



# ENCARDIO RITE

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USERS' MANUAL

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## STRAIN GAGE TYPE LOAD CELL

MODEL ELC-150S-H



Doc # WI 6002.101 R00 | Jun 2006

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### ENCARDIO-RITE ELECTRONICS PVT. LTD.

A-7, Industrial Estate, Talkatora Road Lucknow, UP - 226011, India | P: +91 522 2661039-42 | Email: geotech@encardio.com | www.encardio.com

International: UAE | Qatar | Bahrain | Bhutan | Europe | USA

India: Lucknow | Delhi | Kolkata | Mumbai | Chennai | Bangalore | Hyderabad | J&K

## Contents

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Specifications	2
1.2	Handling of load cell	2
1.3	Conventions used in this manual	2
1.4	How to use this manual	2
<b>2</b>	<b>STRAIN GAGE TYPE LOAD CELL</b>	<b>4</b>
2.1	General description	4
2.1.1	Bearing and load distribution plates	4
2.1.2	Cable connection	4
2.2	Tools & accessories required for installation	4
<b>3</b>	<b>INSTALLATION PROCEDURE</b>	<b>7</b>
3.1	Preparation of sensor before installation	7
3.2	Mounting load cell	7
<b>4</b>	<b>INSTALLATION METHOD FOR THE MEASUREMENT OF LOAD IN STRUTS</b>	<b>9</b>
4.1	General	9
4.2	Installation and taking readings	9
4.2.1	General precautions in laying cable	12
4.3	Trouble shooting	13
4.3.1	Symptom: Load cell reading unstable	13
4.3.2	Symptom: Load cell fails to read	13

## 1 INTRODUCTION

The Encardio-rite model ELC-150S-H is a very heavy duty, high capacity, and precision load cell to measure the compressive loads. The load cell is being increasingly used in several applications due to the following features.

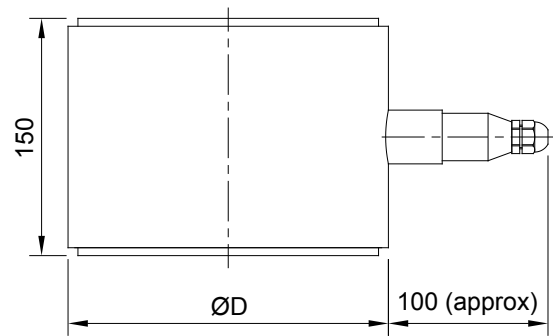
### Features

- Specially designed to suit stringent harsh industrial environments.
- Ideally suited for use with data acquisition systems.
- Having no moving parts and mechanical linkages, hence the system is stable.
- Load cells are temperature compensated within controlled limits, reducing the effect of temperature variation.
- It can also be applied to the measurement of compressive load between structural members, i.e. tunnel supports or at the junction between a beam and the top of a pile strut.

Model ELC-150S-H series load cells has been specially designed to meet the increasing demand in load measurement with a high degree of accuracy and reliability. The load cell is ideally suited for measurement of compressive loads or forces.

Model ELC-150S-H series load cell finds extensive use in experimental research, pile testing and measurement of thrust of rocks.

ELC-150S-H load cell comprises of a high strength martensitic stainless steel sensor element. The sensor utilizes precision sixteen bonded foil strain gages mounted at 45° to each other to minimize effect of uneven and eccentric loading. These are connected in a simple Wheatstone bridge circuit. The output is derived from imbalances in bridge circuit as the sensor senses load. Typically the bridge circuit is excited by 10 VDC to give a full scale output of around 1.5 mV/V.



Cap. (kN.)	ØD
5000	217
6000	217
7500	248
10000	278
12500	293
15000	318

ELC-150S-H load cell is designed for use in environments normally associated with construction activity. Advantage of a conventional strain gage load cell over a vibrating wire load cell lies mainly in ease of taking the reading. Load can be directly read on a suitable indicator. In contrast, the vibrating wire load cell has three (or six) separate elements. These have to be separately read and the average taken to get the correct load. Data logging also in case of vibrating wire load cells requires three (or six) channels. The main advantage of vibrating wire load cell over strain gage load cell is that the former uses a frequency rather than a voltage as output signal. Frequency may be transmitted over long cable lengths of upto 2 km without appreciable degradation caused by variations in cable resistance arising from water penetration, temperature fluctuation, contact resistance or leakage to ground etc.

