



**GOMACO**® *The Worldwide Leader in Concrete Paving Technology*

# The GSI® – GOMACO's Non-Contact Profiler

## Paver-Mounted, Work Bridge-Mounted or the GSI Machine

HW-011203.D14



CC-051129.D2

Two paver-mounted GSI units provide instant rideability results on Interstate 75, near Pinconning, Michigan.

### What is the GSI?

- A non-contact surface smoothness instrument that is so versatile it provides multi-application usage.
- The GSI includes: GSI computer assembly, real-time graphic display, media storage card, two sonic sensors, slope sensor, distance counter wheel assembly, and cables.

### How is it done?

- Three different sensors, two sonic and one slope, read the smoothness data in the wheel tracks (or anywhere on the surface of the slab) on up to eight

traces or four lanes in one pass. The readings are from a six inch (152 mm) footprint to simulate the true picture of the tire contact area on the pavement. The information gathered by the sensors in each trace establishes a measurement of the slab.

### What can the GSI do?

- Provides immediate data to make on-the-go adjustments, if necessary, to assure maximum smoothness results.
- Gives immediate graphic display as to smoothness of the surface.

- Locates irregularities (localized roughness) in the slab that need to be corrected and records that location through the use of a distance tracking encoder.
- Concrete surface can be repaired while still in the plastic state.
- Can read multiple traces simultaneously with the addition of more instruments.
- Smoothness readings can be seen before saw cuts are made for joints and tining or the texturing of the slab.

- Data gathered is used to produce commercially known profilograph indexes.
- Printout of surface smoothness includes station or footage reference from starting station, job information, bump location, and profile index numbers.

### What additional features does the GSI machine have available?

- The GSI machine can be used to check the accuracy of stringline setup before the actual paving takes place.
- Checks accuracy of the sub-grade to obtain maximum yields and determines potential smoothness of the final slab before paving (based on the sub-grade).
- Provides the ability to study the smoothness of the slab during the curing process for future research on mix designs.
- The GSI machine's automated steering capability guarantees the highest repeatability and accuracy in the industry.

### Who would want to use the GSI?

- Paving contractors
- Flat floor slab contractors
- Consulting engineering firms
- DOT (Department of Transportation)
- Federal highway authorities
- FAA

In today's competitive concrete paving market, with increasingly stringent rideability requirements, GOMACO offers a tool to help you achieve maximum paving results...  
**the GOMACO Smoothness Indicator (GSI®).**

The GSI, operating as paver-mounted, work bridge-mounted, or the independent GSI machine, has the ability to monitor and report your smoothness readings to you instantly. It's the ultimate quality-assurance tool available on the market today.

The GSI has the ability to read up to eight traces in a single pass, directly behind the paver. The real-time information collected creates the GSI number, or an instant rolling average of the surface smoothness readings. The GSI number is relative to the IRI (International Roughness Index) number, but created within a much shorter paved distance. That distance can be adjusted by the operator. Along with the GSI number, two other indexes are also calculated continually, the PI or profile index, which is based on the California profilograph, and the IRI. The information can also be exported as an .erd file. The indexes are

derived from the true profile of the surface, determined by the data collected. These indexes are viewed and monitored on the GSI's seven inch (178 mm) diagonal, touch-screen monitor. The touch screen, with adjustable mount, allows optimum viewing.

The on-the-go surface smoothness information includes station and footage documentation for later reference of bump and smoothness locations. The GSI's bump alarm can be set with project parameters. If a bump, localized roughness, occurs during paving that is out of parameter, a bump warning is displayed and the bump's station location is marked on the graph for exact reference.

The GSI's feedback allows on-the-go adjustments to fine-tune the paving operation. You instantly know how changes to a number of different paving variables directly affect the

quality of your ride. Instant results eliminate having to wait until the cured concrete has been profilographed, to see how the ride has been affected by the variables.



GSI units can be mounted to GOMACO Spanit® work bridges. In these photos, the work bridge is attached to the back of a GOMACO GHP-2800 slipform paver.



