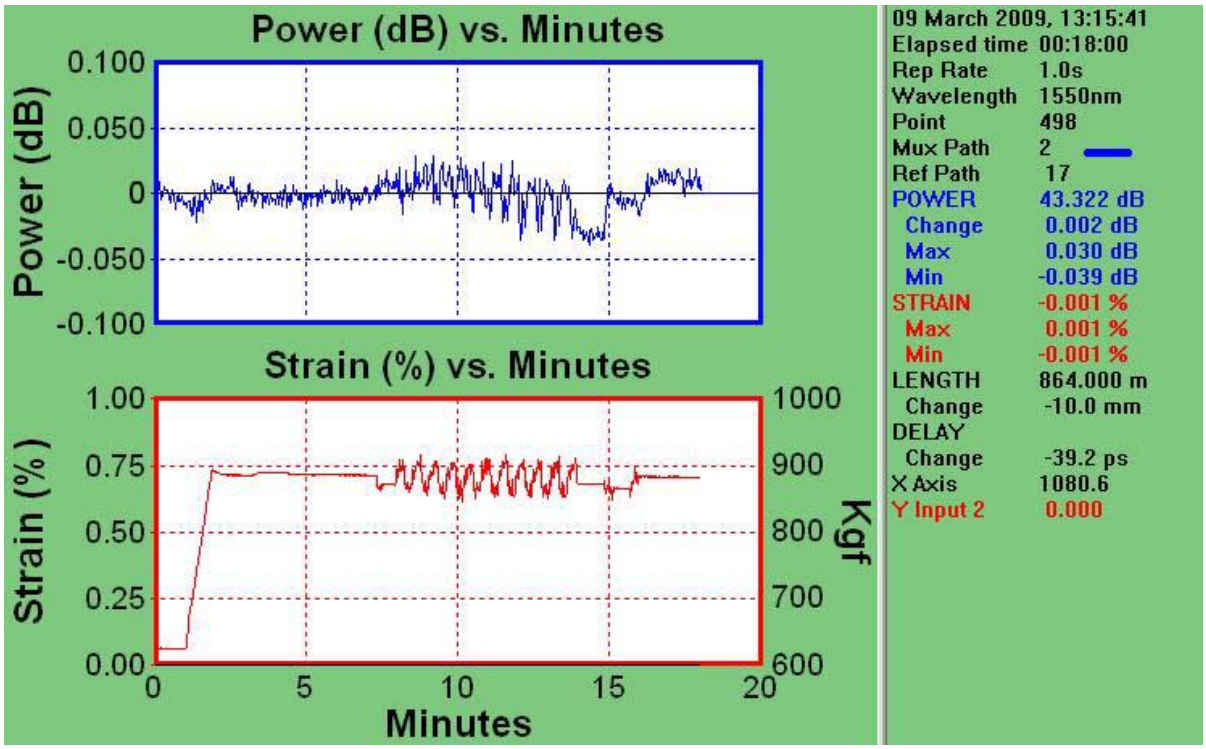


Fig. 4.- Attenuation change (up) and Cable load (down) vs. time during sheave test

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Wire unwrapping**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**UX LC 3907**
Aim:	To verify that the wires do not unwrap when broken up to 18% RTS.
Instruments:	TENSILE EQUIPMENT J. BOT SHEAVE MACHINE, CD400

TEST SETUP AND PROCEDURE:
The cable length under test (between dead-end assembly loading points) is 16.0 m. Two wires are broken by hand on three different sections of the cable sample (six different broken wires in total). Cable load is increased to 18%RTS and the unwrapped length of the broken wires (if any) is measured.

PASS/FAIL:
The unwrapped length of the wires shall not exceed 40cm. The maximum distance from the wire end to the cable shall not exceed 15cm.

RESULT:
At 18%RTS there is no wire unwrapping in any of the three sections. For information, cable load was raised up to 50%RTS and no wire unwrapping was observed. The load vs. time is shown in Fig. 5

CONCLUSION:
The cable met the requirements for the test according to the TERNA standard.

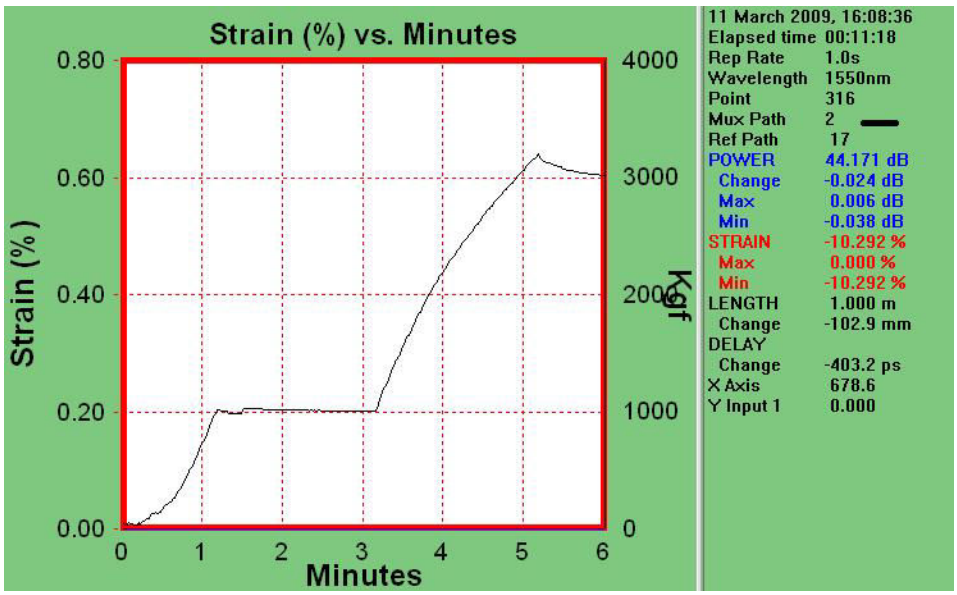


Fig. 5.- Load vs. time for wire unwrapping test

TEST REPORT

Type of cable: **OPGW 09A36z-48M (6609)**
Test name: **Attenuation coefficients and linearity**
Laboratory: PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard: **IEC 793-1-C1C**
Objective: To verify the attenuation coefficients of the fiber.
Instruments: OTDR ANRITSU MW9060A

TEST SETUP AND PROCEDURE:
The drum W07585S from production that is 3545 meters long is used for the test. The attenuation coefficients and linearity are measured by OTDR.

PASS/FAIL:
The attenuation coefficient shall be in accordance with the specifications: 0.36 dB/Km@ 1310nm and 0.22 dB/Km@ 1550nm. Attenuation steps, if any, shall not exceed 0.05 dB.

RESULT:
The results are given in the following table.

FIBER	α_{1310} [dB/Km]	α_{1550} [dB/Km]	Atten. Lin.	FIBER	α_{1310} [dB/Km]	α_{1550} [dB/Km]	Atten. Lin.
AMARILLO	*0.33*	*0.19*	OK	NEGRO	*0.33*	*0.19*	OK
AMARILLO 1	*0.32*	*0.19*	OK	NATURAL 1	*0.33*	*0.19*	OK
AMARILLO 2	*0.33*	*0.19*	OK	NATURAL 2	*0.32*	*0.19*	OK
AMARILLO 3	*0.32*	*0.19*	OK	NATURAL 3	*0.35*	*0.20*	OK
AZUL	*0.32*	*0.19*	*OK*	ROJO	*0.34*	*0.20*	*OK*
AZUL 1	*0.33*	*0.19*	*OK*	ROJO 1	*0.32*	*0.19*	*OK*
AZUL 2	*0.32*	*0.19*	*OK*	ROJO 2	*0.33*	*0.19*	*OK*
AZUL 3	*0.33*	*0.19*	*OK*	ROJO 3	*0.32*	*0.19*	*OK*
BLANCO	*0.32*	*0.19*	*OK*	ROSA	*0.32*	*0.19*	*OK*
BLANCO 1	*0.33*	*0.19*	*OK*	ROSA 1	*0.32*	*0.18*	*OK*
BLANCO 2	*0.33*	*0.19*	*OK*	ROSA 2	*0.33*	*0.19*	*OK*
BLANCO 3	*0.33*	*0.19*	*OK*	ROSA 3	*0.33*	*0.19*	*OK*
GRIS	*0.32*	*0.19*	*OK*	TURQUESA	*0.33*	*0.19*	*OK*
GRIS 1	*0.32*	*0.19*	*OK*	TURQUESA 1	*0.33*	*0.19*	*OK*
GRIS 2	*0.32*	*0.19*	*OK*	TURQUESA 2	*0.33*	*0.19*	*OK*
GRIS 3	*0.34*	*0.21*	*OK*	TURQUESA 3	*0.34*	*0.20*	*OK*
MARRÓN	*0.33*	*0.19*	*OK*	VERDE	*0.33*	*0.19*	*OK*
MARRÓN 1	*0.33*	*0.19*	*OK*	VERDE 1	*0.34*	*0.21*	*OK*
MARRÓN 2	*0.33*	*0.20*	*OK*	VERDE 2	*0.33*	*0.19*	*OK*
MARRÓN 3	*0.34*	*0.21*	*OK*	VERDE 3	*0.34*	*0.20*	*OK*
NARANJA	*0.32*	*0.18*	*OK*	VIOLETA	*0.32*	*0.19*	*OK*
NARANJA 1	*0.32*	*0.19*	*OK*	VIOLETA 1	*0.33*	*0.19*	*OK*
NARANJA 2	*0.33*	*0.19*	*OK*	VIOLETA 2	*0.33*	*0.19*	*OK*
NARANJA 3	*0.34*	*0.20*	*OK*	VIOLETA 3	*0.32*	*0.19*	*OK*
				AVERAGE	*0.33*	*0.19*	←→
				MAXIMUM	*0.35*	*0.21*	←→

CONCLUSION:
The cable met the requirements for the test according to the IEC standard and TERNA specifications.

