

DYNA Force™ Elasto-Magnetic Sensor

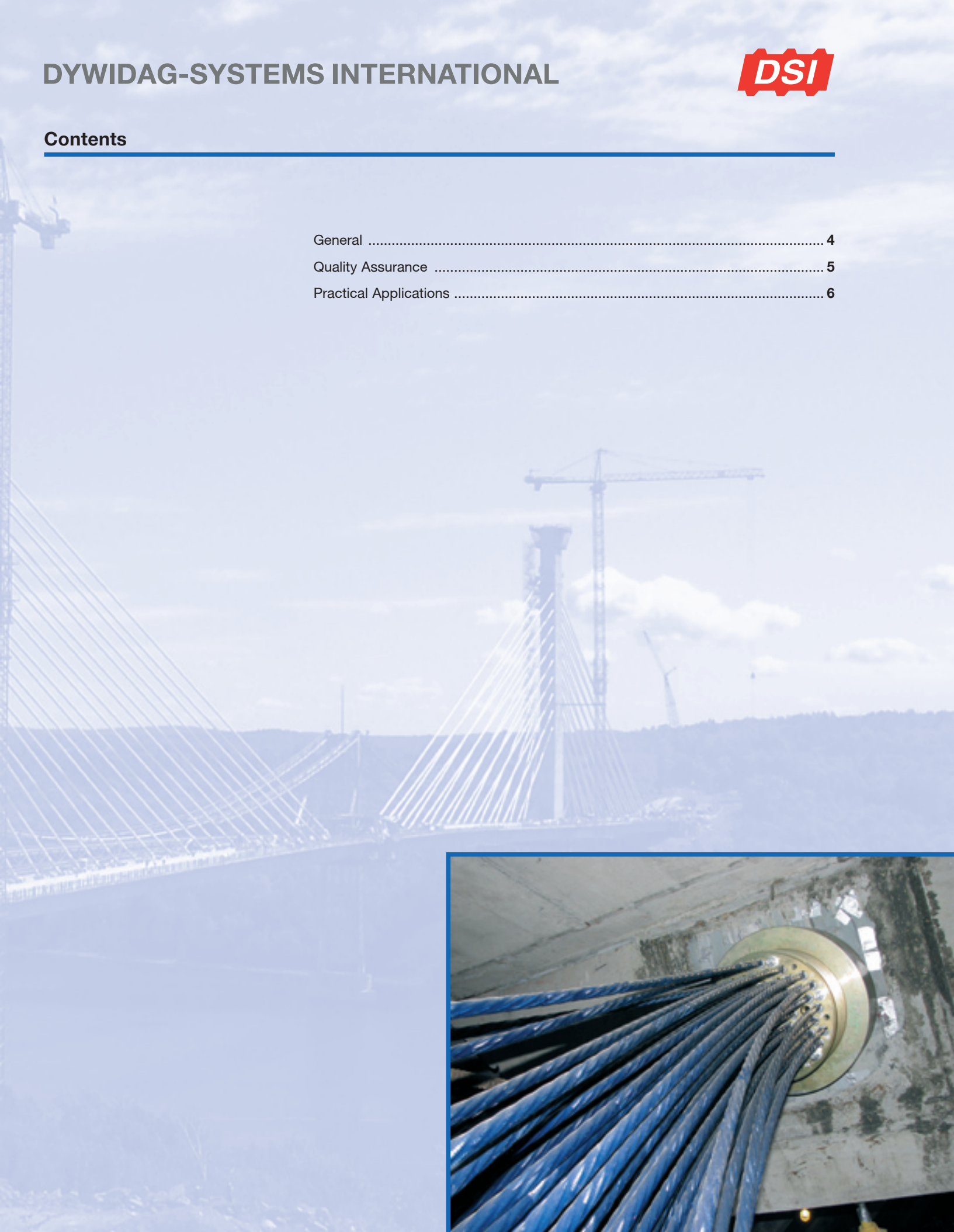


Penobscott Narrows Bridge and Observatory, Maine, USA



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General

On many occasions during construction and service life of the structure, it is crucial to know the force in the post-tensioning system. Although there are many methods to measure the tendon force, most of them are cumbersome, expensive, and the accuracy differs depending on the method used. DYWIDAG has been involved in the development, testing and execution of DYNA Force™ to measure the force in the tendon. DYNA Force™ is being used in cable stay bridges, cable system testing and building structure to measure the force during stressing and to monitor forces during the service life of the structure. DYNA Force™ can be used for bare, epoxy-coated and greased-sheathed steel.

