



POLITECNICO DI MILANO  
DIPARTIMENTO DI INGEGNERIA STRUTTURALE  
LABORATORIO PROVE MATERIALI  
PIAZZA LEONARDO DA VINCI, 32 - 20133 MILANO

Sede di Milano (sede legale e amministrativa)  
Accettazione materiale - Via Celoria, 3 (8:30 - 12:00)  
Tel. 02 2399 4210 - Fax 02 2399 4211

Sede di Lecco  
Corso Promessi Sposi, 29 - 23900 Lecco  
Tel. 0341 48.8793 - Fax 0341 48.8771

Partita I.V.A. 04376620151  
Codice fiscale 80057930150

Codice cliente ALG0192  
Codice Certificato 2011/2749/1

Spett.le  
ALGA S.p.A. - STRUCTURAL DEVICES &  
POST-TENSIONING SYSTEMS  
VIA DEI MISSAGLIA, 97/A2  
20142MILANO - MI ( I )

Certificato di Prova N. 2011/2749 emesso in Milano il 03/11/2011

Richiedente: ALGA S.p.A. - STRUCTURAL DEVICES & POST-TENSIONING SYSTEMS - MILANO

### CERTIFICATO DI PROVA

FATIGUE TESTS ON ANCHORAGE SYSTEM FOR SIKA CARBODUR S626 STRIPS

Sulle pagine seguenti sono riportati:

- le date di esecuzione delle prove;
- la descrizione dei campioni e le modalità di prova;
- i risultati ottenuti.

I risultati contenuti si riferiscono esclusivamente agli oggetti provati.

Questo certificato di prova consta di N. 5 pagine.

Tutte le pagine sono individuate dal N. 2011/2749/1.

Il presente certificato di prova può essere riprodotto solo integralmente e deve essere assoggettato a bollo in caso d'uso ai sensi del D.P.R. 642/72.

IL DIRETTORE DEL DIPARTIMENTO



POLITECNICO DI MILANO  
DIPARTIMENTO DI INGEGNERIA STRUTTURALE  
LABORATORIO PROVE MATERIALI  
20133 MILANO – P.ZA LEONARDO DA VINCI, 32

**Sede di Milano**

accettazione materiale: Via Celoria, 3 Tel.: 02-2399.4210 Fax : 02-2399.4211

Cod. Fiscale 80057930150  
P. IVA 04378620151

**Sede di Lecco**

C.so Promessi Sposi, 29  
23900 Lecco  
Tel.: 0341-48.8793  
Fax : 0341-48.8771

**Applicant:** ALGA S.p.A. – Milano

**Tests data:** September 2011

## FATIGUE TESTS ON ANCHORAGE SYSTEM FOR SIKA CARBODUR S626 STRIPS

### Specimen description and identification

Specimen was realized by CFRP strips type Sika Carbodur S626 (Fig. 1). The specimen was anchored to the testing machine by CFRP barrels and non metallic wedges (Fig. 2). The characteristics of the CFRP strips, declared by the supplier, are:

- nominal section: 60 x 2.6 (156 mm<sup>2</sup>)
- nominal strength: 468 kN

The free length of the specimen, measured between the internal face of the barrels, was 2040 mm. Tests were performed at the Alga laboratory of Montebello della Battaglia (PV) by an hydraulic testing machine with a capacity of 500 kN. The calibration of the testing machine was performed by Alga according to the internal procedure n° 13.017.