TEST REPORT

Type of cable:	**OPGW 09A36z-48M (6609)**
Test name:	**Temperature Cycling**
Laboratory:	PRYSMIAN TELECOM ESPAÑA, S.L.
Test Standard:	**UX LC 3907**
Objective:	To determine the stability behavior of the optical attenuation in the OPGW cable when submitted to temperature cycles.
Instruments:	Temperature chamber INELTEC , EG&G CMP500

TEST SETUP AND PROCEDURE:

Drum W07590X with an OPGW sample 719 m long is introduced inside the 27m^3 climatic chamber. All 48 fibers are spliced in loops of eight fibers for attenuation measurements. The total length under test is 4314m (6fo x719m) for each of the eight measurement channels.

The temperature and the attenuation change are recorded as a function of time with a sampling rate of 1 sample every 5 minutes.

The following cycle is applied

- The drum is pre-conditioned at 25±3ºC for 6 hours.
- The temperature is raised to 60ºC and kept constant for 4 hours.
- The temperature is lowered to -25ºC and kept constant for 4 hours.
- The temperature is raised to 60ºC and kept constant for 4 hours.
- The temperature is lowered to -25ºC and kept constant for 4 hours.
- The temperature is raised to 60ºC and kept constant for 4 hours.
- The temperature is lowered to –40ºC and kept constant for 4 hours.
- The temperature is raised to -25ºC and kept constant for 4 hours.
- The temperature is raised to +25ºC and kept constant for 1 hour

PASS/FAIL:

Optical attenuation changes shall not exceed 0.1dB/Km during the test

RESULT:

Fig. 6 show the Temperature trace and the Attenuation change vs. Time for the test. During the test, the attenuation change never exceeded 0.0035 dB/Km (0.015 dB / 4.3 Km) for any of the fibers.

CONCLUSION:

The cable met the requirements for the test according to TERNA standard.

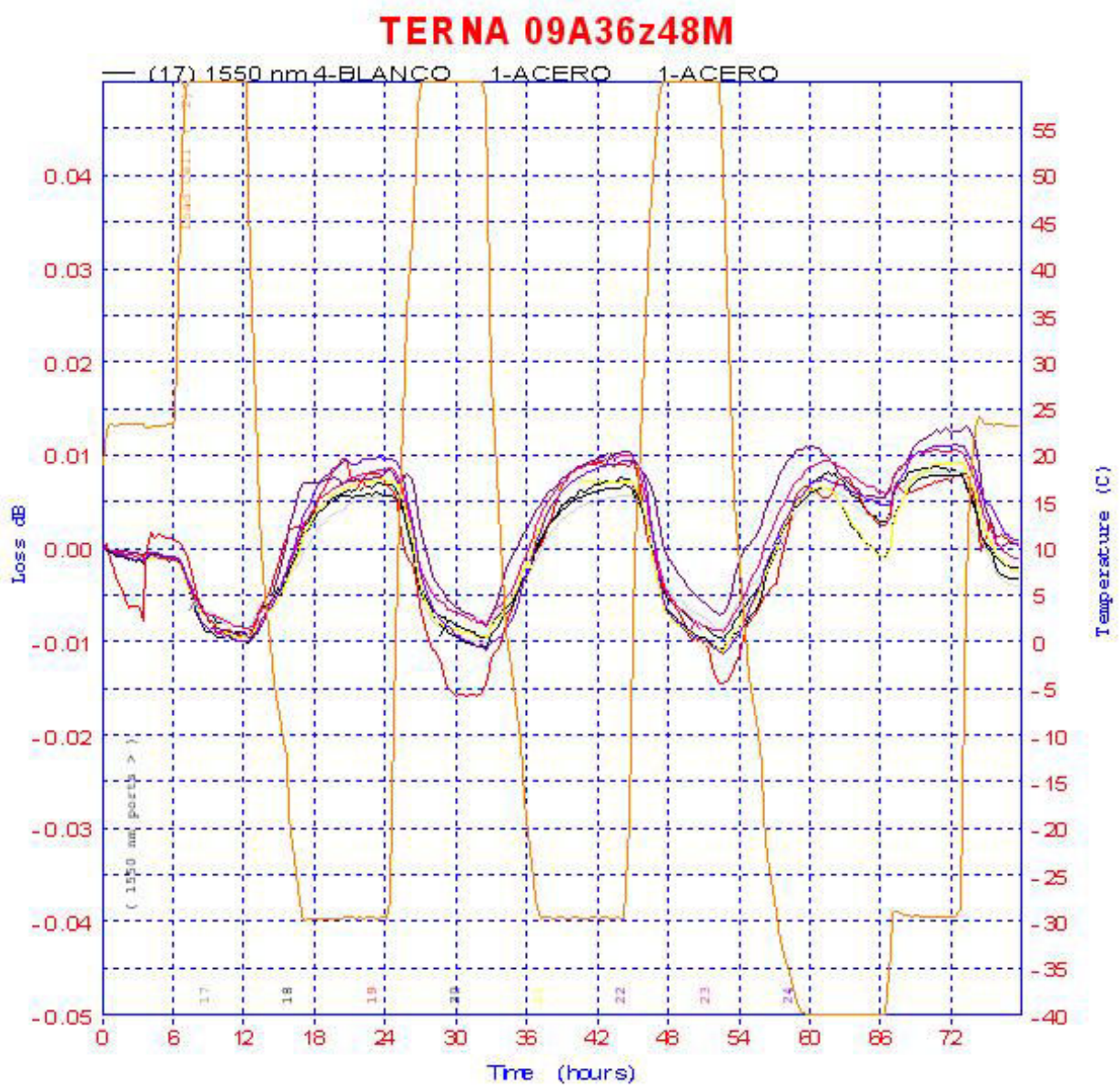


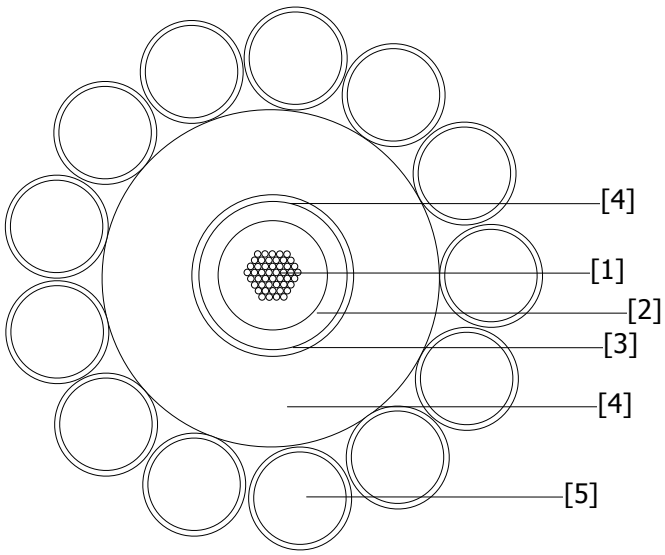
Fig. 6.- Temperature and attenuation change vs. time

Cable data sheet

OPGW 09A36z

OPTICAL GROUND WIRE with capacity for 48 optical fibres

Ref: **6609**



Introduction

Features and benefits

This cable has been custom designed to best match with customer requirements from optical, electrical, mechanical, quality and cost point of view, optimising diameter, weight, breaking load and short circuit capacity.

Optical core is made of optical fibres [1] covered by small PBT loose buffer tube [2] that leaves the fibres free from strain even at highest operating loads.
In sections where there is a high contamination or in the proximity of the sea, Prysmian recommend greasing the cable.

A reinforcing yarns impregnated by hydrogen absorbent jelly [3] protects the fibres against the optical degradation caused by this element.

The aluminium tube [4] provides the cable with:

- high short circuit capacity minimizing material
- best solution to avoid cable corrosion
- a perfect sealing for the optical core
- a high crush resistance

The wires of...

- aluminium clad steel [5].

...provides the cable with:

- the required strength.
- a lightning resistance
- best solution to avoid cable corrosion.
- the remaining short circuit capacity.

PRYSMIAN CABLES & SYSTEMS

Rev.:	Date:	Issued by:
01	30-oct-08	J.Martín

OPGW 09A36z

Ref: **6609**

OPTICAL GROUND WIRE with capacity for 48 optical fibres

Fibre characteristics

See our technical document reference 4377 SM Light™ and FreeLight™ optical fibres.

Cable structure

Optical core

Cables with 24 fibres:

- Without rings: blue, orange, green, brown, slate, white, red, black, yellow, violet, pink, aqua.
- With 1 ring: blue, orange, green, brown, slate, white, red, natural, yellow, violet, pink, aqua.

Cables with 48 fibres:

- Without rings: blue, orange, green, brown, slate, white, red, black, yellow, violet, pink, aqua.
- With 1, 2 and 3 rings: blue, orange, green, brown, slate, white, red, natural, yellow, violet, pink, aqua.

Aluminium Tube

Outer Diameter: 6.8 mm

Armour

Layer 1:

- 13 aluminium-clad steel of 20.3% IACS wires of 2.07 mm.
- Right lay sense (Z).