DYNA Force™ is manufactured based on the theory that the permeability of steel to a magnetic field changes with the stress level in the steel. By measuring the change in a magnetic field the magnitude of the stress in the steel element can be obtained. The DYNA Force™ does not alter the characteristics of the tendon other than its magnetization. The permeability is a function of temperature and magnetization, and a calibration process eliminates the impact of these variables. The program takes into consideration the temperature change effect automatically. A portable Power Stress unit is attached to wire leads from the DYNA Force™. This unit will create the magnetic field and then measure the residual value

and then convert it to a direct force reading. The accuracy of the force measurement is within 1%. DYNA Force™ system is robust, requires no maintenance and has no moving parts. It is composed of sensors and Power Stress unit (read-out box). DYNA Force™ is installed over the strand or bar during construction and a zero reading is taken before applying any post-tensioning force. It is expected to have a similar service life as the bridge/building structure. This will allow the owner to regularly monitor the forces in the post-tensioning system in minutes as a part of their inspection procedures without the need for lift-off equipment or other special expensive techniques. This will also avoid the inaccuracies and risks often associated with lift-off readings. One person can do this job.



Bar DYNA Force™

DYNA Force™ Dimensions

DYNA Force™ Type	Strand/Bar	DYNA Force™ Dimensions		
		ID [in]	OD [in]	Length [in]
Strand DYNA Force™	0.5"	0.71	1.50	5.1
	0.6"	0.78	1.50	5.1
Bar DYNA Force™	1-1/4" & 1-3/8"	1.70	2.80	6.7
	1-3/4"	2.10	3.90	8.3
	2-1/2"	2.85	6.20	12

Note: Dimensions for 2-1/2" bar are preliminary



Power-Stress Unit



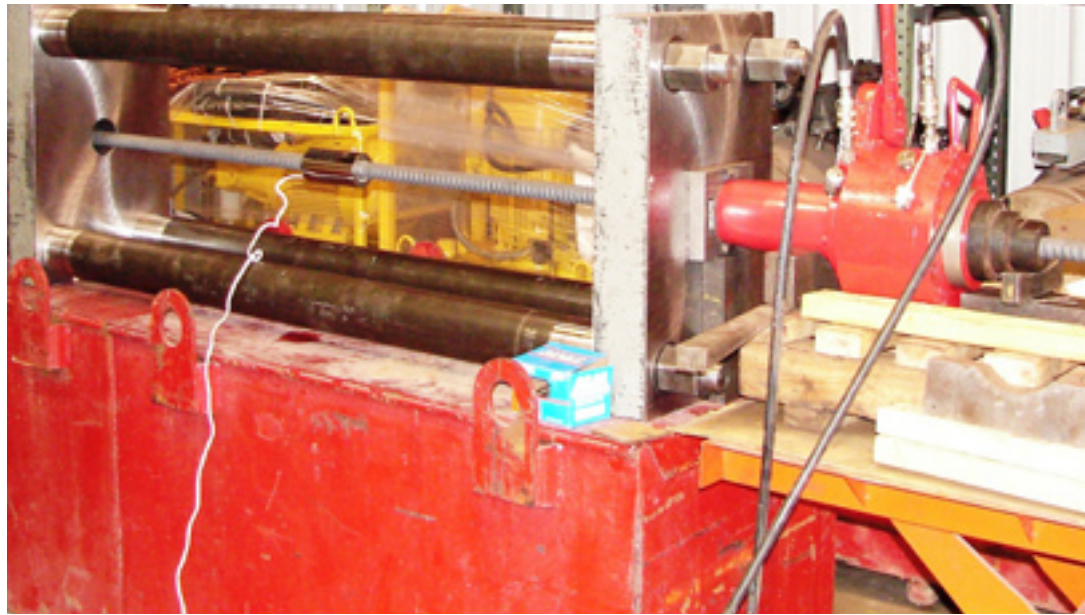
Strand DYNA Force™

Quality Assurance

All DYNA Force™ sensors are professionally made in a quality controlled facility. Furthermore, each DYNA Force™ is tested and individually packed and numbered at the DSI facility before sending to the job site. Although many tests have been conducted in the development

of the DYNA Force™, DSI conducted additional tests to simulate the performance of the system when placed within the anchorage zone of stay cables. In these tests DYNA Force™ sensors were placed near the center and on the outside of the strand bundle. The loads were applied using

a stressing jack and the force was monitored using a very accurate load cell. The load cell readings were compared to the results from the Power Stress unit and very good correlation was obtained.



