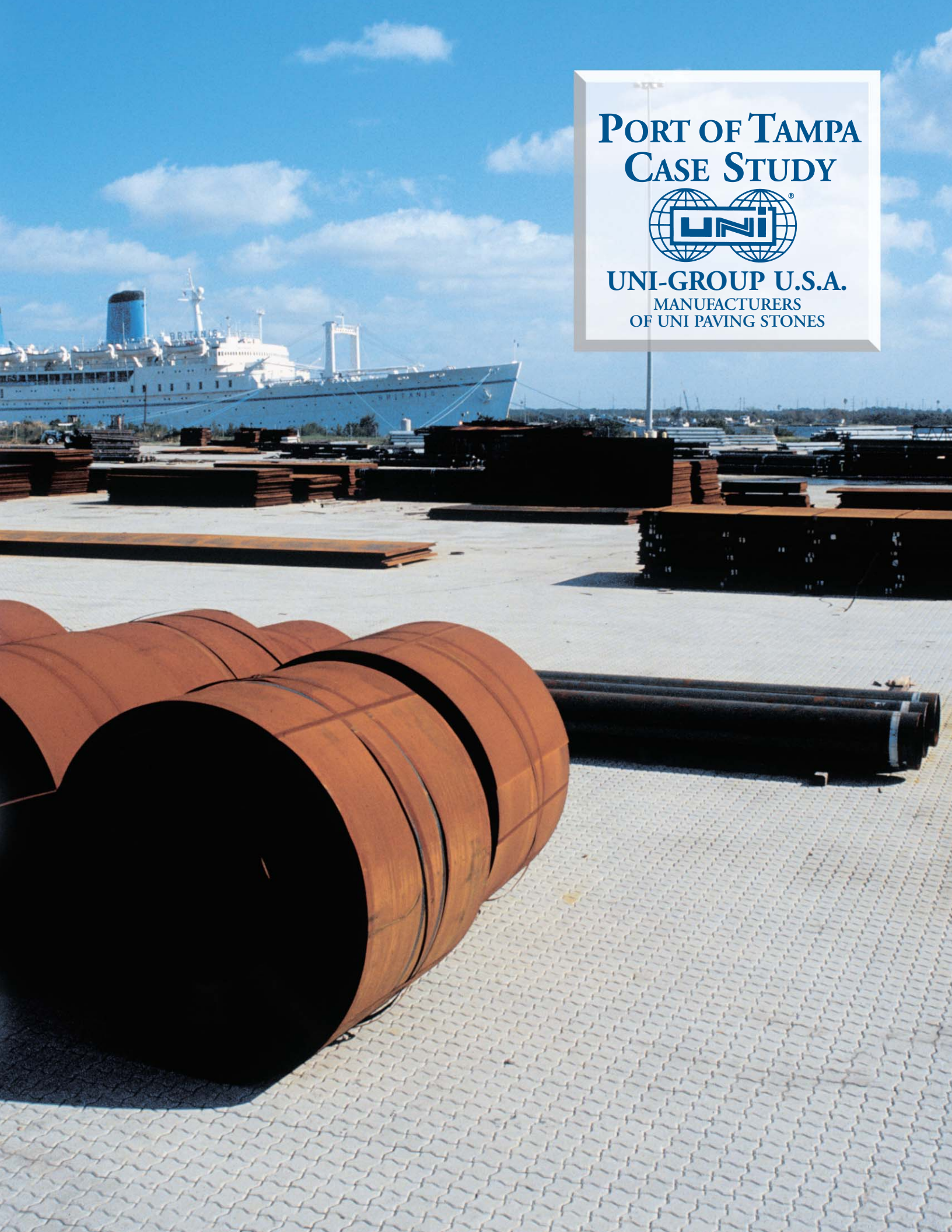


Port of Tampa Case Study

UNI-GROUP U.S.A.