Load cells are available in standard capacities ranging from 5000, 6000, 7500, 10000 and 12500 kN.

## 1.1 Specifications

Capacity (kN)	5000,6000,7500,10000, 12500,15000
Safe Overload	120 % fs
Rated Output	1.5 mV/V $\pm$ 10 %
Zero Balance	< $\pm$ 0.1 % fs
Excitation Voltage	
Nominal	10 VDC
Maximum	20 VDC
Terminal Resistance	
Input	1540 Ohm $\pm$ 5 %
Output	1400 Ohm $\pm$ 1 %
Insulation Resistance	>500 M Ohm at 12V
Temperature Range	-10° to 70° C
Total Error	1 % fs
Creep 30 min.	0.03 % fs
Temp. Effect	
Zero % fs / ° C	$\pm$ 0.05
Span % fs / ° C	$\pm$ 0.03
Enclosure	IP-54

## 1.2 Handling of load cell

The load cell should be handled very carefully during transportation and installation. It should not be dropped under any circumstances. In case, it is dropped, the impact generated will almost certainly result in a shift of zero reading. Refer to Encardio-rite application note AN-1 (data sheet 1147-96) for an appreciation of the magnitude of damage caused to a load cell by impact load.

**CAUTION:** The load cell should not be dropped under any circumstances because this may lead to its permanent damage.

## 1.3 Conventions used in this manual

**WARNING!** Warning messages calls attention to a procedure or practice, that if not properly followed could possibly cause personal injury.

**CAUTION:** Caution messages calls attention to a procedure or practice, that if not properly followed may result in loss of data or damage to equipment.

**NOTE:** Note contains important information and is set off from regular text to draw the users' attention.

## 1.4 How to use this manual

This users' manual is intended to provide you with sufficient information for making optimum use of the strain gage type load cell in your application.

**NOTE:** The installation personnel must have a background of good installation practices and knowledge of the fundamentals of geotechnics. Novices may find it very difficult to carry on the installation work. The intricacies involved in installation are such that even if a single essential but apparently minor requirement is ignored or overlooked, the most reliable of instruments will be rendered useless.

A lot of effort has been made in preparing this instruction manual. However the best of instruction manuals cannot provide for each and every condition in the field, which may affect

the performance of the sensor. Also, blindly following the instruction manual will not guarantee success. Sometimes, depending upon field conditions, the installation personnel will have to consciously depart from the written text and use their knowledge and common sense to find the solution to a particular problem.

To make this manual more useful we invite your valuable comments and suggestions regarding any additions or enhancements. We also request you to please let us know of any errors that you may find while going through the manual.

The manual is divided into a number of sections. Each section contains a specific type of information. The list given below tells you where to look for in this manual if you need some specific information.

*For general description and dimensions: See § 2.1 'General description'.*

*For dimensions of load distribution & bearing plates: See § 2.1.1 'Bearing & load distribution plates'.*

*For wiring diagram: See § 2.1.2 'Cable connection'.*

*For essential tools and accessories: See § 2.1.3 'Tools and accessories required for installation'.*

*For installation of strain gage type centre hole load cells: See § 3 'Installation procedure'.*

*For troubleshooting: See § 3.4 'Trouble shooting'.*

## 2 STRAIN GAGE TYPE LOAD CELL

### 2.1 General description

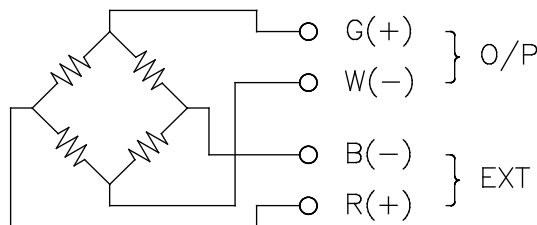
The strain gages are mounted on a stainless steel columnar element. The sectional area of the columnar element is varied in the different capacity load cells to give approximately the same mV/V output for a variation of zero to full load. A cover protects the columnar element by providing o-ring seal.