Testing and Calibration of DYNA Force™

Practical Applications



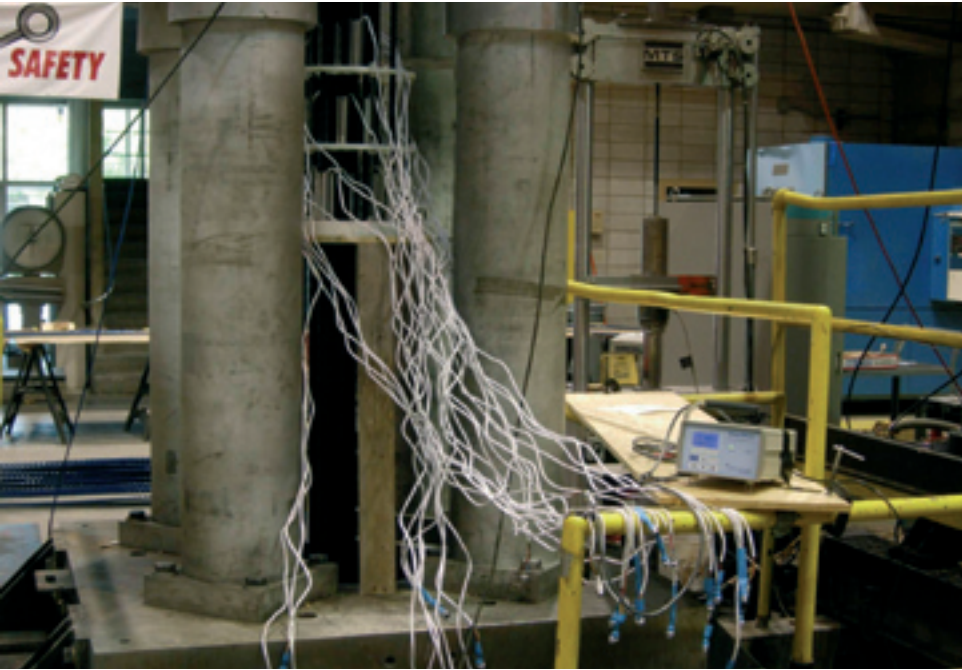
When a DYNA Force™ is installed on a strand/bar, the force in it may be obtained directly by merely attaching the leads from DYNA Force™ to a portable Power Stress unit. No other equipment is needed. DYNA Force™ sensors have been used in many bridge and building structures for the past several years.

DSI supplied two hundred forty sensors for Waldo cable stay bridge, Maine, USA. Each cable had six sensors and the cable forces at each stage of construction were monitored using these sensors. Periodic lift-off operations were made on the strands with sensors. A good correlation was observed. The bridge is now open to traffic and the forces in any cable can be monitored anytime using these DYNA Force™ sensors without any disruption to traffic.

DYNA Force™ in Cable Stay Anchor, Waldo, Maine, USA



Practical Applications



DYNA Force™ in Fatigue Test of Cable Stay System

DSI used DYNA Force™ sensors in a fatigue testing of 41-strand cable stay system. Force in each 0.6" dia epoxy coated strand was monitored at various loading stages during two-million fatigue cycles.



DYNA Force™ sensors were used in moment resisting frames in a City Office building, California. The tendons

were 0.5" diameter greased and sheathed un-bonded strands. DYNA Force™ was used to measure the force

during stressing and will be used to monitor the forces in each loop tendon especially after earthquake takes place.



DYNA Force™ for Seismic Evaluation of Building Structure, California, USA

**DYWIDAG-Systems
International USA Inc.**

320 Marmon Drive
Bolingbrook, IL 60440 USA
Phone: (630)-739-1100
Fax: (630)-739-5517
E-Mail: dsiamerica@dsiamerica.com

525 Wanaque Avenue, Suite LL1
Pompton Lakes, NJ 07442
Phone: (724) 869-0155
Fax: (973) 831-6503
E-Mail: dsiamerica@dsiamerica.com

1250 Connecticut Avenue, NW Suite 200
Washington, DC 20036
Phone: (202) 263-4601
Fax: (866) 308-3832
E-Mail: dsiamerica@dsiamerica.com

3300 SW 50th Avenue
Davie, FL 33314
Phone: (954)-318-1105
Fax: (954)-318-1107
E-Mail: dsiamerica@dsiamerica.com

4732 Stone Drive, Suite A
Tucker, GA 30084
Phone: (770) 491-3790
Fax: (770) 938-1219
E-Mail: dsiamerica@dsiamerica.com

2400 Hwy 287 N, Suite 106
Mansfield, TX 76063
Phone: (817) 473-6161
Fax: (817) 473-1453
E-Mail: dsiamerica@dsiamerica.com

3280 E. 59th Street
Long Beach, CA 90805
Phone: (562) 529-2109
Fax: (562) 529-2225
E-Mail: dsiamerica@dsiamerica.com

**DYWIDAG-Systems
International CANADA Ltd.**

Eastern Division
37 Cardico Drive
Gormley, ON L0H1G0
Phone: (905) 888-8988
Fax: (905) 888-8987
E-Mail: ecd@dsiamerica.com

Quebec Office
C.P. 412
St. Bruno, Quebec
J3V 5GB
Phone: (450) 653-0935
Fax: (450) 653-0977
E-Mail: ecd@dsiamerica.com

Western Division
19433 96th Av.
Suite 103
Surrey, BC V4N4C4
Phone: (604) 888-8818
Fax: (604) 888-5008
E-Mail: wcd@dsiamerica.com

Calgary Office
2816-21 Street N.E., Suite 204
Calgary, Alberta T2E 6 Z2
Phone: (403) 291-4414
Fax: (403) 250-5221
E-Mail: wcd@dsiamerica.com

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