MANUFACTURERS
OF UNI PAVING STONES

PROJECT:
Port of Tampa - Berth 208
Tampa Port Authority, Tampa, Florida

PORT ENGINEER:
Carl E. Fielland, Director of Engineering

PROJECT ENGINEER:
David Volkert and Associates, Inc.
Tampa, Florida

GEOTECHNICAL ENGINEER:
ARMAC Engineers
Tampa, Florida

GENERAL CONTRACTOR:
Kimmins Contracting Corp.
Tampa, Florida

PAVING CONTRACTOR:
Precise Paving, Inc.
West Palm Beach, Florida

CONCRETE PAVER MANUFACTURER:
Paver Systems
West Palm Beach and Orlando, Florida

PAVERS:
3 1/8" (80mm) UNI-Anchorlock®
Natural Grey
Phase I - 530,000 sq ft
Phase II - 218,000 sq ft
Warehouse Facility - 40,000 sq ft

The Port of Tampa, situated on the west coast of Florida on Tampa Bay, is the largest port, per ton, in the state and the 10th largest in the United States. As Florida's deepest port, Tampa handles as much cargo as all of the state's 13 deepwater ports combined. A $100 million infrastructure and capital improvement plan has stimulated growth and development with a focus on bulk cargo, general cargo, ship repair/construction, cruises, and marine recreation.

From 8,000 to 12,000 square feet of UNI-Anchorlock® pavers was installed per day using mechanized paver placement and sand screeding equipment

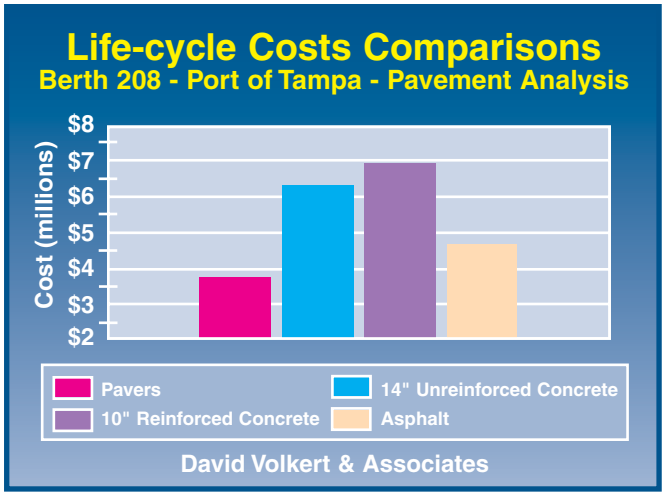


Figure 1

A wide variety of products such as fertilizers, cement, coal, chemicals, petroleum, aggregates, steel, fruit, and poultry are imported from and exported to countries around the world, including Mexico, Japan, India, China, Russia, and Canada. Tampa is also a popular cruise ship port with over 225,000 passengers in 1996 and plans for future expansion.

When the Tampa Port Authority began planning in the fall of 1992 for the upland cargo staging area at Berth 208, where a new 900 foot wharf was scheduled for completion in September of 1994, interlocking concrete pavers were initially not even considered due to the belief that they were for decorative applications only. Research soon proved otherwise. In their abstract "*Selection of a Pavement System for Heavily Loaded Marine Terminal*" for the Ports '95 American Society of Civil Engineers Conference in September 1995, Ross T. McGillivray, president of ARMAC Engineers, Inc. of Tampa, FL, and Carl E. Fielland, director of engineering for the Tampa Port Authority, detailed their pavement research and selection process.

The Authority had previously constructed cargo staging areas utilizing 6 inches (152mm) of asphaltic concrete, placed in two lifts over 18 inches (457mm) of compacted limerock base. However, the performance of the asphaltic pavements had never proven to be completely satisfactory. As a result, it was decided that upgraded pavement systems should be examined for longer-term viability. The pavement systems considered for the 112,620 square yard (94,165 m^2) project included: asphalt with limerock base; unreinforced concrete (356mm) and base; reinforced concrete (254mm) and subbase; and interlocking concrete pavers and base.

An initial evaluation found that based on a 40-year life cycle, the interlocking concrete pavement system would be lower in cost than the unreinforced and reinforced concrete pavements at any time during their lives, while it would be lower in cost than the asphaltic pavement after 6 years. Life-cycle costs comparisons are shown in Figure 1. After visiting the Port of New Orleans, LA, a paver installation of nearly 1 million square feet, it was decided to specify concrete pavers for the Berth 208 cargo staging area.

Paver Systems of West Palm Beach, FL, a member of UNI-GROUP U.S.A., the nation's leading interlocking concrete paver producer organization, worked with Fielland and project engineers David Volkert and Associates, Inc. of Tampa, FL, on the selection of the concrete pavers. After an on-site demonstration at Paver Systems Orlando, FL, manufacturing facility, they chose the patented UNI-Anchorlock® paver. The unique "anchor-interlocking" shape of UNI-Anchorlock® offers superior resistance to tipping and twisting under heavy industrial loads and is specially designed for rapid mechanized installation of large-scale projects such as ports, airports, and depots.