#### 2.1.1 Bearing and load distribution plates

The load cells are very susceptible to eccentric loading. Providing a load distribution plate of proper dimensions at the top reduces the effect. In some applications, a load bearing plate may also be used at the bottom of the load cell. Standard plates stocked by Encardio-rite have the following dimensions:

Capacity kN	T mm	Load distribution/Bearing plate	
		Size	Wt. kg
5000	32	200X200	10.05
6000	32	do	10.05
7500	32	250X250	15.70
10000	50	Φ285	25.03
12500	50	Φ300	27.73

#### 2.1.2 Cable connection



Leads from the Wheatstone bridge circuit are terminated on a small printed circuit board (PCB), through a six-pin glass to metal seal in the cable holder assembly. No load output balancing, temperature compensation and full scale output balancing is being done on the PCB. A suitable four core shielded cable is terminated through a cable joint housing and cable gland.

### 2.2 Tools & accessories required for installation

The following tools / accessories are required for proper cable jointing and installation of the load cell:

- 2.2.1 Soldering iron 25 watt
- 2.2.2 Rosin 63/37 solder wire RF-3C, 30 SWG
- 2.2.3 Thread sealant (Loctite 577)
- 2.2.4 Cable jointing compound (MS 853 and hardener MSH 283 - Mahendra Engineering & Chemical Products Ltd. or equivalent)
- 2.2.5 Accessories for cable jointing compound i.e. rotary tin cutter, stainless steel rod 2 mm  $\phi$ , 150 mm length for stirring, spatula & pouring funnel
- 2.2.6 Acetone (commercial)
- 2.2.7 Toothbrush

- 2.2.8 Cloth for cleaning (lint less)
- 2.2.9 Wire stripper and cable cutter
- 2.2.10 Pliers 160 mm
- 2.2.11 Spanner 18/19
- 2.2.12 Digital multi-meter
- 2.2.13 Encardio-rite model EDI-53L digital indicator/logger



# Encardio-rite Electronics Pvt. Ltd.

A-7 Industrial Estate, Talkatora Road, Lucknow, UP-226011 India

E-mail: geotech@encardio.com, lko@encardio.com; Website: www.encardio.com

Tel. +91 (522) 2661039/40/41/42 Fax +91 (522) 2662403



## TEST CERTIFICATE

Date: 11.03.2011  
Temp. 20 °C

**Customer:**  
**P.O. No.**  
**Instrument:**  
**Capacity**  
**Mfg. Sr. No.**

Model: ELC-150S-H strain gage type compression load cell  
5000 kN

### Dimension details

	I.D.(mm)	O.D.(mm)	Height(mm)
Load cell	NA	220	150

	Length(mm)	Width (mm)	Height (mm)
Top plate	200	200	32
Bottom plate	200	200	32
Bottom fixing plate	200	200	15

### General details

Input resistance	1550	Ohm
Output rsistance	1405	Ohm
Insulation resistance	>1000	Mega Ohm

### Test data

Excitation Voltage 10.000 V

Input Load kN	Output (mV/V)	
	Cycle 1	Cycle 2
0	0.000	0.000
1000	0.323	0.322
2000	0.630	0.631
3000	0.951	0.950
4000	1.262	1.261
5000	1.580	1.580

Max. non linearity 0.41 % fs  
Rated output 1.580 mV/V @ 5000 kN

### Linear gauge factor

- 1) 316.456 kN/mV ( To be used to convert the mV o/p of load cell in engineering units when observations are taken in mV with Voltmeter or other read out units with customer)
- 2) 6329.11 (To be used to read the o/p in engineering unit when Encardio-rite readout unit EDI-53L is used for observations. Refer to attached annexure-1)

### Wiring configuration

Colour	Signal
Red	+ Excitaion
Black	- Excitation
Green	+ Output
White	- Output

**Cable Length** 5 meter

Checked by

Tested by



### 3 INSTALLATION PROCEDURE

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#### 3.1 Preparation of sensor before installation

3.1.1 Clean four wires of the load cell.

3.1.2 Check working of the sensor as follows:

- Resistance measured by a digital multi-meter between red/black terminals should be 1540 Ohms  $\pm 5\%$  and between green/white terminals should be 1400 Ohm  $\pm 1\%$
- Resistance between any lead and outer casing should be  $> 500\text{ M Ohm}$ .
- Using portable digital indicator measure zero balance of load cell. It should be between  $\pm 0.1\text{ mV/V}$ .