Cable characteristics

Mechanical and physical

Approximate cable diameter:	10.9 mm
Approximate cable weight:	361 kg/km
Rated tensile strength (IEEE 1138):	54.2 kN
Maximum load without fibre elongation:	35.7 kN
Elasticity Modulus*:	121.1 kN/mm^2
Section*:	62.0 mm^2
Linear expansion thermal coefficient:	14x10^{-6} ºC^{-1}
Minimum bending radius:	
• On pulley blocks:	300 mm
• On tensioner devices:	450 mm
• After clamping (slack cable):	300 mm
Operating temperature range: from -30ºC to +70ºC	

*for stress-strain calculus

Electrical

Electrical resistance (20ºC): 0.91 Ω/km
Short circuit rating from 50ºC: 24.5 kA^{2}s
Short circuit current for 0.5 s: 7.0 kA

PRYSMIAN CABLES & SYSTEMS

OPGW 09A36z

Ref: **6609**

OPTICAL GROUND WIRE with capacity for 48 optical fibres

Routine tests

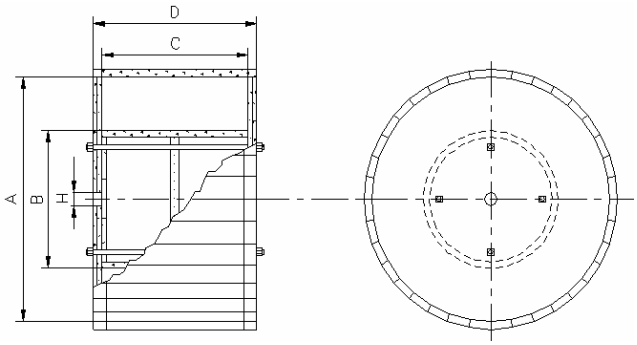
100% of optical fibres will be measured by OTDR technique before leaving factory.

Installation procedure

Prysmian recommends to install the cable described in this specification following the latest version of our "Installation procedures for OPGW fibre optic cable" reference SIG-07-PE-PA-013, "Instruction for the installation of the EWMJ joint box" reference FO-02 and "Instruction for the installation of the EWJ joint box" reference FO-01.

Reels

	Type W	**Type P**
Wheel (A):	1500 mm	2100 mm
Cylinder (B):	900 mm	900 mm
Inside (C):	590 mm	900 mm
Outside (D):	710 mm	1060 mm
Axe (H):	82 mm	105 mm
Weight:		
- empty:	310 kg	440 kg
- full:	1754 kg	4050 kg
Maximum length:	4 km	10 km
Tolerance length of the produced reel: ±3%		



PRYSMIAN CABLES & SYSTEMS

Rev.:	Date:	Issued by:
01	30-oct-08	J.Martín

Annex. A.- Report for hardness of aluminium coating

Centre de Disseny d'Aliatges Lleugers
i Tractaments de Superfície
UNIVERSITAT POLITÈCNICA DE CATALUNYA

VICKERS MICROHARDNESS TEST (ISO 6507/3)

Cable Reference: OPGW 09A36z, diameter of 10,9 mm, 13 Wires

OPGW cable qualification for TERNA

CONFIDENTIAL

Prysmian Cables y Sistemas Telecom España, S.L.
Date: 04.03.2009
Document nº: PRY/09/02/01

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Centre de Disseny d'Aliatges Lleugers
i Tractaments de Superficie
UNIVERSITAT POLITÈCNICA DE CATALUNYA

To: Josep Martin Regalado
Prysmian Cables y Sistemas Telecom España, S.L.

VICKERS MICROHARDNESS TEST FOR "PRYSMIAN CABLES Y SISTEMAS TELECOM ESPAÑA, S.L. "

(Cable Reference: OPGW 09A36z, diameter of 10,9 mm, 13 Wires)

CDAL Report: PRY/09/02/01
March 4th, 2009

Josep A. Picas
Surface Treatment Department

A Vickers Microhardness test has been performed on a cable, and on thirteen individual wire samples, manufactured and supplied by "PRYSMIAN CABLES Y SISTEMAS TELECOM ESPAÑA". The cable is designated, according to the identify card issued by PRYSMIAN, as OPGW 09A36z. Such a cable is constituted by 13 steel wires with aluminium coating, which were individually studied. Thirteen wire individual samples before armouring were identified as cable 1 to13. Wire samples on armoured cable were identified according to the generic designation OPGW 09A36z and individually numbered from wire 1 to 13. The tests were performed at CDAL, Rambla Exposició 24, Vilanova I la Geltrú, 08800 Spain, on March 4th, 2009. The test was developed in accordance with EN-ISO 6507/3 Standard.

TEST SET-UP

Metallographic preparation was carried out with some operations, such as cutting, mounting resin, prepolishing, polishing and cleaning, on each wire sample and the cable sample itself. Each sample was placed on a support in order to carry out the test by means of Fisherscope H100 equipment. After its calibration and optical adjustment, three different regions were selected along the same surface with a straight line generatrix. The minimum spacing between indentations was 1 mm.

Microhardness measurements were indirectly determined thought the own equipment software. On the other hand, they were verified, in a direct way, with a LEIKA microscope system by an Image Analysis Software.

TEST CONDITIONS

The test was performed taking into account EN-ISO 6507. The applied load and the fixed period of time were 245 mN and 15 seconds, respectively.

RESULTS

Individual results, as well as their means, related to each wire are enclosed in Annex A, whereas individual and mean load-unload plots for each sample are joined in Annex B.

CONCLUSIONS

Every sample displays a microhardness mean value higher than 46 HV0.025.

Prepared by: Josep A. Picas
Surface Treatment Responsible

Prepared by: Miquel Punset

Approved by: A. Form

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i Tractaments de Superfície
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Annex A:

Tables

0.245/15/1.0s

Individual cables	HV0,025 Test-1	HV0,025 Test -2	HV0,025 Test-3	HV0,025 Mean values	Av.	s
Cable 1	53	53	53	53		
Cable 2	53	55	53	54		
Cable 3	56	54	54	55		
Cable 4	54	55	54	54		
Cable 5	58	57	56	57		
Cable 6	57	56	56	56		
Cable 7	52	50	53	52		
Cable 8	57	60	60	59		
Cable 9	54	54	53	54		
Cable 10	53	53	52	53		
Cable 11	54	54	55	54		
Cable 12	56	56	57	56		
Cable 13	59	56	58	58	55	2,1

0.245/15/1.0s

09A36z Cable	HV0,025 Test-1	HV0,025 Test -2	HV0,025 Test-3	HV0,025 Mean values	Av.	s
Wire 1	51	51	51	51		
Wire 2	50	46	48	48		
Wire 3	54	52	51	53		
Wire 4	53	55	54	54		
Wire 5	50	49	49	49		
Wire 6	50	50	48	49		
Wire 7	50	47	48	48		
Wire 8	52	51	53	52		
Wire 9	55	53	54	54		
Wire 10	47	48	47	47		
Wire 11	47	49	47	48		
Wire 12	50	50	49	50		
Wire 13	57	56	56	56	50	2,9

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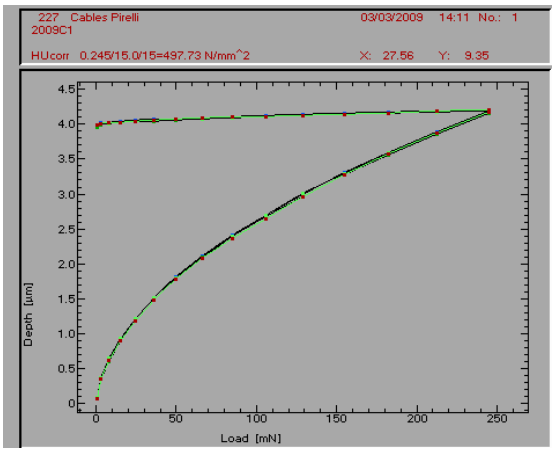
PRY/09/02/01 ANNEX B

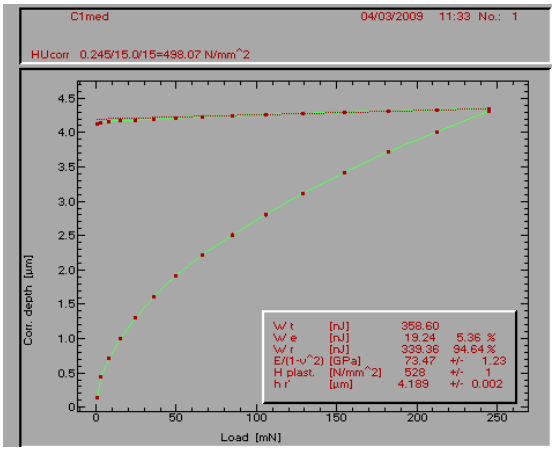
Microhardness test: Load-Displacement Curves

Individual Cable

Cable 1 (09A36z):

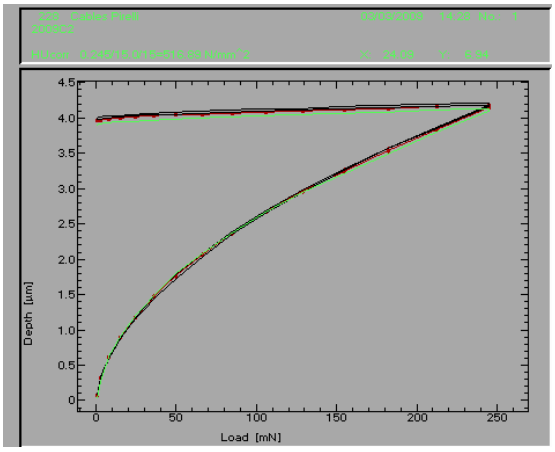


Individual Curves

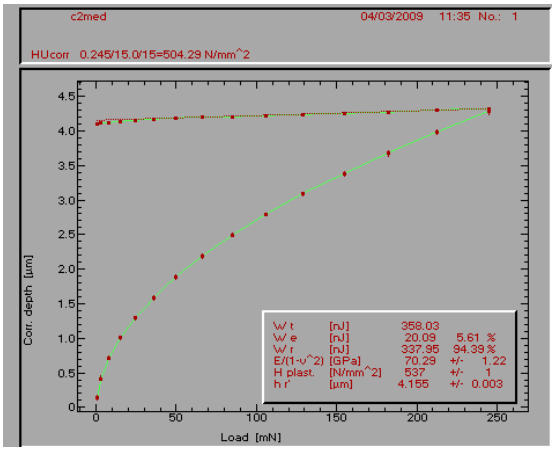


Mean Curve

Cable 2 (09A36z):