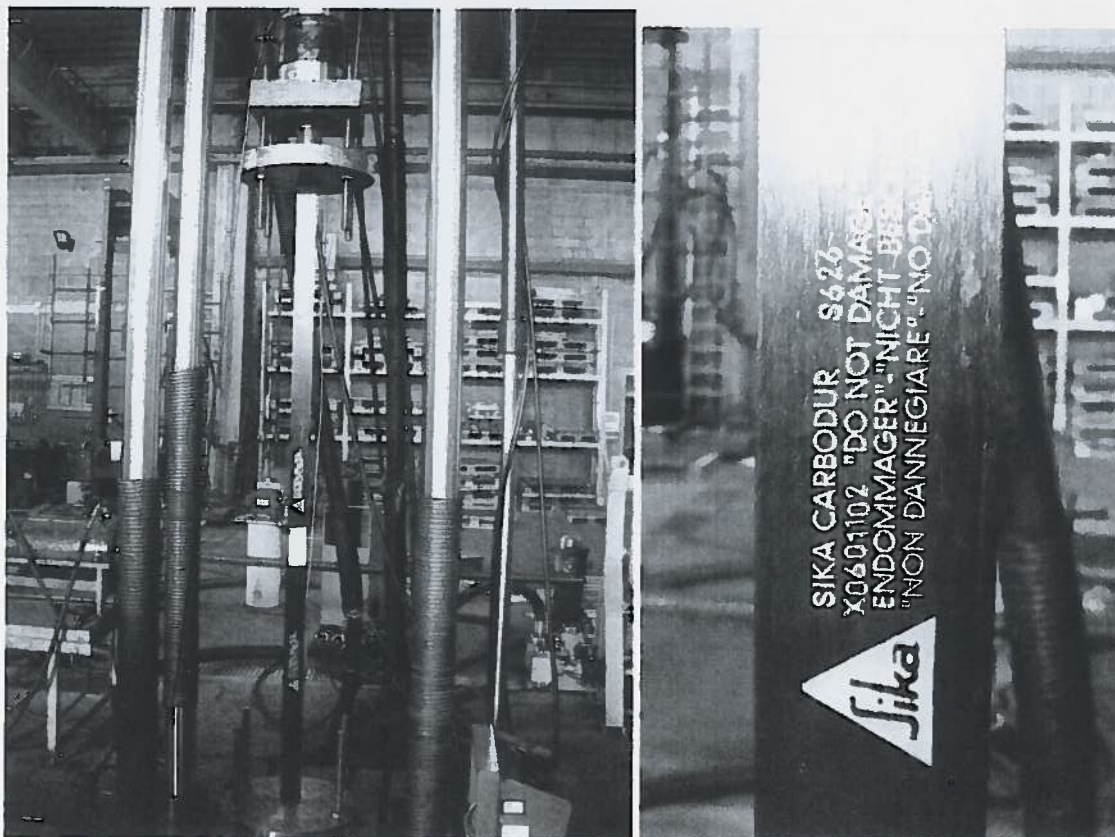


Fig. 1

*Pierluigi Colombi*  
The supervisor  
Prof. Pierluigi Colombi



POLITECNICO DI MILANO  
DIPARTIMENTO DI INGEGNERIA STRUTTURALE  
LABORATORIO PROVE MATERIALI  
20133 MILANO – P.ZA LEONARDO DA VINCI, 32

**Sede di Lecco**  
C.so Promessi Sposi, 29  
23900 Lecco  
Tel.: 0341-48.8793  
Fax : 0341-48.8771

**Sede di Milano**

accettazione materiale: Via Celoria, 3 Tel.: 02-2399.4210 Fax : 02-2399.4211

Cod. Fiscale 80057930150  
P. IVA 04376620151

**Applicant: ALGA S.p.A. – Milano**

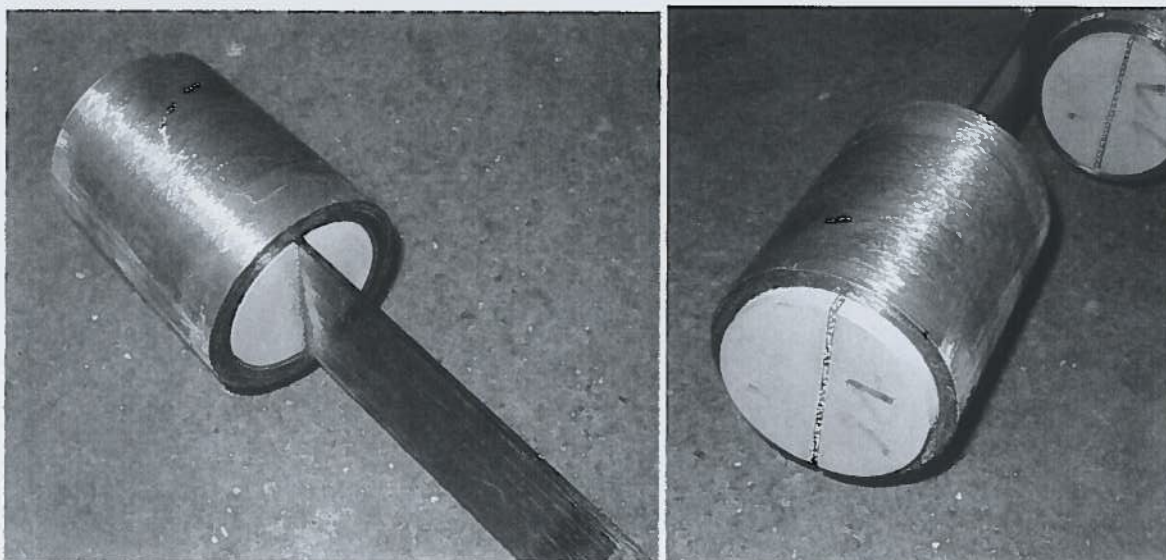


Fig. 2

### Fatigue tests

Three fatigue tests were performed according to document Alga n° 6291. The specimen was first inserted in the testing machine and then constant amplitude sinusoidal fatigue loading was applied. The mean value was equal to 204,36 kN while the load amplitude was equal to 6,24 kN, corresponding to a stress range in the CFRP strips equal to 80 MPa. The relevant maximum load (210,60 kN) was equal to 45% of the nominal strength of the CFRP strip ( $0,45 \times 468 \text{ kN} = 210,60 \text{ kN}$ ). Finally 2 millions load cycles with a frequency of 10 Hz was applied. At the end of the fatigue test the specimen was loaded statically to failure.