Additional analysis of the four pavement systems under consideration was then required to quantify the final recommendation for interlocking pavers as the best pavement for the project. Design loads were based on the TEC-950L Container Handler which has a very high front axle load of 106,000 lb (943kN). The Authority had typically used Florida DOT flexible pavement design methodology. However, since it relates all axle loads to an equivalent number of 18-kip (80kN), it could not be used for pavement design to support loads required for port applications.

1. Daily Traffic Load Includes:
   250/500 Container Handler Trips per Day
   50/100 Truck Trips per Day
2. Taylor TEC-950L Container Handler

Empty Weight:	152,000 lb	676 kN
Track Width:	12.375 ft	3.77 m
Tire Pressure:	120 psi	827 kPa
Axle Spacing:	18.75 ft	5.72 m
Dual Wheel Spacing	23.1 ft	7.04 m

3. Assume 100% 40 ft (12m) Containers Handled
4. Trucks with 4 & 5 Axles, GVW 80,000 lb (356kN) or greater
5. Terminal in Operation 260 Days per Year
6. 25-Year Design Life
7. Est. Subgrade CBR = 15%

Figure 2

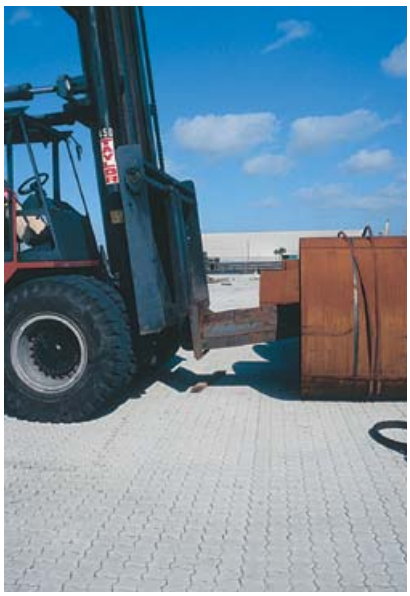
One of the methods used to assess the four pavement systems was LOCKPAVE,® a structural pavement design software program developed by Dr. Brian Shackel, a leading international engineering authority on geomechanics and interlocking concrete pavements. The data from LOCK-PAVE® and other sources was then used to compare the other pavement options under consideration against the interlocking concrete pavers. Figure 2 shows the base information that was used for the evaluation of the site paving requirements.

After the decision was made to utilize concrete pavers for the pavement surface, the analyses and design then involved the assessment of the base course and the necessary site preparation to ensure satisfactory subgrade performance. A variety of base materials was considered, including limerock, asphaltic concrete, soil cement, Econocrete, pavement quality concrete and dense graded limestone with grid reinforcement.

The "anchor-interlocking" shape of UNI-Anchorlock® offers superior resistance to twisting and tipping and is designed for cost-effective mechanical installation

General criteria for the base materials included strength, a high elastic modulus, the ability to be free draining, possession of a high particle soundness and ease of installation. It was determined that a granular material would work best with the variable subgrade at the site and that geogrid reinforcement would offer additional strength that was compatible with the aggregate material. The granular base would also facilitate repair or reconstruction of the pavement for the addition of subgrade structures or for subgrade and base settlement repairs should they be required. Based on the research data, an 18 inch dense-graded limestone was selected for the base with a FDOT Type 1 geogrid at 9 inches. Findings also indicated the limestone base would result in a potential savings of approximately $300,000 over Econocrete, based on the 112,620 square yards (94,165 m^2) of material required for the pavement. Figure 3 shows the final pavement cross section utilized for the cargo staging areas at Berth 208.

Like many port facilities, Berth 208 was built over dredged marine fill, miscellaneous soils, and debris. "With these types of soils, it is expected there will be some settlement during the life of the pavement," said Fielland, "and the ease of access for base and subgrade repairs was one of the principal reasons for using interlocking concrete pavers. The UNI-Anchorlock® pavers also provide a flexible pavement surface that is capable of moving with subgrade and base settlement, yet remains serviceable as a cargo staging area." Fielland added that although specifications had called for 95% compaction of the top 12 inches of the subgrade, they were only able to achieve 92%, due to poor soils.