Individual Curves



Mean Curve

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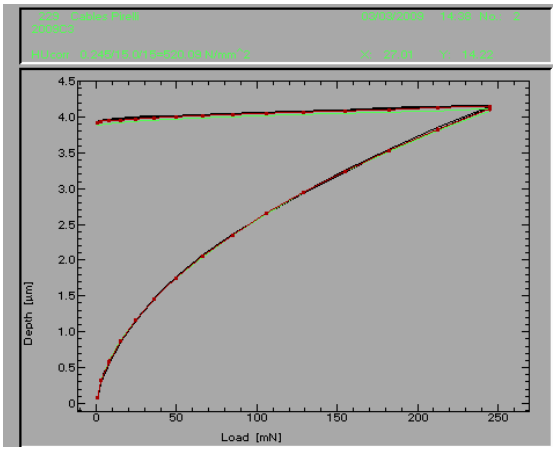
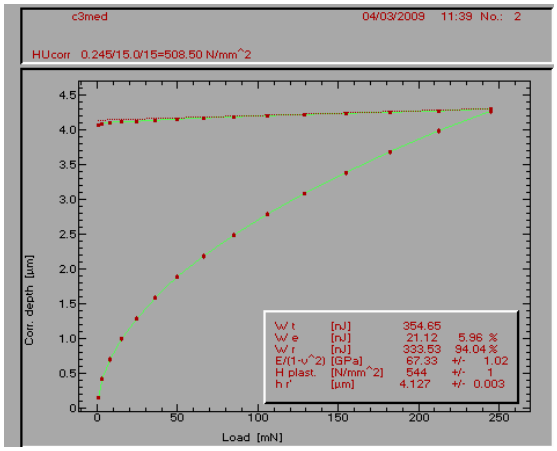
Cable 3 (09A36z):

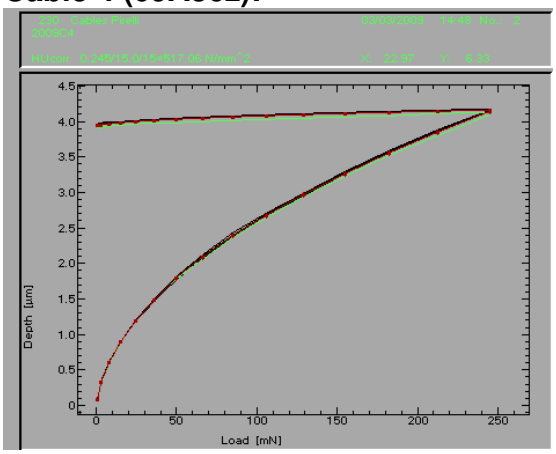


Individual Curves

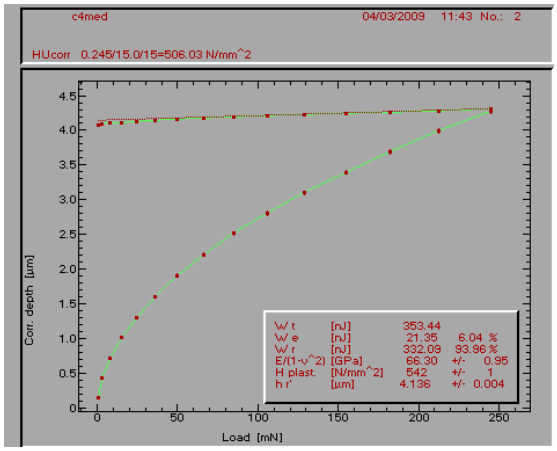


Mean Curve

Cable 4 (09A36z):



Individual Curves



Mean Curve

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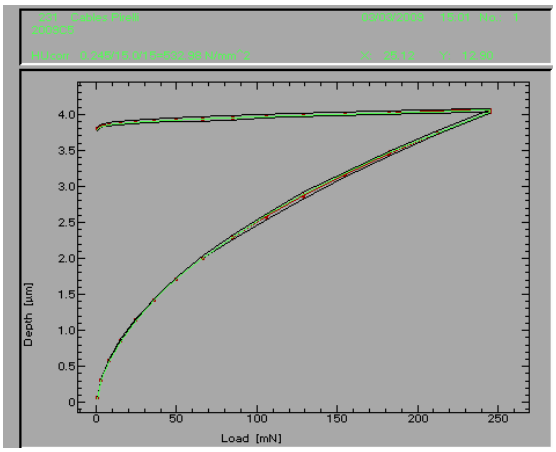
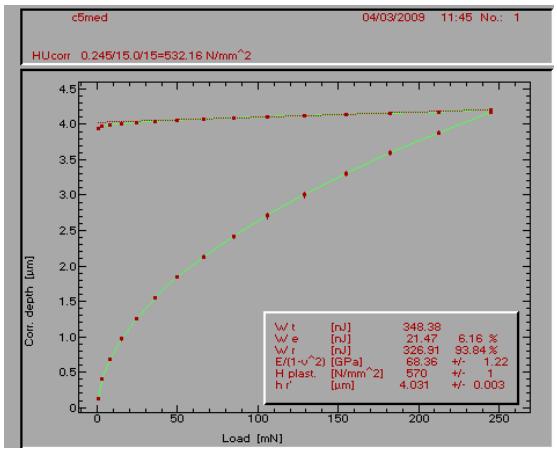
Cable 5 (09A36z):

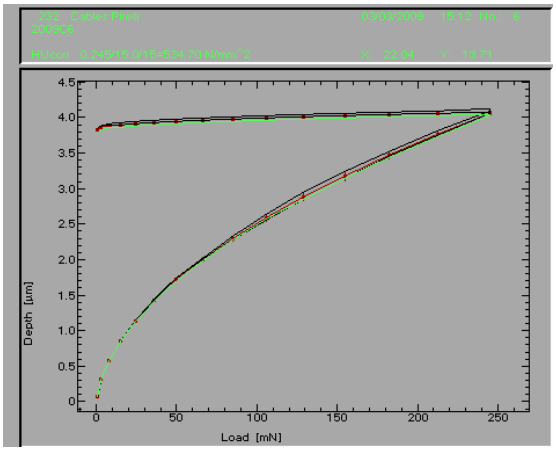


Individual Curves

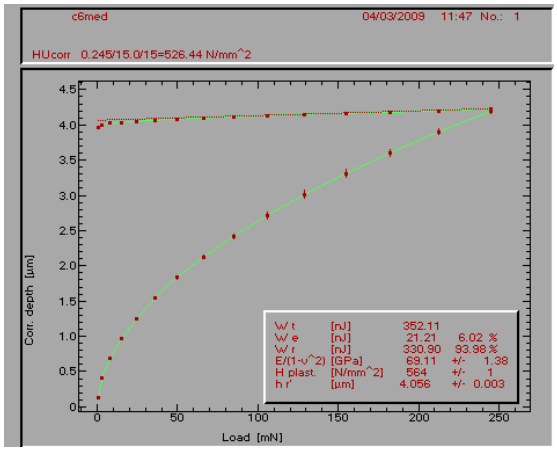


Mean Curve

cable 6 (09A36z):



Individual Curves



Mean Curve

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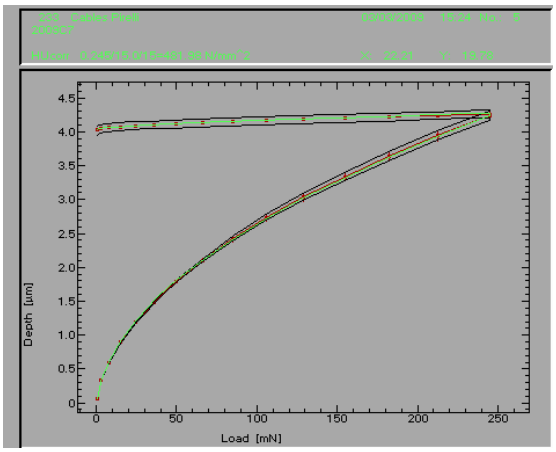
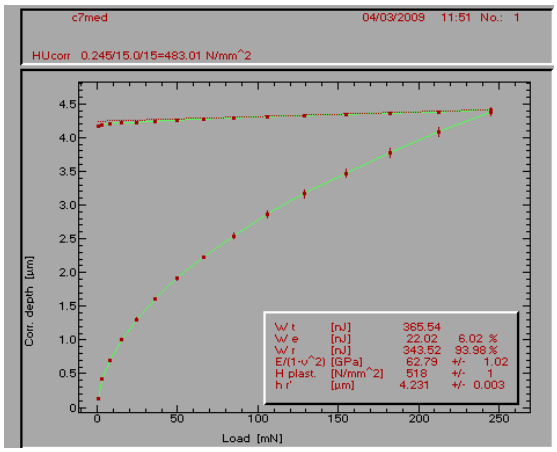
Cable 7 (09A36z):