**NOTE:** Check sensor for proper functioning before installation.

3.1.3 Check cable visually for any cuts, damaged sheath etc. Cut appropriate length of cable (add 1 m extra length for cable jointing). Always determine correct length of cable required. **CAUTION:** Cable should always be removed from a spool by rotating the spool. This will reduce chances of nicking, bending or twisting of the cable.

3.1.4 Connect required length of cable to sensor as described in operating manual on cable jointing # WI-6002.11E.

3.1.5 Check working of the sensor again following the procedure described in § 3.1.2.

**NOTE:** Add cable resistance when checking resistance between leads after cable jointing if required. For EC-0107 cable (7 x 0.25 conductor) resistance is around 49 Ohm/km (multiply by 2 for both leads). In case any other cable is used, make necessary addition in resistance value.

#### 3.2 Mounting load cell

3.2.1. Load cell assembly should always be mounted on a machined seating pad of thickness greater than flat bearing plate. Seating pad should be grouted perpendicular to axis of load application. The load cell should be installed between flat bearing and load distribution plates. These plates should be parallel to each other and normal to axis of load cell. In case surface of the flat bearing and load distribution plates cannot be maintained parallel, spherical settings or wedges or compensation washers made of copper/high density plastic material should be used.

**NOTE:** Eccentric loading and uneven or warped bearing and load distribution plates have a profound effect on the load cell reading. Having thicker top and bottom plates reduces the effect.

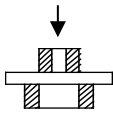
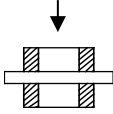
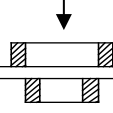
Careful mounting is required to reduce effect of eccentric loading. The load cell should be mounted between flat bearing top and bottom plates of proper thickness depending upon the load cell capacity. The load should be centralized with respect to load cell axis. In case the surfaces are not parallel, spherical settings or wedges should be employed. Compensation washers made of copper, high density plastic or any similar deformable material may also be used.

**NOTE:** As already explained, an uneven bearing or load distribution plate can affect accuracy of reading. So can bending or distortion of plates. It is essential to use bearing/load distribution plates of correct thickness and finish.

Reading. The effect is reduced in case the plate in-between is thicker. It is therefore The effect of bearing/load distribution plates bending is illustrated by an experiment performed on an Encardio-rite 50 tf centre hole load cell, loaded on an universal testing machine to full capacity. For purpose of the experiment a flat plate was placed on the load cell and load applied through bushes of different diameters. The result is displayed below.

It will be noticed that if the bush is smaller or larger, the load cell reading is different from the actual

advisable to use thick bearing and load distribution plates.

		Load cell response to applied load (50 tf)	
		23 mm thick plate	35 mm thick plate
Smaller bush	 <p>Load cell</p>	105 %	101%
Same size bush	 <p>Load cell</p>	100 %	100 %
Larger bush	 <p>Load cell</p>	96 %	99 %

## 4 INSTALLATION METHOD FOR THE MEASUREMENT OF LOAD IN STRUTS

### 4.1 General

The Encardio-rite model ELC-150S-H series load cell is a heavy duty, high capacity, precision load cell and is ideally suited for measurement of load in struts. Because of no moving parts and mechanical linkages the load measurement system using the load cell is stable. The load cells are temperature compensated reducing the effect of temperature variation. Besides load cell, the measurement system includes stay rods, top and bottom mounting plates, junction box, cable, switch box and a readout unit. A typical mounting scheme for struts is shown in figure 1. Dimensional details of the load cell assembly are provided in figure 2. For wiring details, refer to figure 3.