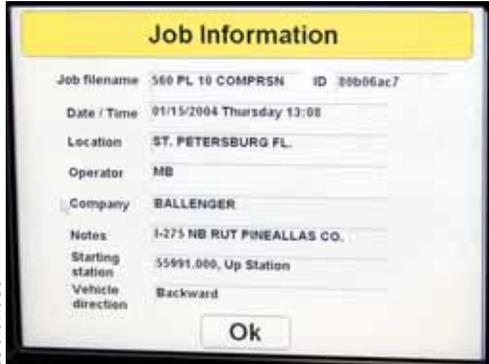
The GSI machine follows a GOMACO GP-4000 paver, right behind the finishers, on the Central Texas Turnpike. The GSI takes smoothness readings simultaneously from four different traces and uses the data to establish a measurement of the slab.

EG-010819 D2

EG-010819 D6

HW-050531 D28

Screen shots taken during the paving process illustrate the many different screens and the variety of information available, at the touch of a fingertip, on the GSI's touch-screen display.



EG-010410 D8

Part of calibrating the system is entering job-site information into the GSI's computer.



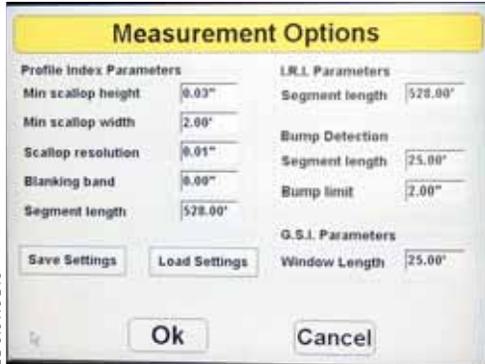
EG-010410 D12

This stretch of roadway posted some good numbers on the IRI index.



EG-010410 D13

Two different sensor traces can be displayed on the computer's screen at a time.



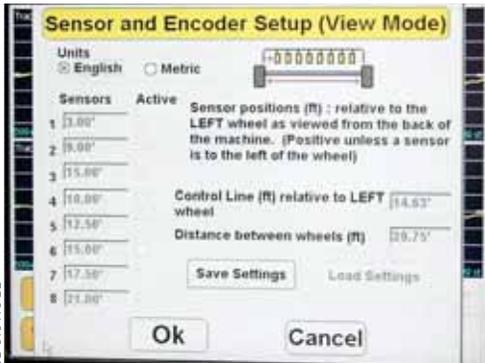
EG-010410 D10

The GSI provides ride numbers for three different indexes with this set-up screen.