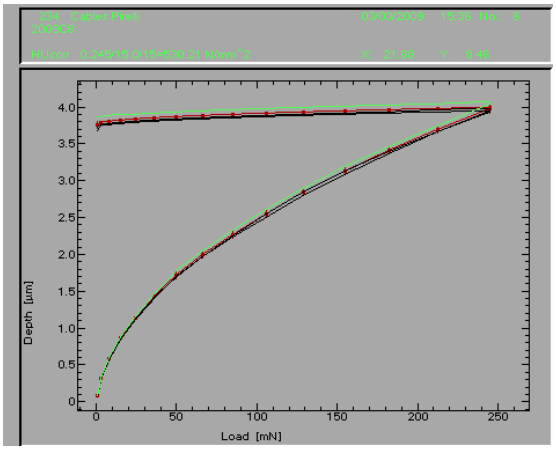


Individual Curves

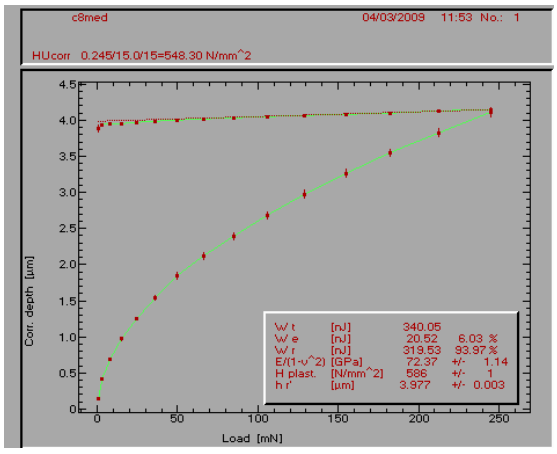


Mean Curve

Cable 8 (09A36z):



Individual Curves



Mean Curve

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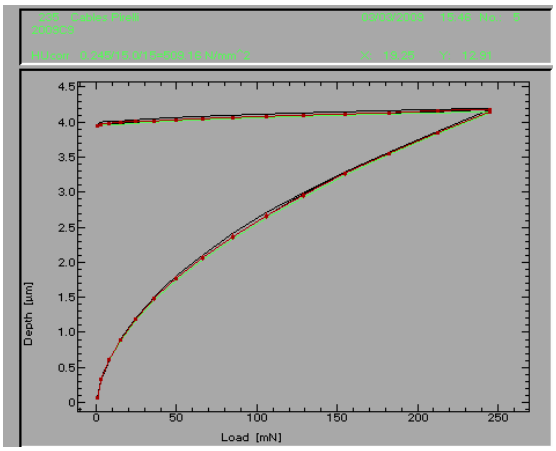
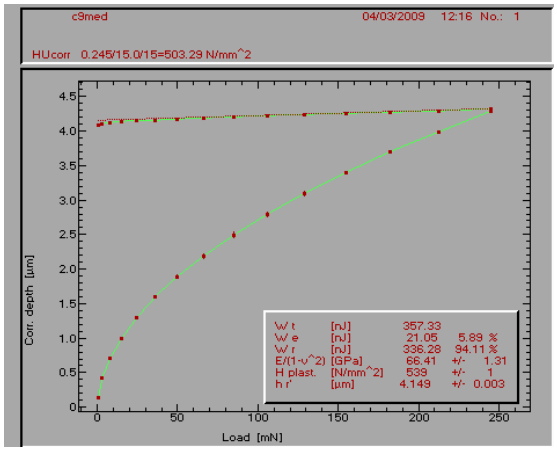
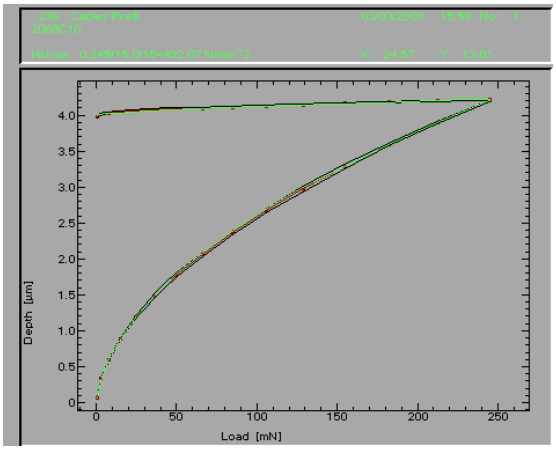
Cable 9 (09A36z):

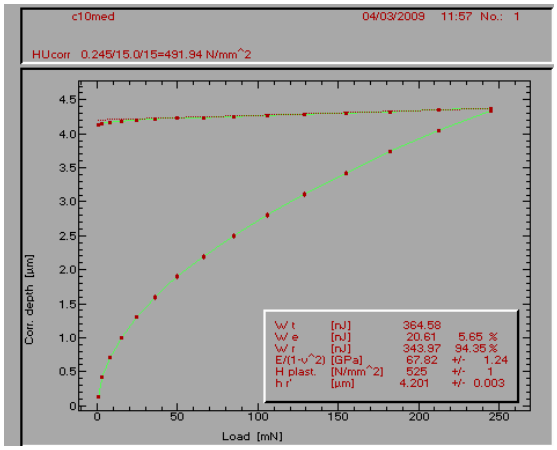




Individual Curves **Mean Curve**

Cable 10 (09A36z):





Individual Curves **Mean Curve**

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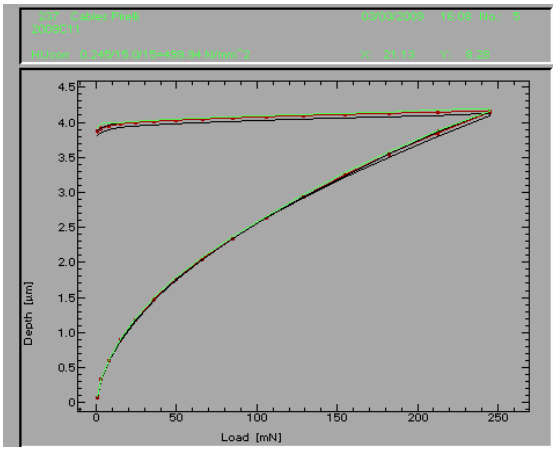
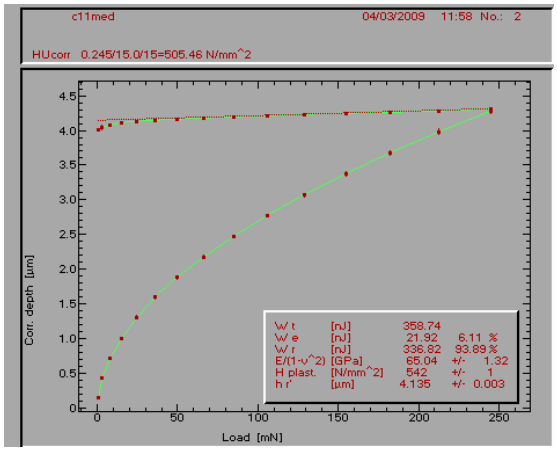
Cable 11 (09A36z):

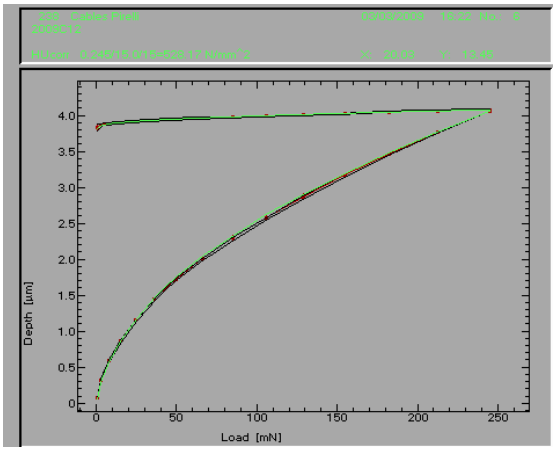


Individual Curves

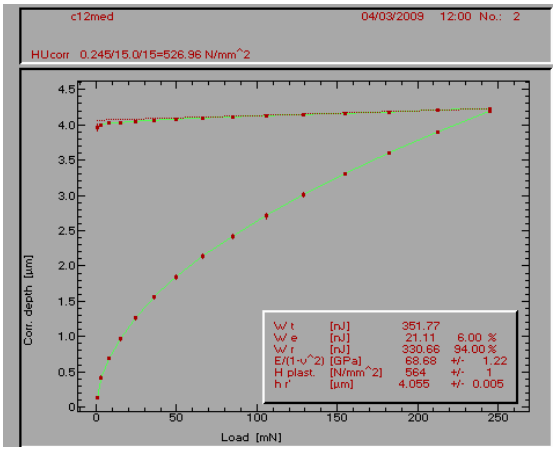


Mean Curve

Cable 12 (09A36z):