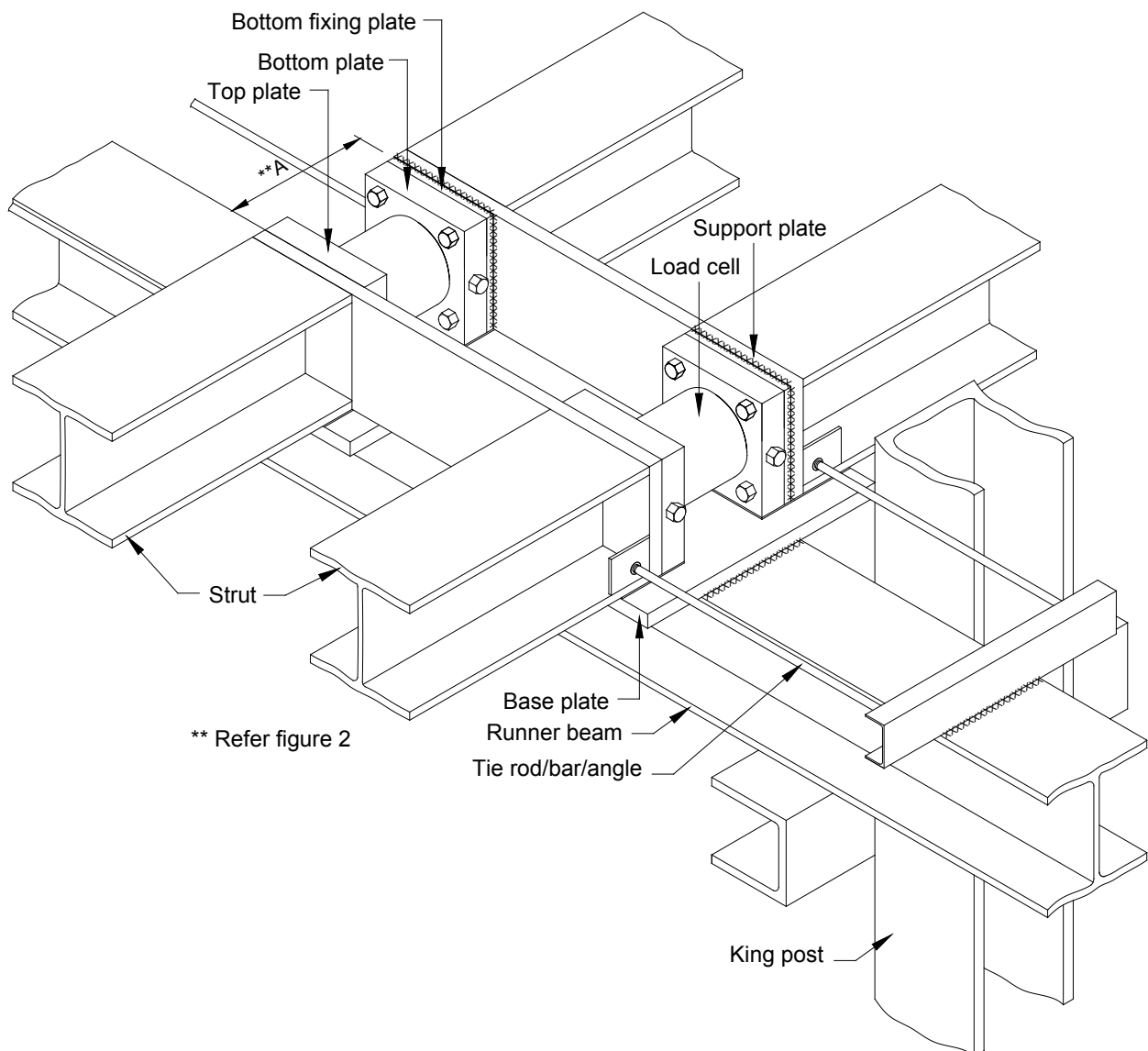


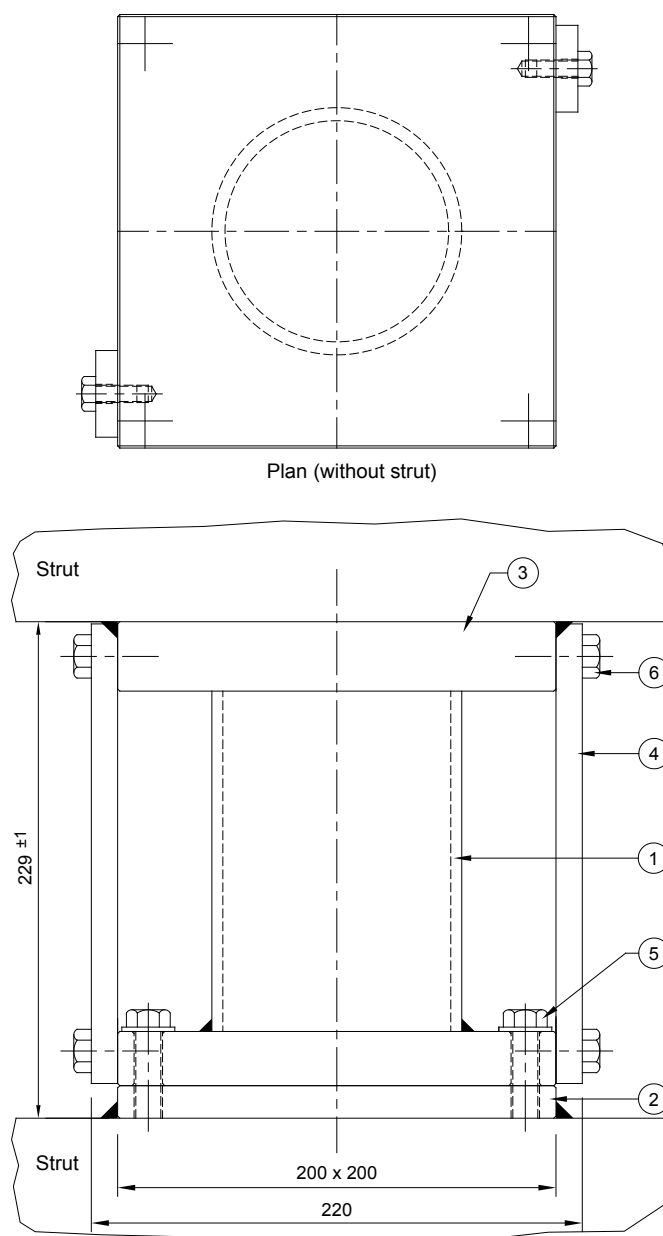
Figure 1

### 4.2 Installation and taking readings

4.2.1 Struts contractor to prepare struts for mounting the load cells. Weld two base plates around 500 mm x 300 mm x 25 mm on runner beam as shown in figure 1. These will support the struts over the runner beam at the location where the load cells have to be mounted. The faces of the struts have to be provided with support plates for mounting of load cells.

4.2.2 Mount the dummy load cell (1) on bottom fixing plate (2) by hex bolts M10X45 (5). Place top plate (3) on the dummy load cell and fix the retaining plates (4) by hex bolts M8X25 (6) as shown in the figure. With struts in position, lift the dummy load cell assembly by suitable means and position it between flanges at specified location and position it at the centre of the strut to minimize the effect of eccentric loading. Weld the top plate and bottom fixing plate to the strut flanges as shown in figure 2. Repeat procedure for other locations also.

Remove the retaining plates (4) by unscrewing the bolts M8X25 (6). Remove the dummy load cell from bottom fixing plate by unscrewing the bolts M10X45 (5). Place the load cell ELC-150 S-H 5000 kN with bottom plate (refer figure 3) on the bottom fixing plate (pre-welded with the strut) and fix the whole assembly by the hex bolts M10X45 to the bottom fixing plate. Mount the retaining plates on top plate (pre-welded with the strut) and bottom fixing plate to align the whole assembly if required.



