



## Port of Baltimore Finishes a Project Triple-Header



### *Good Things Come in Threes*

In a package of three areas, The Port of Baltimore, Maryland placed an additional 1.5 million sf (150,000 m<sup>2</sup>) of concrete pavers in 2001. Three recently placed areas have now brought the total area at the Port to about 1.9 million sf (190,000 m<sup>2</sup>). Baltimore ranks with the Ports of Oakland and Freeport (Bahamas) in that all three now have similar sized areas of concrete pavers for heavy loads.

#### **Old and New Terminals Benefit**

The Port operates several public shipping terminals and leasing to private operators as well. Two of the busiest public terminals, Dundalk and Seagirt, use concrete pavers. With 13 berths and 12 cranes, the 570-acre (231 ha) Dundalk Terminal handles just about everything that can be stacked or rolled in a ship; containers, automobiles, farm and construction equipment, wood pulp, and steel. Big roll-on/roll off vessels deliver or pick up cars, tractors, construction equipment, or anything else that moves under its own power into and out of the ships.

#### **Rehabilitated Pavement for Dundalk**

About 530,00 sf (53,000 m<sup>2</sup>) of concrete pavers were placed at Dundalk in berths 8 and 11 that receive deliveries of steel-tracked construction equipment. To achieve this, a 6 in. (150 mm) layer of the existing asphalt was removed along with the concrete pads. The space left by the removed concrete pads was filled with asphalt. Then an inch (25 mm) thick of bedding sand was placed, and the 5 in. (120 mm) thick concrete pavers.

The engineering consulting firm, Moffatt & Nichol Engineers in Baltimore provided the design and specifications for the paver projects, and has done so for previous interlock-

*Over a decade of use: Seagirt at the Port of Baltimore was one of the first American ports to use concrete pavers for container handling areas. The first installment shown here in 1989 included 230,000 sf (23,000 m<sup>2</sup>) that paved the wharf area under the giant cranes.*

ing concrete pavement projects. According to Bill Wheaton, P. E., Project Engineer with Moffatt & Nichol, “The concrete pavers replaced the existing concrete and asphalt to offer increased abrasion resistance from steel-tracked vehicles.” No pavement surface is entirely resistant to steel tracks, so the pavers still will see some abrasion wear from the steel tracked equipment. However, the modular nature of the pavers makes them less expensive to replace than asphalt or poured concrete. Worn spots can be repaired with minimal interruptions in the yard operations.

**Continued Paving for Seagirt**

Opened in 1990, Seagirt, a 275-acre (111 ha) parcel consists of a 140 acre (57 ha) container terminal boasting seven, 20-story high-speed cranes to load and unload the largest, (post Panamax) container ships. The initial construction of the wharf in the late 1980’s included 230,000 sf (23,000 m<sup>2</sup>) of concrete pavers under the giant cranes. Adjacent to this area is a 70-acre (28 ha) Intermodal Container Transfer Facility with rail service enabling intermodal (train-truck) transfer of containers 24/7. It’s the backyard of Seagirt where much movement occurs of the containers.

In 1997, the Port initiated a US\$10.7 million expansion of Seagirt Berth 4 with a new yard for containers and truck chassis. The November 1997 issue of this magazine reported on its construction (“Port of Baltimore Goes Again with Pavers”). The yard stores truck chassis and a few containers. The pavement is performing well, showing little signs of distress while preventing static indentation from chassis supports that typically occurs in asphalt pavement. The pavement is designed for much higher loads associated with container handling that it will likely experience in the future.

Berth 4 continued expansion this year with over 600,000 sf (60,000 m<sup>2</sup>) of concrete pavers placed in a new area. The project really started about 19 years ago when land for the pavement was reclaimed from the Chesapeake Bay during the initial construction the I-95 Fort McHenry Tunnel. Like most dredged bay soils, the material at Seagirt wasn’t the best for supporting pavements. Bill Wheaton noted that the area had the worst soils of all areas developed over the past several years. Importing better soil from elsewhere for the entire area wasn’t economical. In 1994, the Port sought to improve the quality of the stockpiled soil by having selected weak portions removed.

In 1997, a 5 ft. (1.2m) layer of sand on geotextile was placed as sur-



*In 1997, the next install installment was about 560,000 sf (56,000 m<sup>2</sup>) at Seagirt, now used for storage of truck chassis.*



*Truck trailer legs place point loads on the four year old interlocking concrete pavement with no damage in most areas.*



*Like the past projects, recent construction of paving at Seagirt used mechanical equipment placing concrete pavers manufactured and stacked in the final laying pattern.*



After an area was paved, large plate compactors like these compacted the concrete pavers into the bedding sand. The machines were also compacted the units again after the joints were filled with sand.



The contractor used a large sweeper to spread the fine sand into the joints between the millions of concrete pavers.



High abrasion resistance to steel tracked equipment is why over a half a million square feet (over 50,000 m<sup>2</sup>) of concrete pavers were used at Dundalk in the Port of Baltimore.

charge (weight) over the entire area of soil. The weight of the sand slowly compressed the soil and pushed excess water into wick drains in the soil. The weight of sand on the dredged soil caused settlement in the soil as much as seven feet (2.1 m) in some places.