### Measurements

At the beginning of the tests the external diameter of the CFRP barrels were recorded by a calliper together with the width and the thickness of the CFRP strips (Table 1). The measurements was repeated during the fatigue test at intervals equal to 500000 cycles.

### Results

Table 1 reports the results of the measurement performed during the fatigue tests. At the end of the fatigue tests no apparent damage of the anchorage was visually observed. The results of failure tests are reported in Table 2. Note that due to a technical problem the failure load and the elongation at failure was not recorded at the end of the first test. The relevant load elongation diagrams are reported in Fig. 3. Static failure was due to brittle fracture of the CFRP strips.

*Pierluigi Colombi*  
Prof. Pierluigi Colombi



POLITECNICO DI MILANO  
DIPARTIMENTO DI INGEGNERIA STRUTTURALE  
LABORATORIO PROVE MATERIALI  
20133 MILANO – P.ZA LEONARDO DA VINCI, 32

Sede di Lecco  
C.so Promessi Sposi, 29  
23900 Lecco  
Tel.: 0341-48.8793  
Fax : 0341-48.8771

**Sede di Milano**

accettazione materiale: Via Celoria, 3 Tel.: 02-2399.4210 Fax : 02-2399.4211

Cod. Fiscale 80057930150  
P. IVA 04378620151

**Applicant: ALGA S.p.A. – Milano**

**Specimen n° 1**

CYCLE	UP.1	UP.2	UP.3	DOWN	THICK.	WID.
0	77.72	77.58	77.57	78.87	2.63	60.47
500000	77.70	77.59	77.44	78.71	2.64	60.45
1000000	77.73	77.34	77.51	78.40	2.63	60.46
1500000	77.71	77.50	77.32	78.37	2.63	60.50
2000000	77.66	77.43	77.61	78.41	2.63	60.48

dimension [mm]

**Specimen n° 2**

CYCLE	UP.1	UP.2	UP.3	DOWN	THICK.	WID.
0	77.63	77.70	77.71	77.21	2.64	60.66
500000	77.74	77.71	77.69	77.21	2.65	60.69
1000000	77.56	77.68	77.72	77.23	2.65	60.62
1500000	77.60	77.72	77.71	77.23	2.65	60.59
2000000	77.61	77.69	77.73	77.23	2.65	60.61

dimension [mm]

**Specimen n° 3**

CYCLE	UP.1	UP.2	UP.3	DOWN	THICK.	WID.
0	77.52	77.55	77.50	77.73	2.64	60.73
500000	77.49	77.48	77.54	77.81	2.65	60.68
1000000	77.51	77.49	77.54	78.15	2.64	60.79
1500000	77.55	77.48	77.53	78.06	2.64	60.78
2000000	77.54	77.46	77.54	77.76	2.63	60.79

dimension [mm]

Table 1

Test	Failure load [kN]	Elongation [mm]
1	-	-
2	348,91	33,04
3	342,93	32,65

Table 2

*Pierluigi Colombi*  
The supervisor  
Prof. Pierluigi Colombi



POLITECNICO DI MILANO  
DIPARTIMENTO DI INGEGNERIA STRUTTURALE  
LABORATORIO PROVE MATERIALI  
20133 MILANO - P.ZA LEONARDO DA VINCI, 32