**Figure 2**

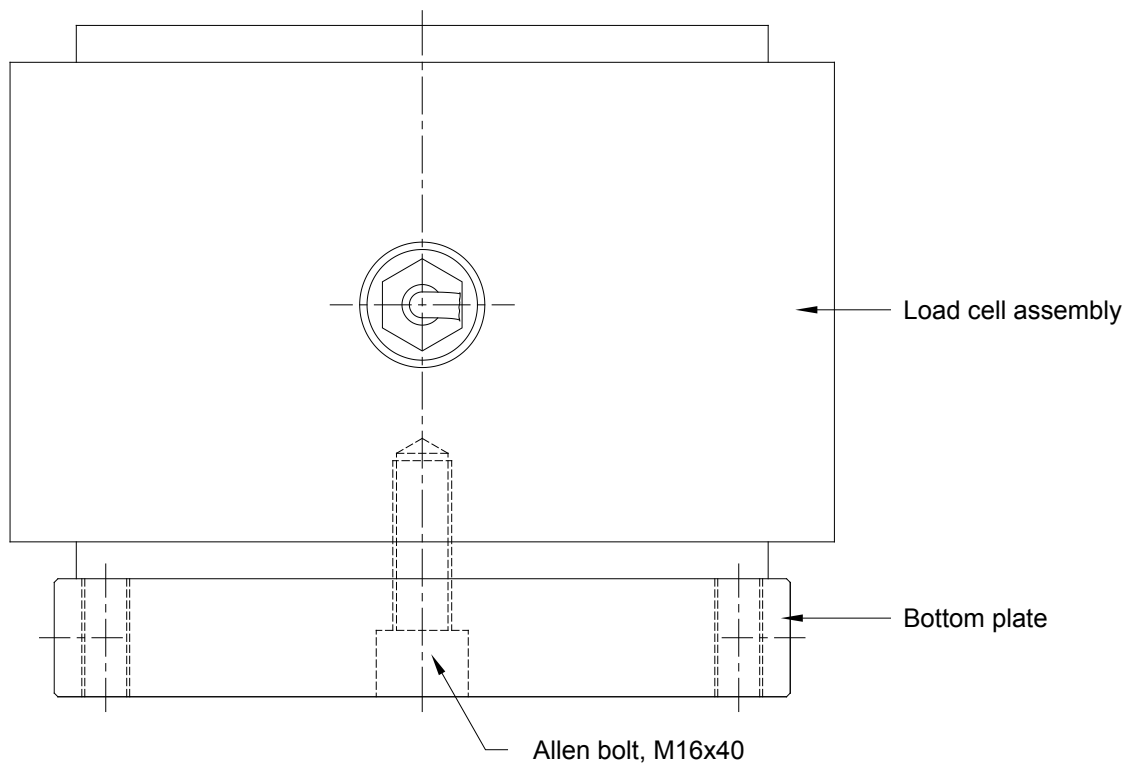


Figure 3

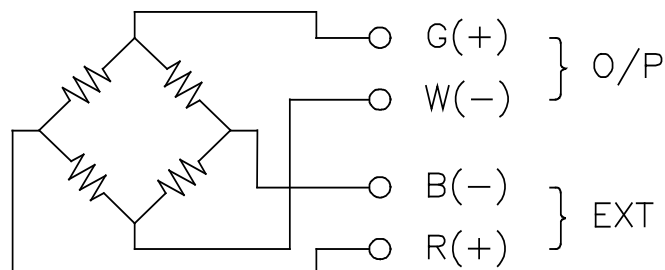


Figure 4

**CAUTION:** Take care that heating during welding to the support plates does not damage load cells. Rags soaked in water must be wrapped around the load cells to avoid unnecessary increase in temperature during welding. Use a dummy load cell assembly as shown in figure: 2 to avoid such type of damages.

**NOTE:** Preparing struts suitably for purpose of mounting load cells and providing appropriate tie rods, base plates and support plates are in scope of struts contractor. Tie rods can be of round, flat bars or angle iron.

To install the load cells, it may be necessary to make some structural modifications, which can be discussed with Encardio-rite prior to implementation.

The work in § 2.2 is to be executed by the struts contractor under supervision of Installation personnel.

4.2.3 Remove the two retaining plates once the load cell system is installed. Preload the system to the specified value.

4.2.4 Check the load cell reading. Take corrective action in case the reading is not within the specified

limits.

- 4.2.5 Anchor the signal cable from the load cells to the steel surface using adhesive lined or blind riveted cable clamps as appropriate. Route the cable to the local junction box. To let the adhesive bonds gain full strength, avoid unnecessary handling of the cable for the next 24 hours.
- 4.2.6 Mount a junction cum switch box at a suitable location where the load cell readings can be taken conveniently. It is recommended to mount the switch box on an angle iron framework by making four 13 mm holes at a spacing of 118 mm x 405 mm. Fix switch box with four M12 x 50 mm hex bolts, washers, spring washers and nuts. Protect junction box from rain, wind and sunlight etc. by fixing a protective cover over it.
- 4.2.7 Terminate the load cells cable coming from local junction box into the switch box. The switch box has ten input cable glands. The ones not in use should be kept blocked. A four-pin connector has been provided to assist in taking readings with the EDI-53L read-out unit.