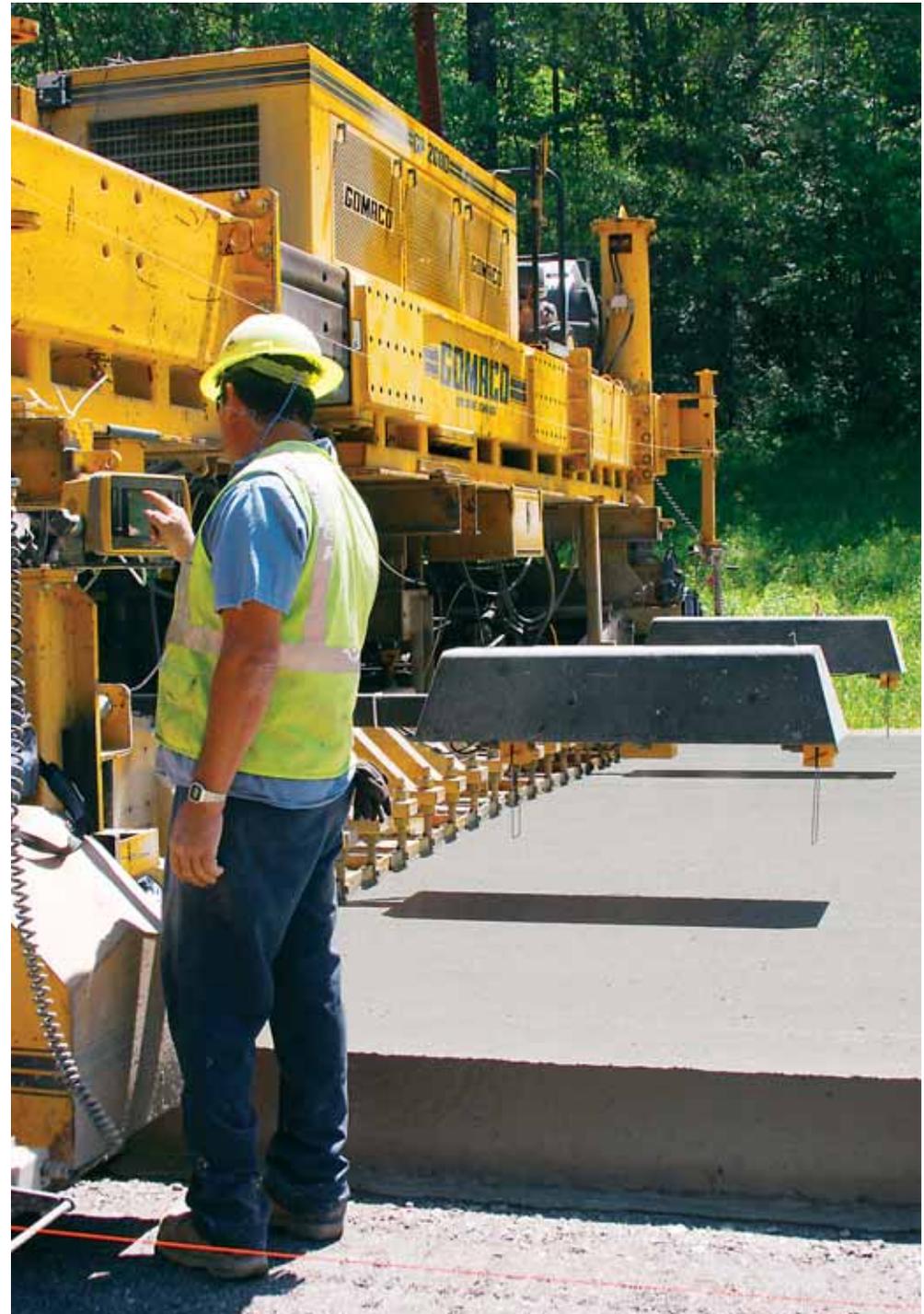
EG-010410 D11

A trace shows how this section of roadway did using the two-tenths blanking band.



EG-010410 D2

Sensor positioning has to be measured out so the GSI computer knows what it's measuring.



HW-051111 D8

Two paver-mounted GOMACO GSI units monitor the smoothness in each driving lane. The information is instantly displayed and reviewed on a single touch screen mounted on the side of the paver.



HW-051113.D5

The paver-mounted GSI was a powerful diagnostic tool as a contractor worked in Alabama to fine-tune their paving process for a challenging rideability specification.

## Paver-Mounted GSI® –

Immediate smoothness readings are available with the GSI on-board your paver. The paver-mounted GSI is a cost-effective quality control tool that is quick and easy to install on your GOMACO paver. Since it's on-board the paver, any interference with the rest of the paving train or finishing crew is minimal. It also has the capability of reading multiple traces, from one to eight.

GOMACO is experiencing an increased demand for the paver-mounted GSI as a tool for checking rideability on-the-go.

The effectiveness and quality of the GSI has been verified by contractors on projects around the world and by independent studies. The GSI recently completed a three phase research project by The Strategic Highway Research Program (SHRP2) for the Transportation Board of the National Academies. The study, in phase one, set out to identify real-time smoothness measuring technologies for concrete paving. Phase two and three consisted of field demonstrations and evaluations.

The following are some published observations and results on how well the GSI performed in the study...

*The consensus among the contractors was that the GSI's real-time smoothness measuring technology represents a valuable quality control tool. Examples of intentional process changes that can be evaluated include:*

- *Equipment adjustments*
  - Paver speed
  - Vibrator frequency
  - Sensitivity of paver evaluation controls
  - Oscillating correcting beam frequency
  - Numerous others
- *Process changes*
  - Concrete workability
  - Concrete dumping/spreading procedures
  - Stringline tension
  - Hand finishing techniques
  - Mixing time
  - Stopping the paver vs. slowing the paver
  - Numerous others

*The report also goes on to say that the GSI is also a powerful diagnostic tool; similar to equipment used by automotive*



HW-111106.D14

GSI units mounted to a GHP-2800 profile new Interstate 69 in Indiana.



HW-111010.D16

The GSI display, mounted at eye level on the side of the paver, offers a variety of viewing options of the information collected by the GSI.

