Bassett Convergence System

Applications

The Bassett Convergence System (BCS) is used to monitor tunnels for potential damage from nearby construction activities.

Operation

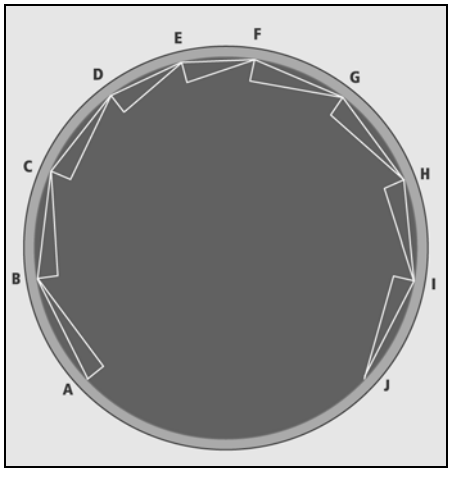
The BCS monitors the movement of reference points that are mounted on the tunnel lining. The reference points are aligned to a plane that is normal to the axis of the tunnel.

A system of articulated arms links each reference point to the next and forms a series of virtual triangles, as shown in the drawing.

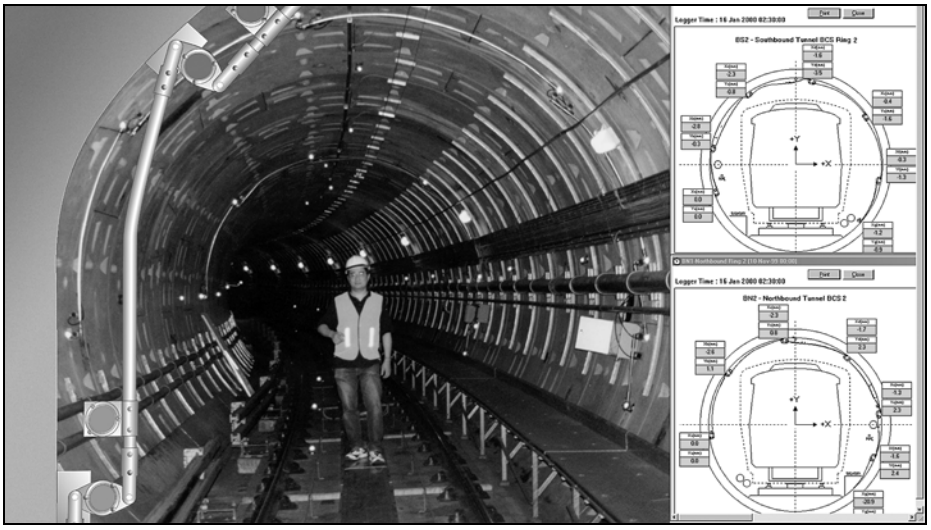
A tilt sensor is mounted on each arm. Spatial displacement of the reference points moves the arms and results in changed tilt readings.

Tilt readings are recorded by a data logger and retrieved at scheduled intervals by a remote computer. The readings are then processed by BCSWin software and the resulting displacement data are displayed in graphic or tabular form.

The system can operate in near-real time. A complete set of tilt readings can be recorded in about five seconds, and the remote computer can update the graphic display in just a few seconds more.



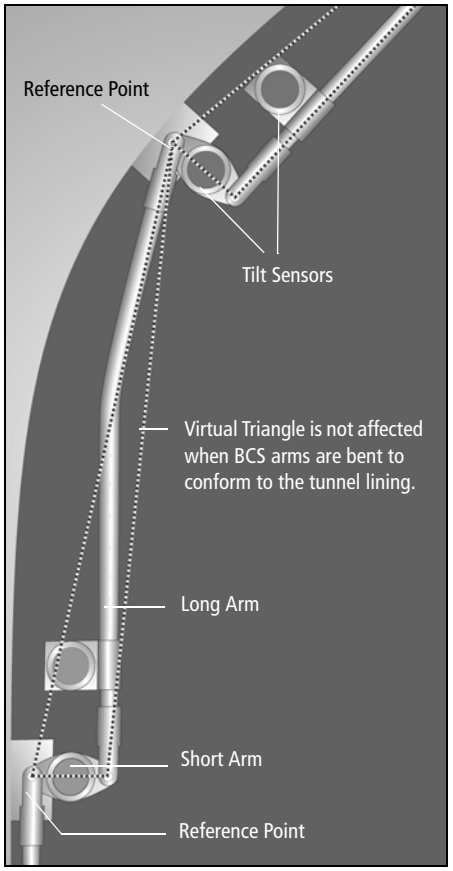
The BCS can perform a survey of the tunnel section in about five seconds and provide near-real time X and Y displacement data for each reference point.