A Taylor TEC-450L transports a roll of coiled sheet steel weighing over 37,000 lb

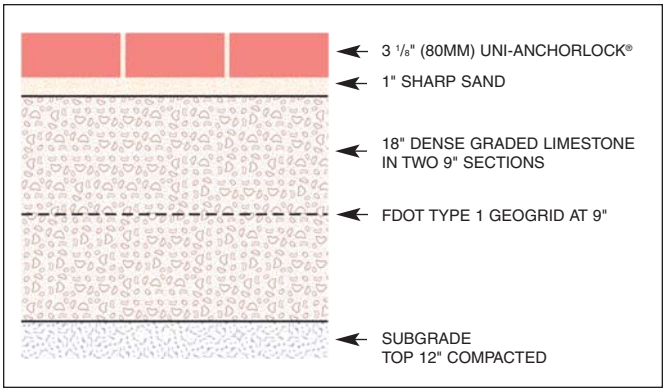


Figure 3

Precise Paving, Inc. of West Palm Beach, FL, was the paver contractor for the project. Using mechanized screeding and paver placement equipment, about 70% of the project was installed with a single machine. A second was used to assist on the remainder. From 8,000 to 12,000 square feet was installed per day, which required several truckloads of pavers to be on-site at all times to ensure an uninterrupted workflow. "The dentated shape of the UNI-Anchorlock® paver allows for fast, easy, and accurate installation," said Bob Goossens, president of Precise. "The average rate for rectangular pavers installed in a herringbone pattern is about 5,000 to 7,000 square feet per machine per day, and an extra man is required, so installing Uni-Anchorlock® is substantially faster." Recently, when making scheduled repairs to an area that had experienced some subgrade settlement, Precise was even able to *uninstall* the pavers mechanically, instead of the usual hand-removal, due to the superior interlock of UNI-Anchorlock.® After repairs were completed, the pavers were reinstated mechanically.

Over 1 million square feet (94,165 m^2) of interlocking concrete pavers will eventually be installed at Berth 208, one of the largest port installations in the U.S. The first phase, consisting of 530,000 square feet (49,238 m^2) of 3 1/8" (80mm) thick UNI-Anchorlock® pavers was completed in October of 1995. Another 218,000 square feet (20,253 m^2) was installed during Phase II in the fall of 1997, with an additional 40,000 square feet (3,715 m^2) utilized for outside storage around a warehouse facility on-site.

To date, Berth 208 has mainly been used for storage of imported steel coils, pipe, rods, and plates. Ellsworth Brown, facilities manager with Tampa Bay International Terminals, operators of Berth 208, said the UNI-Anchorlock® pavers are performing well, with no cracking under the heavy loading from steel products and cargo container handlers. "The large coils of sheet steel weigh approximately 40,000 lb each and generate extreme point loads which are concentrated over a very small area, while the stacks of 42 foot steel pipe can weigh as much as 70 tons," Brown said. More than 200,000 tons of steel are shipped annually through the port, making it their 2nd largest general cargo commodity. With the success of the Berth 208 installation, the Authority hopes to use more UNI-Anchorlock® pavers for future cargo staging areas.

As the nation's leaders in industrial paver production, UNI-GROUP U.S.A. manufacturers have supplied most of the major port projects in the United States to date, including the Port of New Orleans, LA; the Port of Oakland, CA; the Seagirt Terminal in Baltimore, MD; Port Canaveral, FL; the Port of New London, CT; and the Pier IX Terminal in Norfolk, VA, as well as the Crowley Terminals at the Port of St. Thomas, Virgin Islands and Port of Panama.

UNI-Anchorlock® pavers are capable of withstanding exceptionally heavy point loads, such as that generated by a 393,000 lb cargo crane

REFERENCE:

"Selection of a Pavement System for Heavily Loaded Marine Terminal," Ross T. McGillivray and Carl E. Fielland, 1995.

Please note: Pavement design varies with climate, available construction materials, design methods, soil conditions, and traffic load. A qualified design professional should be consulted in concrete paver applications to ensure desired results.

Contact your local UNI-GROUP U.S.A. manufacturer for more information:

"Industrial Pavement Applications Using UNI-Anchorlock® Pavers" - Video

"Applications for Concrete Paving Block in the United States Market" - Manual by R.S. Rollings and M.P. Rollings, 1992

Lockpave Pro® - Structural pavement design software

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