The RCC was placed in the North yard during the hot season, and I believe that the contractor did not water properly, so the surface dried out. When that occurs, you do not get any matrix on the top of the surface. As tires start running over the RCC, it abrades and self-destructs. This caused quite an alarm at first.

One fix for the problem was to place a coal tar emulsion on the areas that were abraded, along the tracks and where the strads come into the train and turn. We placed two or three coats to see how it held up. The coal tar emulsion has since wore off, but it did its job in preventing cracking.

There are some maintenance problems with RCC, due to the uncontrolled cracking. All things being equal, I would choose cast-in-place over RCC due to the fact that you get a tighter matrix on the surface, better control over cracking and better control over your grade.

RCC EQUIPMENT DEVELOPMENTS AND CONSTRUCTION TECHNIQUES

BY
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Roller Compacted Concrete (RCC) is providing an interesting alternative to many agencies that are in the business of providing hard surfaced areas. It overcomes some of the problems of asphalt while providing the benefits of conventional concrete at a reduced price.

Knowledge of RCC has expanded considerably from the time of its first use in the mid-1970's, but there still is a need for experimentation and more research to make this product even better.

RCC is essentially the same material as conventional concrete. The difference is that it is backed a bit differently and placed differently. RCC typically has a little less cement content than conventional concrete and is rolled into place instead of being cast into place. Because it is a dry mixture, the water content is less. So, RCC is basically a non-plastic or dry mix.

RCC pavement thickness design methods are generally accepted to be the same as conventional concrete. RCC has the idiosyncracy that the initial cracking occurs at very long joint spacing. This produces, as far as cracks go, a very wide or open crack, any where from 1/4 to 1/2 inch.

This poses a problem with pavement design. The criteria for conventional concrete is based on the fact that, at a joint or edge of a crack, we have load transfer across that joint and support by the adjacent panels in all directions. If we take an RCC crack, we have essentially a free edge, and the pavement has to be thicker to sustain the increased stress. To account for the stress, design methods dictate or require that design loads be increased by as much as 20 percent.

If the RCC is batched and constructed properly, the flexible strength of RCC tends to be anywhere from 10 to 30 percent stronger than conventional concrete. So the increase in stress is offset by the increased flexible

strength.

Earlier intermodal yards had stacking or picking equipment that protruded beyond the sides of the boxes. This prevented the boxes from being stacked closer together than 15 to 24 inches. With technology, the new picking equipment allows boxes to be stacked butt to butt and side to side. There is no room between the boxes. This gives greater space utilization, but it is a potential disaster for a material on which the containers sit.

Each container typically has a 6"x6" square steel pod in each corner to support the box on the pavement. If we work with containers of 50,000 pounds each and stack them four high, then each bottom corner pad carries a load of 200,000 pounds.

With fully loaded containers stacked four high on rolled compacted concrete or portland cement concrete, spaced about 24 inches between stacks, we would need a pavement thickness of about 18 to 20 inches. With containers stacked with no room between, we need a 28-inch thick section of concrete to hold those boxes without cracking the concrete.

Another area of pavement design that needs attention, which has been overlooked on some projects, is that newer picking equipment may be as much as 15 percent heavier than older equipment, a difference of up to 30,000 to 40,000 pounds.

In discussing construction, RCC pavement can be divided into two categories: those pavements used for dirty operations and those pavements used for clean operation.

A dirty operation is one in which the handled product leaves the pavement covered with a residue, such as when logs or coal are stored on pavement. The RCC surface is covered or only partially visible, thus the surface does not have to be "pretty". In addition, there is not much concern with cracks or minor rattling, and the speed of the operation equipment is relatively slow. So, the surface tolerance can be relatively loose.

A clean operation, typical of an intermodal yard, handles material that is containerized so there is nothing to get the pavement dirty. However, the operating equipment tends to move at a relatively fast speed. Thus, the looks and performance of the surface are more important here, and the surface tolerance is more critical, than that of a dirty operation.