In preparation for building the pavement base this year, the portion of the sand surcharge layer was excavated and a new 30 in. (750 mm) thick layer of select borrow (mostly sandy soil) was placed and compacted over the remaining surcharge and existing wick drains. This layer was placed over geotextile. This compacted layer provided a foundation for a 9 in. (225 mm) thick layer of hot mix asphalt course that was strengthened with a modifier. A 9 in. thick dense-graded, aggregate base was then placed and compacted over the asphalt (see dia-

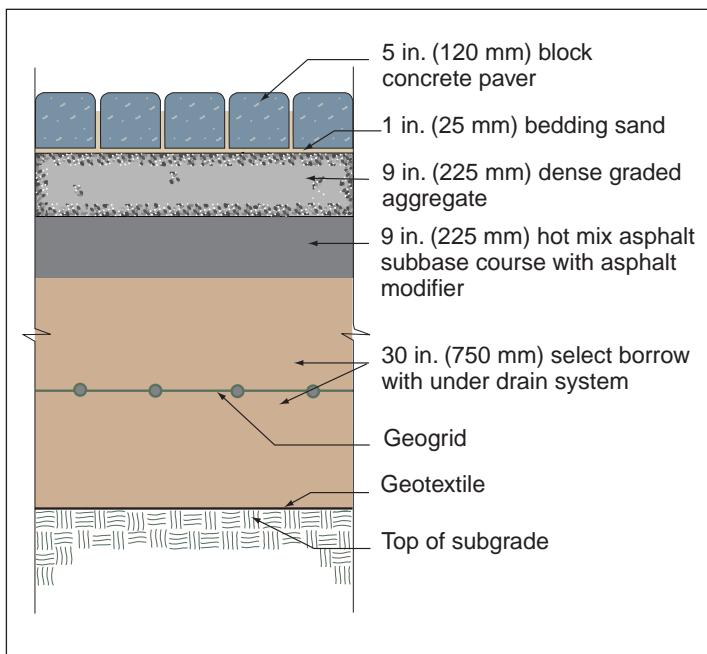
gram). The asphalt subbase included drain holes to allow movement of water through the aggregate base, asphalt, select soil subgrade, and into a drain system routed to the storm water drain pipes.

After completing compaction of the aggregate base, a 1 in. (25 mm) thick bedding sand layer was screeded using powered equipment. Concrete sand was used with essentially no material passing the No. 200 (0.075 mm) sieve. Like the 1997 Seagirt project, the bedding sand under the pavers was evaluated for hardness to help ensure that it would not degrade under concentrated wheel loads from container handling equipment.

### Mechanical Installation Standard for Port Pavement

Mechanical installation equipment was used for paving the Dundalk and Seagirt projects. With trained operators, the equipment lifts and places about a square yard (m<sup>2</sup>) of pavers every 20 to 30 seconds. Each machine can pave about 5,000 to 6,000 sf (500 to 600 m<sup>2</sup>) per day. After a substantial area of concrete pavers is placed on the bedding sand, the units are compacted into it with a large plate compactor. The joints are filled with sand and the pavers are compacted again. The specifications called for proof rolling the entire surface with a minimum 10-ton rubber-tired roller.

ICPI members manufactured and mechanically placed the bedding sand and pavers. As with all paver projects with the Port of Baltimore, the thickness of the pavers used is 5 in. (120 mm). While most ports use 3 1/8 in. (80 mm) and some use 4 in. (100 mm) thick units, the Port of Baltimore was influenced in the mid-1980's by their sister port of Rotterdam, The Netherlands. The European Container Terminal (ECT), a privately owned shipping terminal there has over 20 million sf (2 million m<sup>2</sup>) of 5 in. (120 mm) thick concrete pavers. That entire project was built on land reclaimed from the sea, where constant settlement was expected. The thicker pavers tolerate a



## Paver Projects at the Port of Baltimore

Year	Location	Area sf (m <sup>2</sup> )	Operations
1989	Seagirt Berth 4	230,000 (23,000)	Wharf area
1997	Seagirt Berth 4	560,000 (56,000)	Chassis & container yard
2001	Dundalk Berths 8 & 11	530,000 (53,000)	Ro-Ro
2001	Seagirt Berth 4	620,000 (62,000)	Container yard
<b>Total</b>		<b>1,940,000 (194,000)</b>	

high degree of settlement while remaining serviceable.

### Pavement Design Maximizes Interlock

Some settlement is expected at Seagirt, because the entire area is built from dredged material. Tom Shafer, P. E. with Moffatt & Nichol Engineering and Dr. Matthew Witczak from Arizona State University developed the pavement structure originally designed for the Seagirt pavement area built in 1997. The intent of using the base rather than the asphalt beneath the pavers is to allow for a bit more settlement. A greater amount of interlock is expected which should increase the strength of the paver layer. The 9 in. asphalt layer placed further down in the structure offers some additional dampening of settlement that might occur in the soil subgrade.

The container handling equipment intended for use on the pavers at Berth 4 will be “top picks” that move containers, by grabbing them from the top. When fully loaded, the equipment has wheel loads over 50,000 lbs. (22,700 kgs), five to seven times higher than wheel loads from highway trucks. Mike Hild, P.E., Director of Engineering with the Port of Baltimore, is the main reason why the Port is a repeat user of concrete pavers. According to Mr. Hild, it’s because of their low maintenance. “Once the pavement is built, we don’t want to mess with a lot of maintenance. Repairs costs time and money, and we need as much use of the yards as possible, especially as the container and cargo throughput of the port grows.” ♡



*A massive load of 450,000 lbs. (204,100 kg) rests the concrete pavers at Dundalk in the Port of Baltimore. The rig is carrying a large metal press bound for Indiana for use by the automotive manufacturing industry.*