Four Bassett Convergence Systems are installed in this light rail system in Kuala Lumpur. The low-profile design allows normal operation of the tunnels. Screen graphics at right are produced by BCSWin software. Displacements are displayed in color-coded boxes that change from green to yellow to red as displacements increase.

Advantages

- The BCS is designed specifically for tunnels. The system fits close to the tunnel wall and does not interfere with normal traffic. Arms can be shaped to provide extra clearance or to bypass obstructions.
- Unlike optical systems, the BCS has no line-of-sight requirements and can be installed around corners. In addition, the BCS is not affected by changes in the refractive index of air caused by passage of a train.
- The BCS easily accommodates normal tunnel traffic, vibration, temperature changes, and electromagnetic emissions.
- The BCS can complete a survey of a tunnel section, process the readings, and generate displacement data in seconds. This is important for the protection of trains and passengers when nearby construction may damage the tunnel.



Two sides of the virtual triangle have fixed lengths, and two tilt sensors monitor changes in tilt. From this, changes in the length and position of the third side of the triangle can be calculated. Displacement data are accumulated from one triangle to the next to calculate the absolute position of each reference point.

BCS REFERENCE POINTS

Pivot Pin 56806310
Mounting Bracket 56806350
Collar with Set Screw 16806072

There are many possible ways to configure the Bassett Convergence System, but experience has shown that best results are obtained no more than 12 reference points, with a distance of no more than 1.5 meters between points.

Each monitored point requires one pivot pin and one mounting bracket. In an open loop system (the most common), termination of the last arm requires one pivot pin, one mounting bracket, and one collar with set screw.

BCS ARMS & SENSORS

Short Arm 56806250
Short Arm Sensor 56806200

Long Arm Tubing 16804250
Long Arm Sensor Mount 56806150
Long Arm Sensor. 56806100

Each monitored point requires two arms, a short arm and a long arm. The short arm consists of a short arm and an short arm sensor. The long arm consists of tubing, a long arm sensor mount, and a long arm sensor. Tubing for the long arm is supplied in 10' lengths and is cut to the required length at installation time.

Sensor Type: Uniaxial electrolytic tilt sensor.

Range: ±10° for short arm sensor, ±2° for long arm sensor.

Resolution: 9 arc seconds for short arm sensor, 3.6 arc seconds for long arm sensor.

Linearity: ±0.3 mm per meter for short arm sensor, ±0.1 mm per meter for long arm sensor, both at 20 °C using a 5th order polynomial curve fitting and temperature compensation.

Accuracy: Factors affecting accuracy are the number of points and the diameter of the tunnel. Installation factors, such as alignment of the arms, also affect accuracy. Typical accuracy for a 6 or 7 point system with a 30 to 35 foot perimeter is ±0.5mm (±0.02 inch) or better.

SIGNAL CABLE

Signal Cable 50613527
Nylon Cable Tie 02840004

Order cable for each sensor. Cables are tied to the tunnel lining when possible and must be directed to the data logging system at one side of the tunnel.

Dr. Richard Bassett installing the original BCS in a London Underground tunnel.

BCS SOFTWARE

BCSWin Program 55500108
BCSWin Configuration 95500108

BCSWin is a data reduction, processing, and presentation program. It applies sensor calibration factors, performs necessary calculations, and generates the screen displays for up to 99 BCS rings.

BCSWin Configuration customizes BCSWin for a particular site, organizing sensors, calibration factors, gauge lengths, coordinates, calculations, graphics, and presentation screens.

DATA LOGGER COMPONENTS

CR10X Data Logger. 56701110
PS12LA Power Supply 56703120
AC Adapter, 90 to 260 VAC 56703124
SC32A Serial Interface 56704010
Interface Cable 50306872
ENC 16/18 Enclosure 56705020
AM16/32 Multiplexer 56702110
Com200 Telephone modem. 56704410
LoggerNet Software 56708020

Required CR10X components include the CR10X data logger, a power supply with an AC adapter or large capacity battery, an SC32A serial interface and interface cable for communication with PC, one AM16/32 multiplexer per 8 measured points (there are two sensors per point), and weatherproof enclosures for all logger components. Typically a telephone modem is included so that data can be retrieved without visiting the logger.

LoggerNet software is required for each data logging system. It is used to write and compile monitoring programs, transfer programs to the data logger, and retrieve data by direct wire or modem.

See the data sheet for the CR10X data logger for more details.

Durham Geo Slope Indicator, 12123 Harbour Reach Drive, Mukilteo, WA, 98275 USA
Tel: 425-493-6200 Tel: 866-916-0541 Fax: 425-493-6250 Email: solutions@slope.com

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DURHAM GEO SLOPE INDICATOR