*technicians to identify needed auto repairs. The current state of practice is to cautiously make an equipment/process change and wait approximately 24 hours for feedback when the hardened pavement can be profiled. With the GSI, the process becomes instant.*

On a paving project in Alabama, a GOMACO contractor equipped their two-track GP-2600 with two paver-mounted GSI units. Strict ride specifications allowed no room for error, so they spent three days fine-tuning their paver and their paving

processes. Changes were tracked on the GSI's Event Log, which allows important events such as sensitivity changes, draft changes and more to be marked on a graph. The entire list of marked changes can be reviewed. Then, the instant feedback from the GSI showed them what each change was doing to their concrete. They knew right away if the change had improved their quality or hurt it. No 24-hour wait was involved before a profilograph could be run on the new concrete roadway.



EG-010826.D6

A paver-mounted GSI unit provides immediate monitoring to assure proper paver setup and performance or examine for corrective measures that need to be taken.



EG-010811-D2

The GSI Grade Analysis Tool builds a profile of the grade and estimates the concrete yield of the project.

## GSI® Tools™ – Grade Analysis

A GSI trace over a prepared grade for paving can provide a complete grade analysis with our GSITools software. This software provides a cut and fill report for final grade preparation and can build a profile of the grade to estimate the concrete yield of the project.

The following is an overview of the Grade Analysis Tool features:

- Grade Analysis Report  
Selected profiles | Trace details | Slab volume | Project parameters |  
Grade cut/fill summary | User selected graphs
- Project Trace Selection  
Add/delete reference (stringline or stringless) traces | Add/delete wheel path traces
- Project Parameters  
Slab definition | Grade cut/fill parameters | Sensor positions | Grade offsets
- Table View  
Elevation data | True profile data | Grade cut/fill details | Grade cut/fill summary
- Graph View  
Elevation | True profile | Grade cut/fill details

## GSI Tools - Grade Analysis Report

Project File Name: GradeAnal1.gtp  
Report Date: 2/16/2005 10:55:12

### Selected Profiles

#### Stringline

#	ID	Filename
1	SL_1	DAY 9 SMOOTH.SL1.ERD
2	SL_2	DAY 9 SMOOTH.SL2.ERD

#### Wheel Path

#	ID	Filename
1	WP_1	DAY 9 SMOOTH.T01.ERD
2	WP_2	DAY 9 SMOOTH.T02.ERD
3	WP_3	DAY 9 SMOOTH.T03.ERD

### Trace Details

Data Points	Length	Start Station	End Station
7286	1214.33 ft	87+75 st	75+61 st

### Slab Volume

Name	Value
Slab Volume (1214.33 ft x 24.00 ft x 1.00 ft)	29144.00 ft <sup>3</sup>
Volume Deviation	210.55 ft <sup>3</sup>
Total Volume (Slab Volume + Deviation)	29354.55 ft <sup>3</sup>

### Project Parameters

Name	Value	Units
Slab Depth	12.00	IN
Slab Width	24.00	FT
Cut Max	0.05	IN
Fill Max	-0.05	IN
Stringline Width	30.00	FT
Sensor 1 Position	6.00	FT
Sensor 2 Position	12.00	FT
Sensor 3 Position	18.00	FT
Sensor 4 Position	24.00	FT
Sensor 5 Position	30.00	FT
Sensor 6 Position	36.00	FT
Sensor 7 Position	40.00	FT
Sensor 8 Position	46.00	FT

### Grade Cut/Fill Summary

#	Start Station	End station	Type	Length(ft)	Volume(ft <sup>3</sup> )	Max Depth(in)	Trace
1	87+46 st	76+01 st	FILL	1145.33	336.62	-0.10	WP_3
2	87+15 st	87+06 st	CUT	8.50	-1.84	0.06	WP_1
3	87+05 st	86+47 st	CUT	58.00	-12.68	0.06	WP_1
4	86+45 st	86+43 st	CUT	2.83	-0.62	0.05	WP_1
5	86+42 st	84+41 st	CUT	200.83	-54.72	0.09	WP_1
6	84+41 st	84+09 st	CUT	32.50	-7.36	0.06	WP_1
7	84+04 st	82+28 st	CUT	176.67	-42.25	0.07	WP_1
8	82+12 st	81+60 st	CUT	52.00	-11.51	0.06	WP_1
9	81+58 st	81+48 st	CUT	9.83	-2.13	0.06	WP_1
10	81+42 st	81+40 st	CUT	2.67	-0.57	0.05	WP_1
11	81+31 st	81+29 st	CUT	3.00	-0.64	0.05	WP_1
12	81+24 st	81+22 st	CUT	2.33	-0.52	0.05	WP_1
13	81+20 st	81+18 st	CUT	2.33	-0.51	0.05	WP_1
14	81+10 st	81+08 st	CUT	2.17	-0.47	0.05	WP_1
15	80+94 st	78+16 st	CUT	277.33	-67.33	0.07	WP_1
16	78+14 st	76+97 st	CUT	116.83	-25.92	0.06	WP_1
17	76+96 st	76+93 st	CUT	3.00	-0.65	0.05	WP_1