**NOTE:** Sensors, cables and switch boxes should be properly identified with proper tags. Writing serial/code number and location on a strip of paper, placing strip near the item and covering it with a transparent plastic cello tape, can do temporary identification. Use paint for permanent identification, which is necessary to prevent errors in the long run and ease in operation.

**CAUTION:** Care should be taken that installed load cell, junction box, cable and switch box are properly protected against direct sunlight, wind effects, water and mechanical damage caused by normal construction activity, vehicular traffic and vandalism.

Re-check the load cell readings with the EDI-53L read-out unit or with other read-out unit.

Cable laying

#### **4.2.1 General precautions in laying cable**

Careful and skilled cabling is required in the installation of a load cell. The load cell/cable joint and a large part of the cable may be exposed to blasting and construction work. They should be suitably protected. Part of the cable may be permanently embedded and no future access may be available for any maintenance and corrective action.

The procedure for laying of cables differs with individual installations. In general, however, all installations have the following common requirement:

- The cable must be protected from damage by angular and sharp particles of material in which cable is embedded.
- Cables may be spliced without affecting sensor reading; nevertheless splicing should be avoided wherever possible. If necessary, use special cable jointing kits available from the factory.

Precaution must be taken that the cables are properly tagged, onward from the point from which they come out of the load cell. With the best possible precautions, mistakes may still occur. Tags may get lost due to the cable getting accidentally cut. Encardio-rite uses the convention that looking from the junction box or the observation room towards the sensor, the cable from the most distant sensor is always at the left hand side. In that order, the cable from the closest sensor is at the extreme right.

**NOTE:** A simple code for remembering this is "LL-SR". Longer (cable) left, shorter (cable) right when viewing the sensors from the observation room.

**CAUTION:** **Tagging them every 5 m, onwards from the point from which they come out of the load cell, should properly identify all cables.** The tags should be of a non-corrosive material like stainless steel or plastics.

**CAUTION:** Follow the Encardio-rite convention that looking from the junction box or the observation room towards the sensor, the cable from the most distant sensor is always at the left hand side and the cable from the closest sensor is at the extreme right.

Similarly, as an Encardio-rite convention, the cable from the most distant sensor should be connected to the extreme left socket in the junction box. Succeeding cables from the sensors are connected progressively towards the right in the junction box.

Care should be taken that the wiring is neat and professional. If necessary all cables should be passed through MS/Copper/PVC solid or flexible tubing that should be clamped to the main frame at suitable intervals. The guiding principle should be to protect cable from any damage.

### **4.3 Trouble shooting**

Once installed, remedial action is limited. Maintenance and trouble shooting is consequently confined to periodic checks of cable connection and functioning of the read-out unit. Refer to following list of problems and possible solutions should problems arise. For any additional help, consult factory.

#### **4.3.1 Symptom: Load cell reading unstable**

- Check insulation resistance. Resistance between any lead and outside casing should be  $> 500 \text{ M Ohm}$ . If not, cut a meter or so from end of cable and check again.
- Check if portable digital indicator works with another load cell? If not, the indicator may be malfunctioning. Consult manual of indicator for trouble shooting instructions.
- Use another portable digital indicator to take the reading.
- Check if there is a source of electrical noise nearby? General sources of electrical noise are motors, generators, transformers, arc welders and antennas. If so shielding from electrical noise could reduce problem.

#### **4.3.2 Symptom: Load cell fails to read**

- Cable may be cut or crushed? Check resistance between leads by a digital multi-meter. It should be  $1540 \text{ Ohm} \pm 5 \%$  between the red/black leads and  $1400 \text{ Ohm} \pm 1 \%$  between the green/white leads. If the cables are long, please add cable resistance when checking resistance (multiply by 2 for both leads). If resistance reads infinite or a very high value, a cut in the cable is suspected. If resistance reads very low ( $< 100 \text{ Ohm}$ ), a short in cable is likely.
- Check if portable digital indicator works with another load cell? If not, the indicator may be malfunctioning. Consult manual of strain indicator for trouble shooting instructions.
- Use another portable digital strain indicator to take the reading.