Individual Curves



Mean Curve

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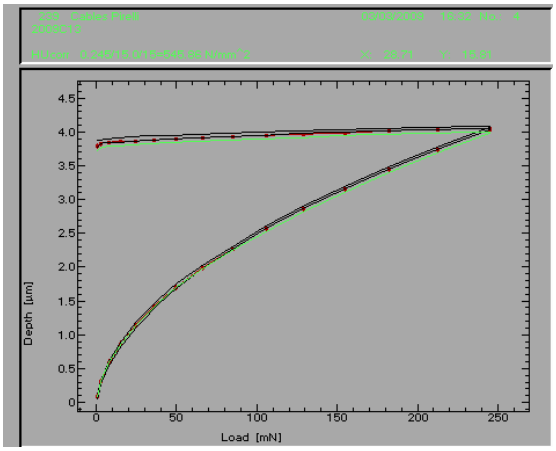
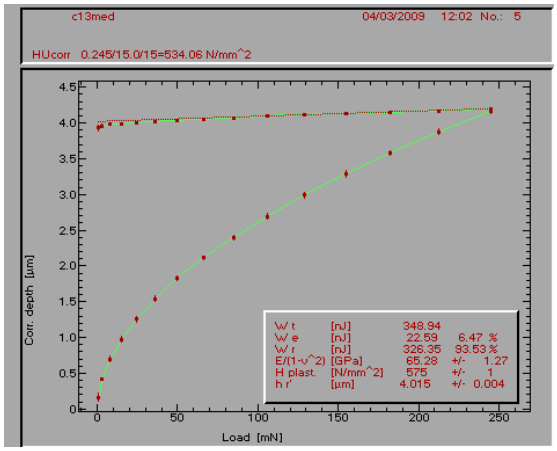
Cable 13 (09A36z):



Individual Curves



Mean Curve

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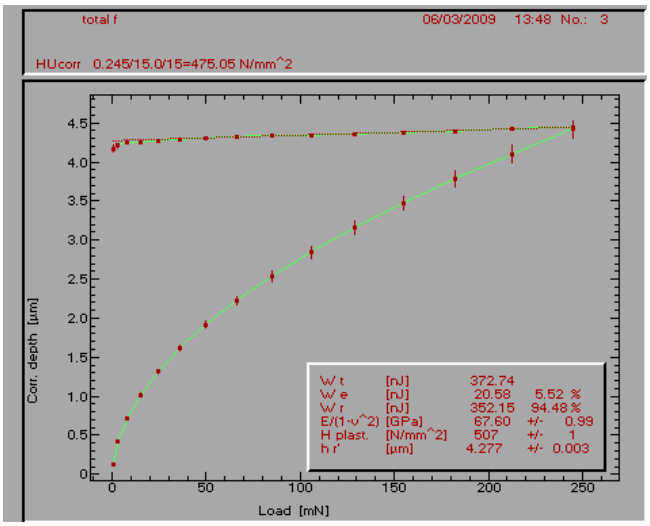
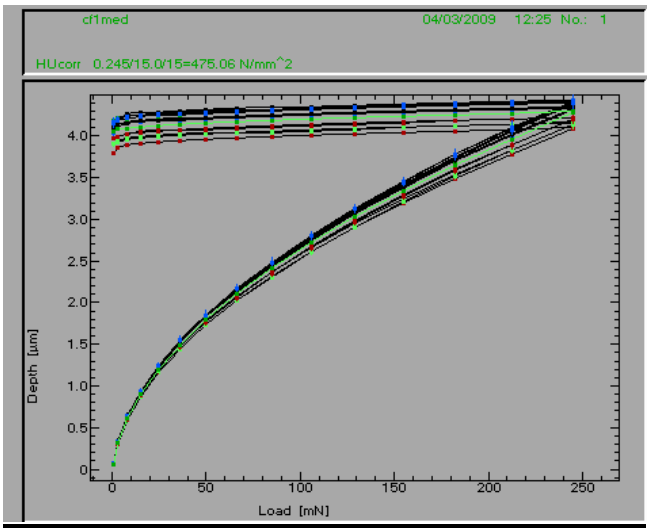
Individual measurements: all on Cable (09A36z)

Cable 09A36z, 13 Wires



Mean Curve (all tests on 09A36z)



Individual Curves (all tests on 09A36z)

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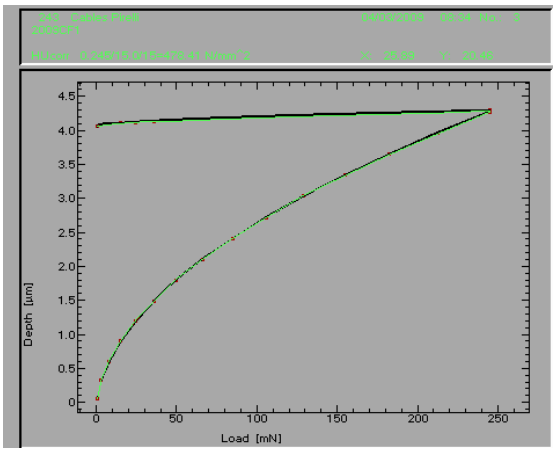
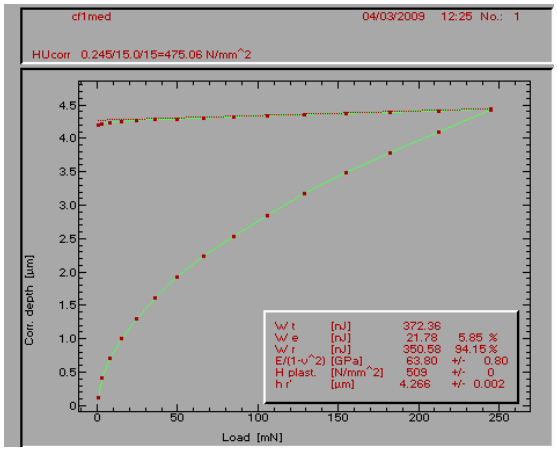
Wire 1(09A36z):

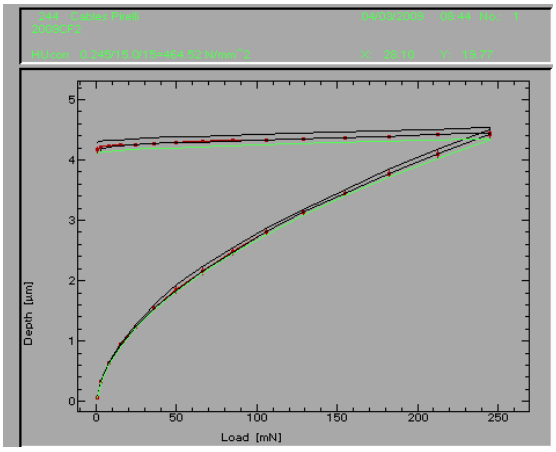


Individual Curves

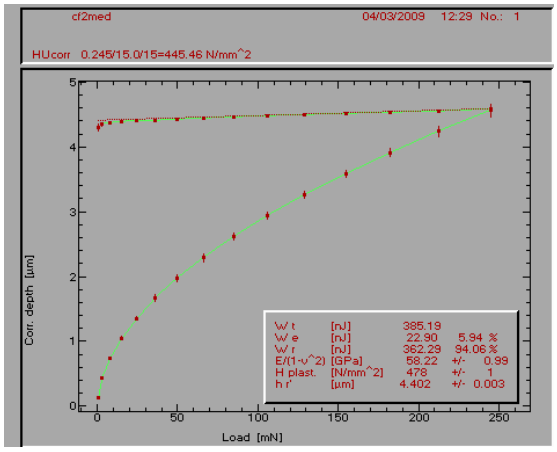


Mean Curve

Wire 2(09A36z):



Individual Curves



Mean Curve

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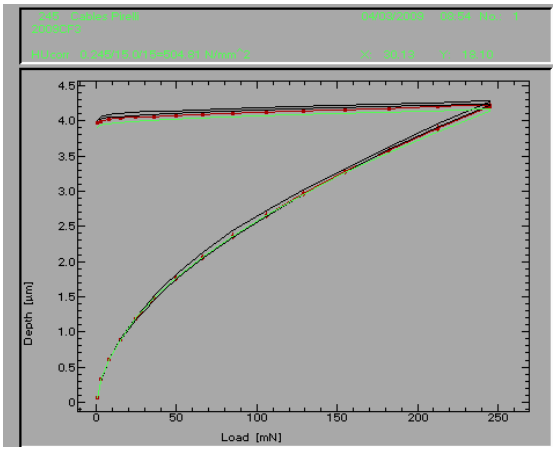
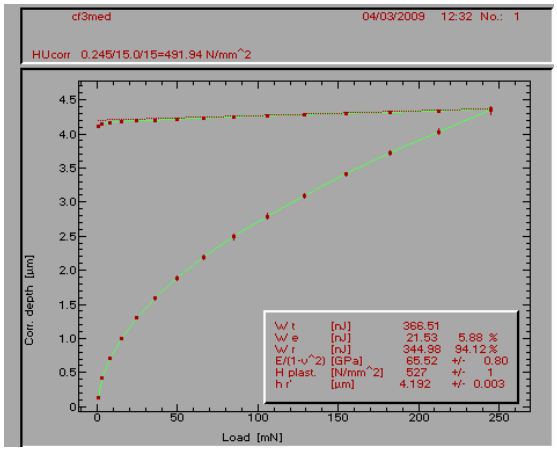
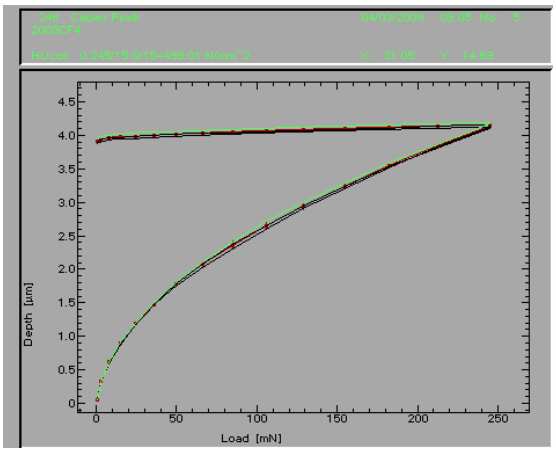
Wire 3(09A36z):