**GSI 3D** File Tools Help

Total Station Tracking Data(m)

TPS	X	Y	Z	Tracking	Thread	Bad
1	0.000	0.000	0.000	No	0	0
2	0.000	0.000	0.000	No	0	0
Cur	0.000	0.000	0.000	No	0	0

Total Station Selection  TS=1(Unchecked), TS=2(Checked)

Sonic Sensors

	1	2	3	4	5	6	7	8
1/400ft	0	0	0	0	0	0	0	0
m	4524...	1548...	0.000	1060...	0.000	0.000	0.000	0.000
ft	0.000	0.000	1553...	0.000	1078...	1492...	1068...	1086...
Status	NoData							

Slope Sensor Data

Axis	Slope %	Degrees °	Radians	Status
Cross Slope	0.000	0.000	0.000	No Data
Long Slope	0.000	6113776...	0.000	No Data

Start MGuide

Sensor Sensor World Coordinates

#	X	Y	Z
1	0.000	0.000	-4524172...
2	0.000	0.000	-1548345...
3	0.000	0.000	-0.000
4	0.000	0.000	-1060809...
5	0.000	0.000	-0.000
6	0.000	0.000	-0.000
7	0.000	0.000	-0.000
8	0.000	0.000	-0.000

History Complete  
Machine Direction

Direction: 1.571  
Orientation: 0.000

# GSI® – Survey Tool

With the GSI Survey Tool, a GSI trace over an existing roadway can provide data for a 3D model in an overlay application. The GSI will collect the data with multiple traces (up to eight) in a single pass for the pave model. The GSI operates with a prism mounted to the machine and a Total Station located on a hub. This data collection provides Eastings, Northings, and Elevations for the pave model. This single pass with the GSI on a project totally eliminates the tedious handwork of two survey engineers and provides an accurate visualization of an existing roadway for a 3D model to be used for stringless paving of an overlay project.



The GSI profiles the grade with 3D stringless controls. Each trace collects the X, Y, and Z positions needed to create a true 3D map of the terrain.

