What the beginner needs to know

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THE UNITED STATES has been one of the last major industrialized nations to enter the concrete block paving field. This has been mostly due to the fact that asphalt and poured concrete paving has been so vastly used in all parts of the US and is still so very low priced that concrete block paving cannot compete on price. It probably never will until a great deal more automation in laying of the pavers in place is achieved since manual labour for such work is very expensive and difficult to find in the US.

A place for concrete block pavers was made with the US national effort to rebuild inner-cities. In the early 1970's, it became a credo of architects and citizens' committees on preservation not to tear down the older buildings and replace them with new glass and steel structures, but to remodel and rennovate. the standing buildings and to put these structures to new use. This also created a desire to bring back "human scale" into the design of neighbourhoods. Europe and the United Kingdom were used as an example of good planning and recycling of old buildings and neighbourhoods. In study trips overseas, these people noticed the paving which existed in many cities, and this idea was brought to the US. At the same time, a deep building recession in the US in 1974 made many concrete block and precast concrete producers look around for new business. The paving market looked like a good opportunity to the concrete block industry, since so much of the plant necessary to produce concrete block paving was already in place.

In the early 1970's, the National Concrete Masonry Association sent a group of its staff to look at the paving market around the world. We talked to people involved in research or in the making of pavers in the Scandinavian countries, in Germany, Belgium, Holland, France and in England. Some of the people we talked to are on the programme of this Conference.

We found a great deal of co-operation, but also a good many contradictions. I will discuss some of this information today because it was a learning process for us since we had no experience whatsoever with paving. Our association was involved with concrete block and concrete brick, and all of these products were used for construction of walls. The paving market was a mystery to us in regard to what is required to make a quality paving block which will perform well, and last 20 to 25 years without replacement.

Our first question was "can a quality concrete paving unit be made on an American block machine?" We needed to know this answer since there were already 2500 block machines in operation in the US, and introducing pavers into the US would be much easier if new manufacturing equipment did not have to be purchased.

Most of the people we discussed this question with in Europe said "no". Our chief engineer studied the vibration cycles and production methods, and came to the conclusion that the answer was "yes". The technology of making a concrete block paver was somewhat different from making concrete block, but there were also many similarities. You must remember that the quality standards for concrete block are the highest in the world in the US, and for this reason, the way concrete block was made was not so different from the way pavers had to be made. We found that the real difference was economic, not technological. American concrete block machines can produce pavers with the proper quality, but the pallet size of the machine is too small. Therefore, as the market grew for pavers and production had to be increased, the pallet size of the American block machine was too small for high volume production, and this was related to the price which had to be charged for the pavers.

Our next question as a beginner was "what quality standards are necessary to make a durable yet competitively priced concrete block paver"? This question was the most difficult because there were so many answers in Europe, and not all of them had to do with quality, but with competition. We also found this a difficult question to answer since not all countries tested for quality the same way. Therefore, answers were related to the test methods, and this was not understood by us until we began to compare test methods in various countries in Europe and the United Kingdom against those used in the United States.

I would say that even though the U.S. now has about 100 plants making concrete block pavers, and we have issued a tentative specification, we still do not understand all the technology needed to make a quality block paver. For instance, when we began to search for the proper way to measure good quality, every European country except Holland stated that compressive strength was one of the best indicators. But we found that compressive strengths which were recommended ranged from 6000 psi (41.3 MPa) to 10,000 psi (68.9 MPa). Germany had the most experience with the strength of pavers, but there were two problems. In Germany, the concrete which goes into a paver was tested in a cube, whereas in the US, the actual product is' tested. Therefore, "strength" meant something different in the US as compared to Germany. The other problem we discovered was that the paver market was divided into interlocking shapes and sizes in many parts of Europe and manufacturers of patented shapes and sizes used strength of pavers as a competitive weapon to win a larger share of the market. There is nothing wrong with this practice, but it did confuse us when we tried to discover what is the proper strength for a durable concrete block paver which will last for 20 to 25 years under light traffic.

Holland had tried compressive strength, and after failures began to occur even as strength of pavers increased, they changed to tensile strength. We were informed that failures dramatically decreased when tensile strength testing was adopted, and we were shown several examples of busy streets where pavers had been in place for many years with no sign of disintegration of the pavers. This added another question to our search for durability.

Strength of pavers, however it is measured, is related to durability. Many European countries have harsh winters where freeze-thaw conditions and use of de-icing chemicals affect the durability of concrete block pavers. This then was one critical testing procedure - the relationship of freeze-thaw to compressive or tensile strengths, to air-entrainment, to aggregate use and aggregate gradation, to cement content, to amount of colouring pigment. But here again, as beginners we found many opinions - all based on either experience or research, but when we looked deeper, we found no standard testing techniques being

applied in all countries the same way. As an example, the US uses the American Society for Testing Materials (ASTM) as a standard for testing. But there is no one standard test for freeze-thaw in ASTM - there are actually four different such tests. There is no ASTM for measuring physical properties of concrete block pavers.

We came back to the US with a lot of information, but also a good many additional questions. We checked with many of the experts in various research laboratories and government agencies in the US for information which could resolve some of the conflicting information we had received. But we found no one in the US had any experience with concrete block pavers, and therefore the information we got was related to other products and what those products required to make them durable. As an example, the National Highway Research Department informed us that durability of concrete under freeze-thaw and deicing was very much related to air entrainment. To add to our confusion, the experts at the Highway Research Laboratories in the US stated that if air was entrained, it was not necessary to make concrete block pavers with such strong concrete as 8000 psi (55 MPa). This opinion was in direct opposition to what had been told to us by many manufacturers of concrete block paving units in Europe!

But there was still other information which was needed. For instance, how was durability of the concrete block paver related to the thickness of the paver and to the sub-base on which it is placed. In order for concrete block pavers to be somewhat competitive in price to other paving materials such as asphalt and poured concrete, a concrete block paver had to be as thin as possible and have as little cement in it as possible since cement was the most expensive part of the paver mix. Back in those early 1970's, we consulted with the Portland Cement Association, but found that their sub-base technology was all built around a rigid pavement such as poured concrete, and we had no way of knowing whether this was related to a flexible pavement, such as concrete block pavers. We finally found an authority on flexible pavements who had come from the Asphalt Paving Institute in the US, and we are now piecing together the relationship of durability of concrete block pavers to sub-base technology. The US Corps of Engineers has done some research in this field as well. You might be interested in knowing that the US Corps of Engineers has recommended the use of concrete block pavers on US installations as a result of their research. Their work however, was done on road use, and not on the manufacture of pavers.

I have touched on machine technology, on quality standards, especially as related to strength and durability, on testing methods, on sub-bases and thickness of the concrete block paver. All of these are important for the beginner to know something about. Having said this, I can also say that by taking information which is available in many places in Europe, the UK and other countries, and by applying it with some caution, it is possible to develop a paving market for concrete block pavers without first solving all problems and getting the answers to ail the questions. We did this in the US and printed a specification which we felt was good enough to start with although we knew that it was just a beginning, and more would have to be added later. Most of our specifications are based on what we thought was the best knowledge which had developed by that time in the different European countries. We applied these experiences to the US where similar weather conditions prevailed. With this specification, about ten million square feet (930,000 m^2) per year are now manufactured in the United States. We are in our second stage of investigation through research at the NCMA laboratory, and that paper will be presented on Wednesday.