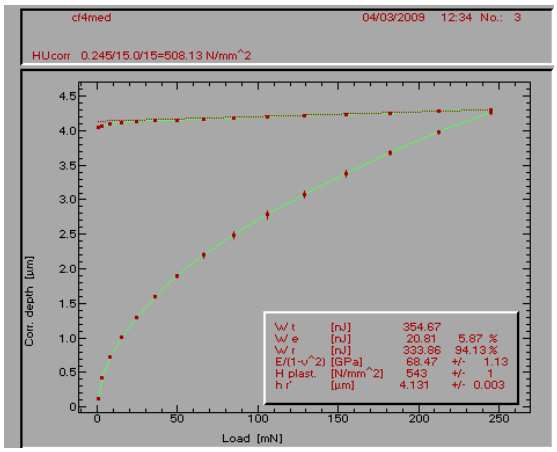




Individual Curves **Mean Curve**

Wire 4(09A36z):





Individual Curves **Mean Curve**

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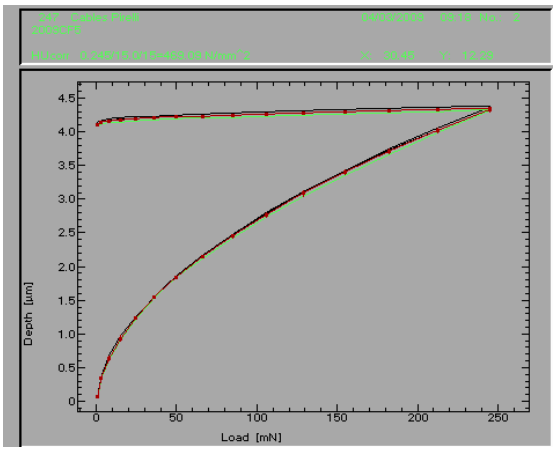
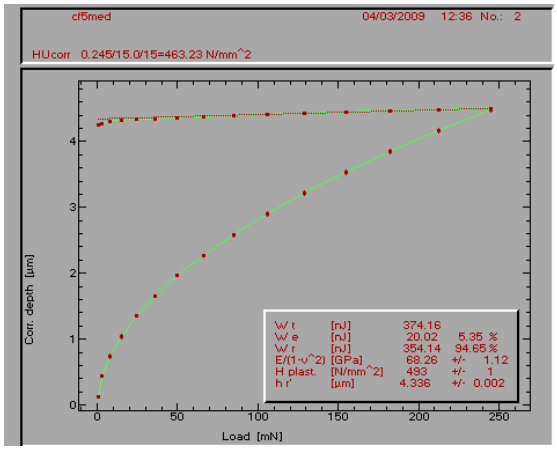
Wire 5(09A36z):

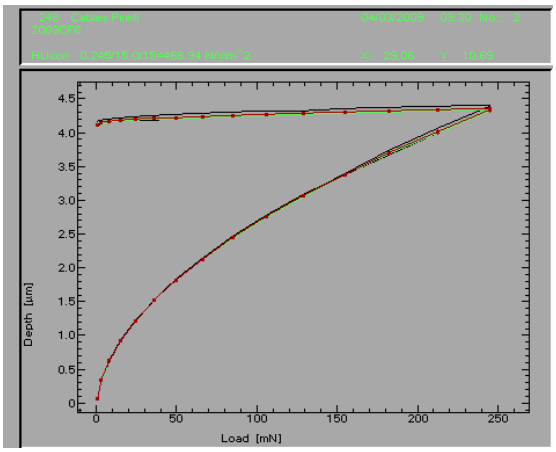


Individual Curves

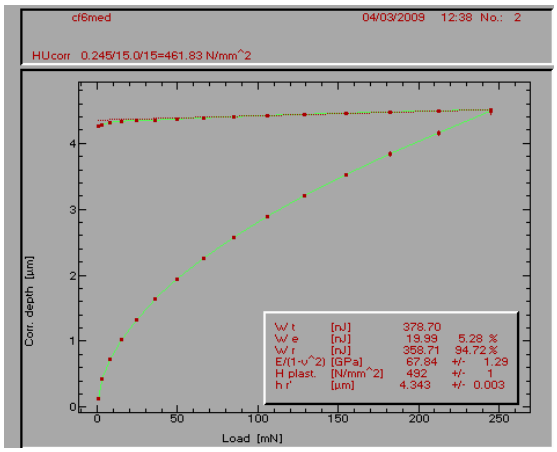


Mean Curve

Wire 6(09A36z):



Individual Curves



Mean Curve

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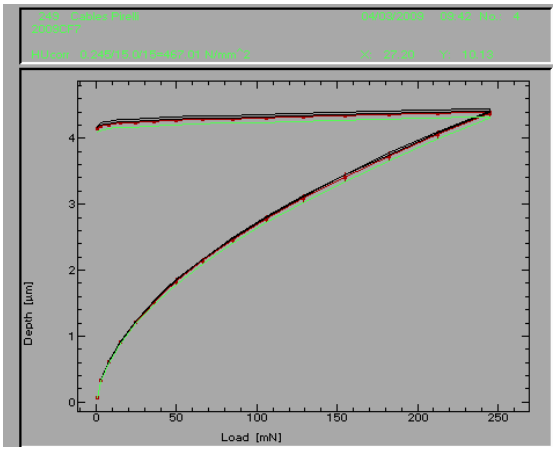
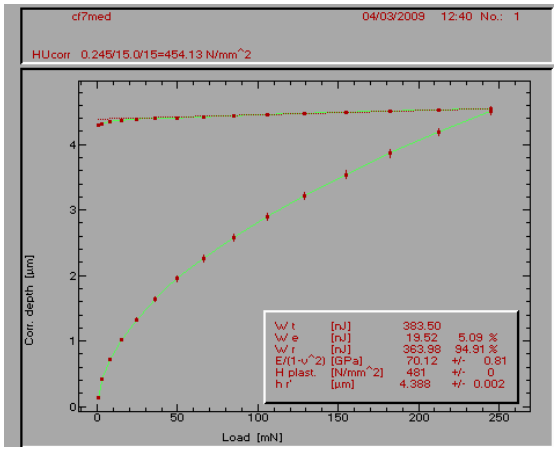
Wire 7(09A36z):

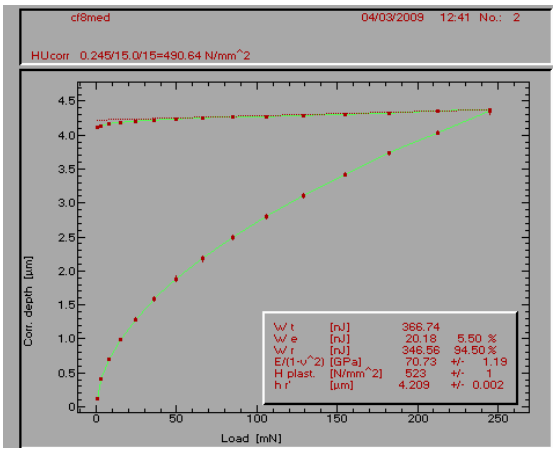


Individual Curves

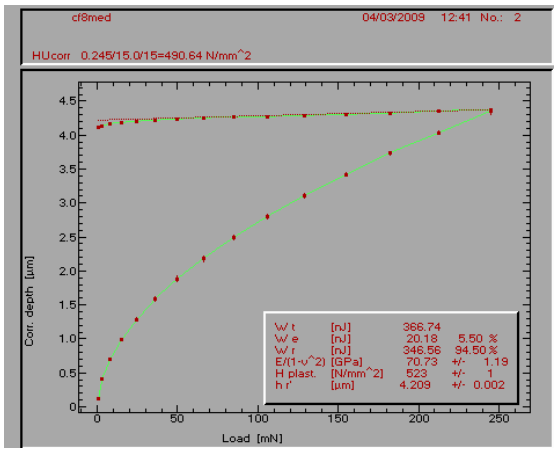


Mean Curve

Wire 8(09A36z):



Individual Curves



Mean Curve

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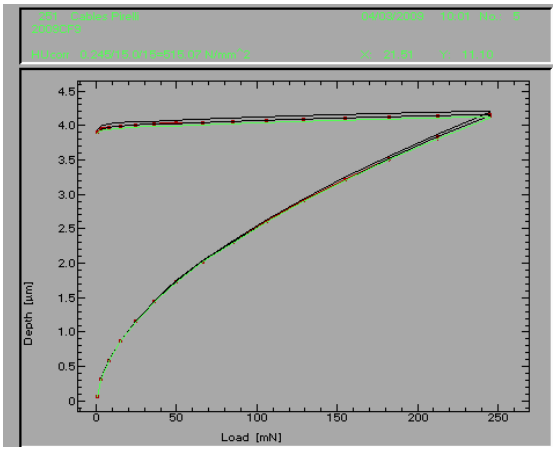
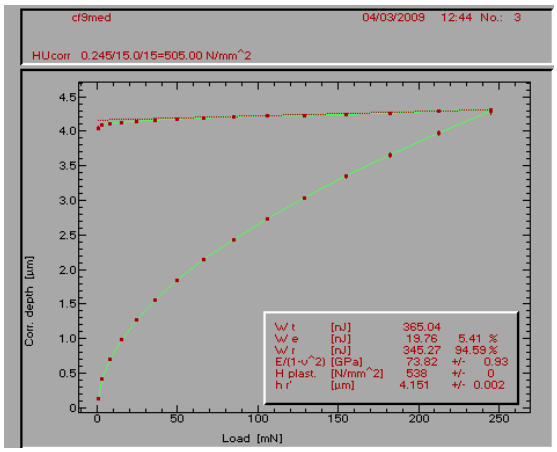
Wire 9(09A36z):