RCC is really an asphalt paving operation using a portland cement bound material rather than using an asphalt cement bound material. Typically, your RCC surfaces have very open texture, and are relatively flat with a slope of maybe 1/2-inch in 10 feet. For a dirty operation, you can use any type of paving equipment for RCC, but for a clean operation, laydown machines with tamping bars should be used. For drainage purposes, a minimum 1 percent slope should be used.

One of the two most important factors in achieving quality in any kind of portland cement is curing. Unfortunately, most contractors putting down RCC do

not have an appreciation of the need for curing. Consequently, joint surface rattling problems arise. The U.S. Army Corps of Engineers is experimenting with straight-on curing compounds. Their procedure is to continuously and thoroughly saturate the RCC for the first 24 hours. After that they apply two full strength applications of the curing compound. This seems to work well in keeping a good moist surface that continues to gain strength and durability. This is being considered as a standard procedure for RCC.

To achieve the desired performance of RCC, the density has to be proper. At least 96 percent density should be reached.

RCC is rapidly becoming accepted as the third major method of paving, competing with conventional concrete and with asphalt. It has the potential to become the dominant method of paving, since it provides the quality of conventional concrete, typically at a lower first cost than asphalt.

USE OF UNREINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

AT THE BURLINGTON NORTHERN SEATTLE INTERNATIONAL GATEWAY

BY
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In December 1984, Burlington Northern Railroad (BN) decided to build a new container handling facility at Seattle, Washington. The project was begun in response to a growing intermodal market in the Pacific Northwest and the advent of new double stack equipment technology. The new facility is called the "Seattle International Gateway" (SIG; see Figure 1). This paper discusses the design, construction and performance of the Portland Cement Concrete Pavement used at SIG.

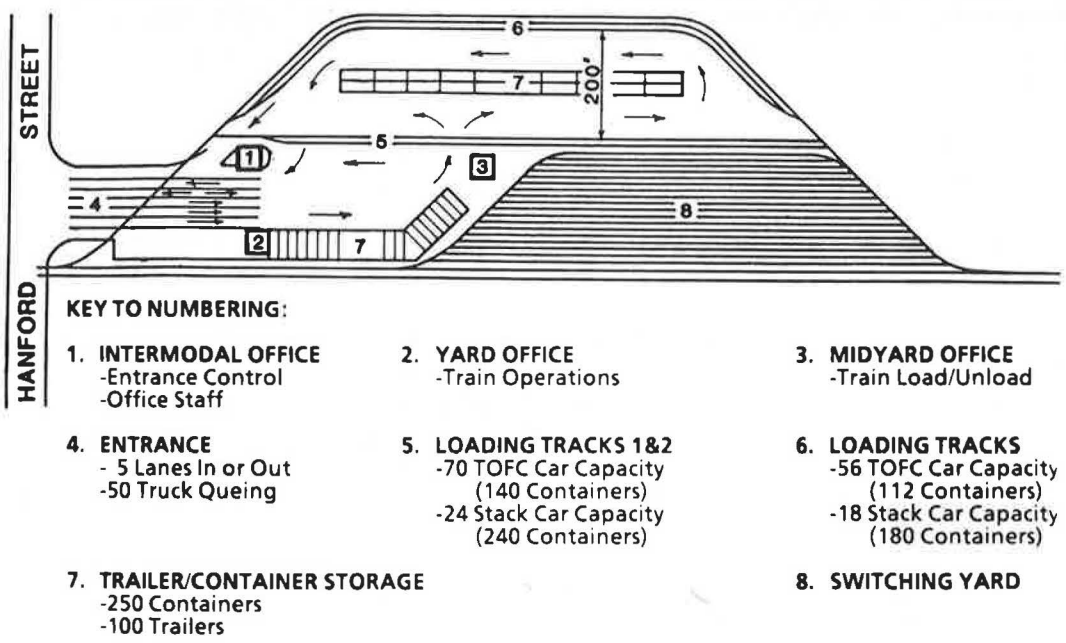

FIGURE 1. Seattle International Gateway: new yard capacity and operation