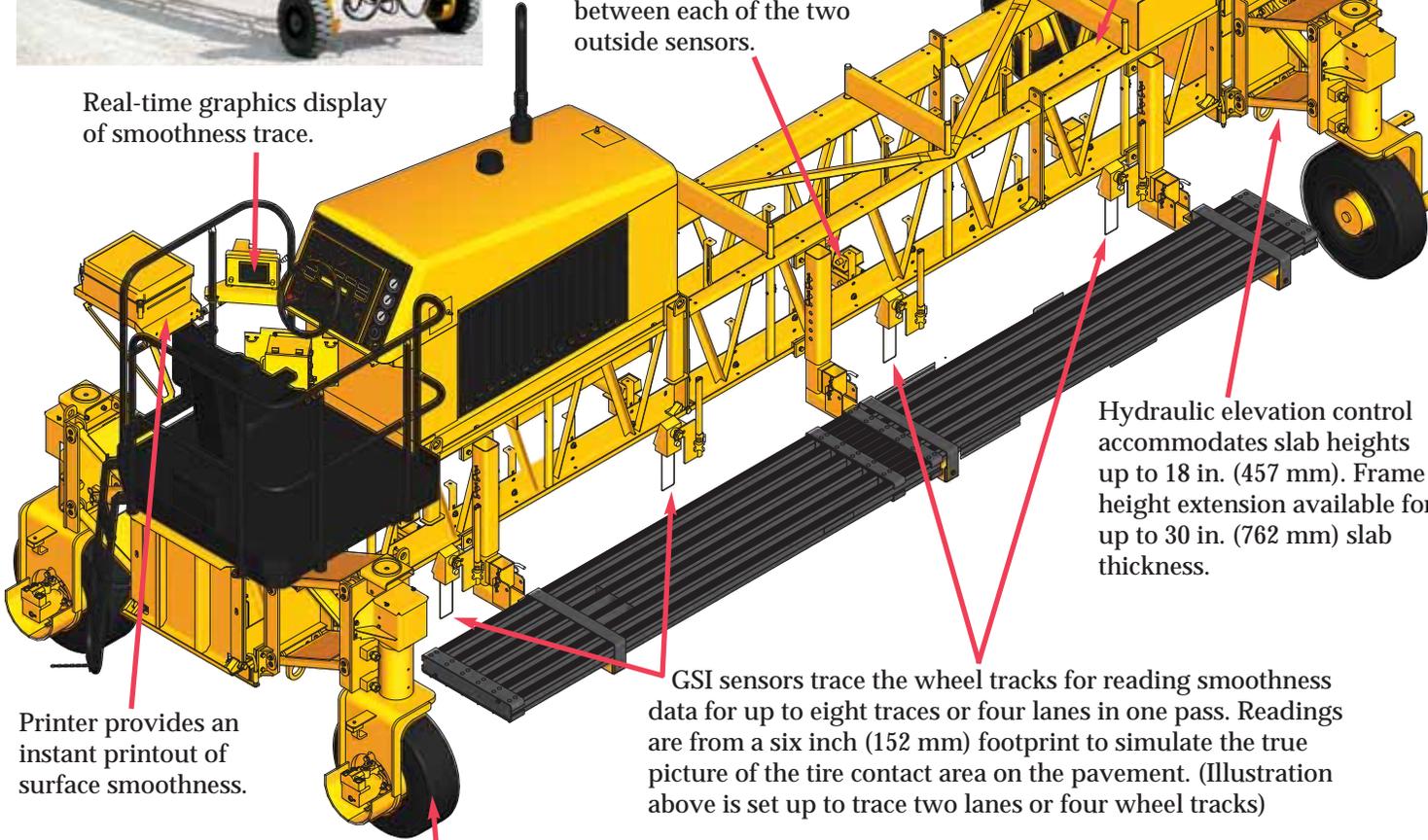


The GSI in transport mode easily travels around the job site.

Real-time graphics display of smoothness trace.

Slope sensors are located between each of the two outside sensors.

Lightweight, modular truss frame.



Printer provides an instant printout of surface smoothness.

Hydraulic elevation control accommodates slab heights up to 18 in. (457 mm). Frame height extension available for up to 30 in. (762 mm) slab thickness.

GSI sensors trace the wheel tracks for reading smoothness data for up to eight traces or four lanes in one pass. Readings are from a six inch (152 mm) footprint to simulate the true picture of the tire contact area on the pavement. (Illustration above is set up to trace two lanes or four wheel tracks)

Heavy-duty, industrial puncture-proof, solid tires.

## GSI® Machine Specifications:

**Engine:** 4024T John Deere diesel engine, 60 hp (44.8 kW), Tier 2.

**Frame:** Pin-connected main frame. Standard frame length is 30 ft. (9.14 m).

**Automated Steering Control System:** Electronic/hydraulic forward and reverse steering control system. Control panel with monitor gauges.

**Hydraulic Leg Assemblies.**

**Four Wheel Suspension:** Hydraulically driven, all wheel steering, wheels turn 90 degrees for loading or moving the machine.

**Tires:** Solid rubber tires, 28 in. (711 mm) x 9 in. (229 mm) R15 in. (381 mm) wheel.

**Steering:** All-wheel steer.

- Coordinated four-wheel steer (operational & transport mode)
- Crab-steer (operational & transport mode)
- Front-steer only (operational & transport mode)
- Rear-steer only (operational & transport mode)
- Counter-rotate (operational mode)
- Stringline steer (operational mode)

**GSI Computer Assembly:** includes real-time graphics display, computer assembly, media storage card.

**Four Wheel Track Sensor Assemblies:** includes eight sonic sensors, slope sensors, mounting brackets and cables. Sensors trace the wheel tracks for reading smoothness data for two lanes.

**Operators Platform:** includes seat assembly.

**Emergency Stop Switches.**



The Worldwide Leader in Concrete Paving Technology

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