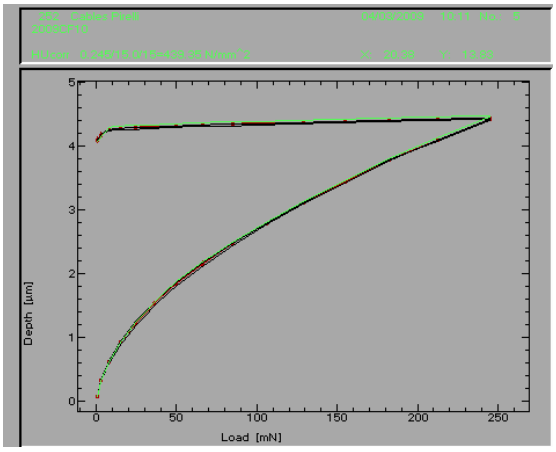


Individual Curves

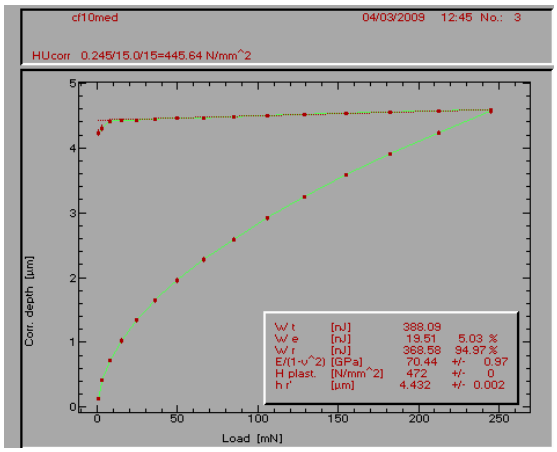


Mean Curve

Wire 10(09A36z):



Individual Curves



Mean Curve

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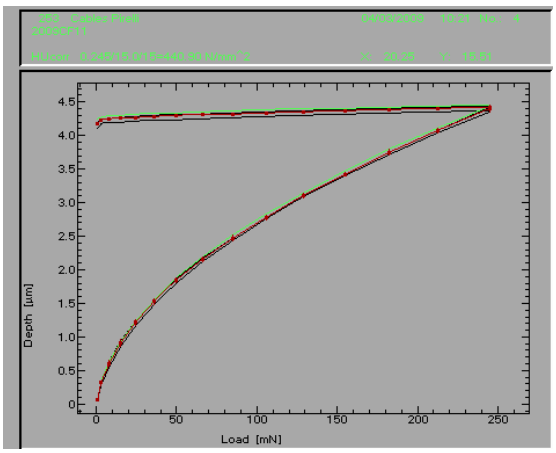
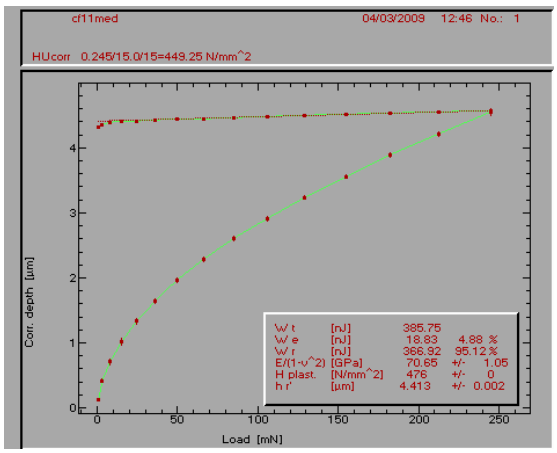
Wire 11(09A36z):

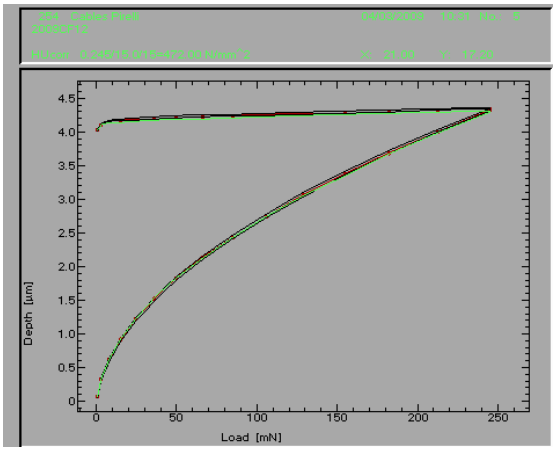


Individual Curves

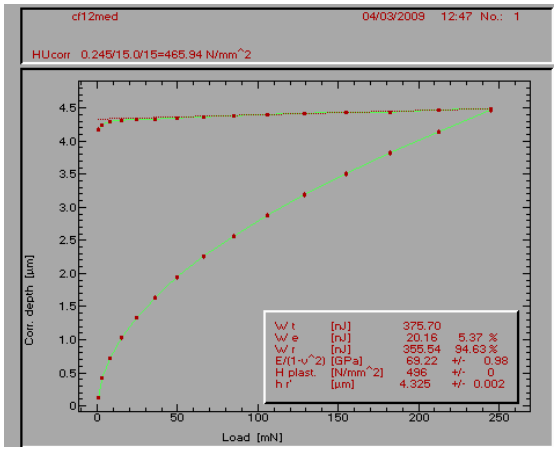


Mean Curve

Wire 12(09A36z):



Individual Curves



Mean Curve

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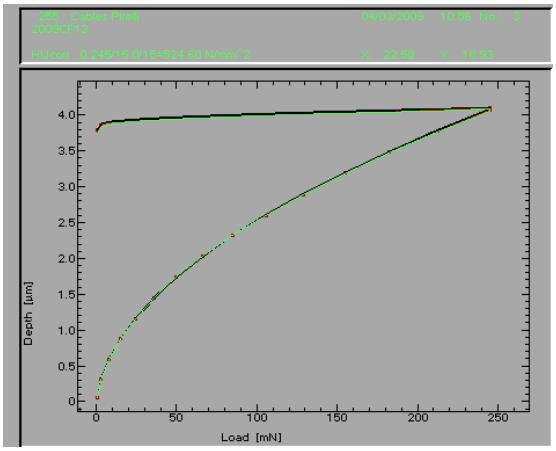
Wire 13(09A36z):



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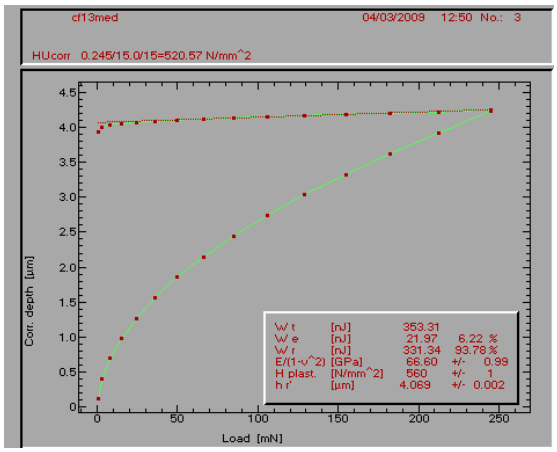

Mean Curve

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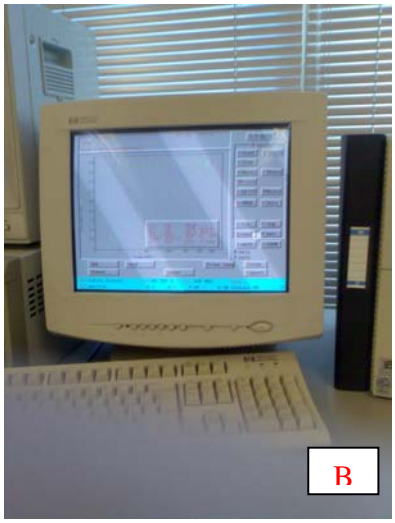

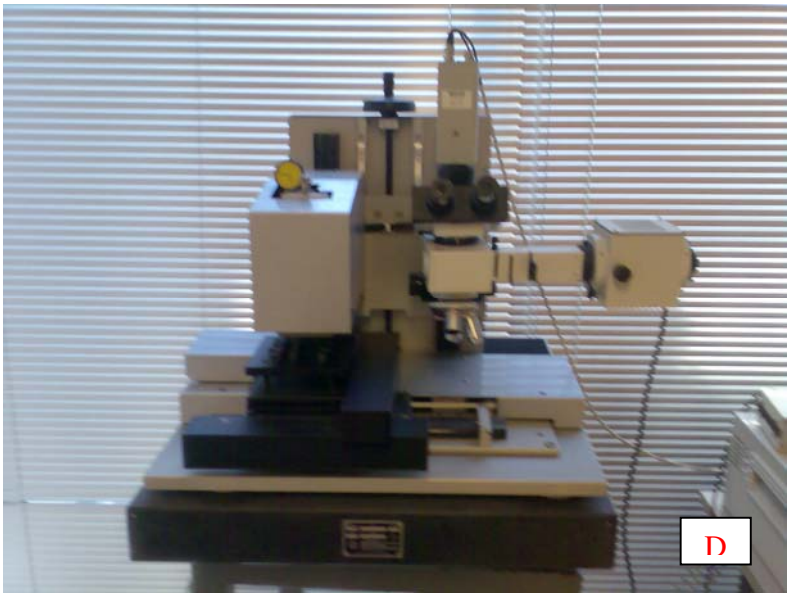

FISHERSCOPE H100 Equipment

A) Fisherscope H100 equipment Assembled.
B) Hardware Unit.
C) Positioning System.
D) Mechanical Indentation System and Microscopy adjustment unit.