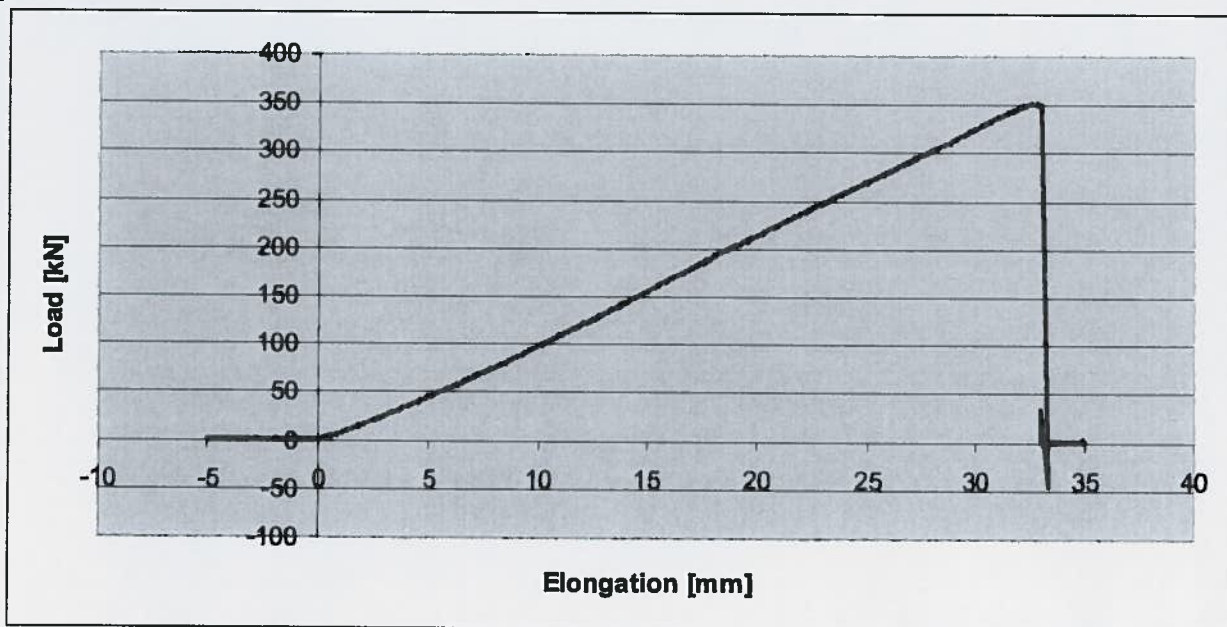
**Sede di Lecco**  
C.so Promessi Sposi, 29  
23900 Lecco  
Tel.: 0341-48.8793  
Fax : 0341-48.8771

**Sede di Milano**  
accettazione materiale: Via Celoria, 3 Tel.: 02-2399.4210 Fax : 02-2399.4211

Cod. Fiscale 80057930150  
P. IVA 04376620151

**Applicant: ALGA S.p.A. - Milano**

**Specimen n° 2**



**Specimen n° 3**

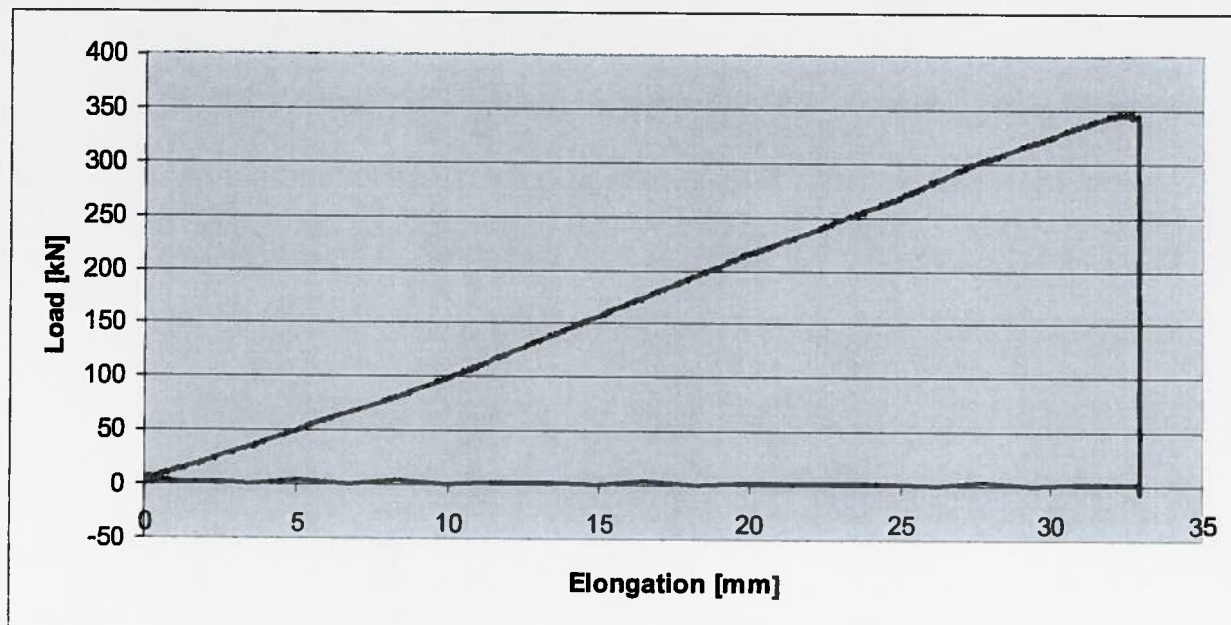


Fig. 3

*Pierluigi Colombi*  
The supervisor  
Prof. Pierluigi Colombi