

# **Transportation Research Board**

## **Transportation Related Noise and Vibration**

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Summer Meeting, July 10-13, 1994 - Philadelphia, PA

Highway Noise Session

### **Resurfacing for Noise Reduction: Results of an Experimental Overlay**

*By:*

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East Orange, New Jersey

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New Jersey Highway Authority  
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by Bela Schmidt and Robert J. Fischer

**Introduction**

The New Jersey Highway Authority operates the Garden State Parkway, a limited access toll road, which extends for 173 miles along the length of the state of New Jersey, from Cape May in the south to the New York State Line in the north.

In recent years the New Jersey Highway Authority has received an inordinate number of noise complaints from neighbors along the northbound roadway of the Garden State Parkway in the Toms River area. At one area of complaints the pavement surface consists of Portland cement concrete pavement slabs originally constructed with joints on 15 foot centers, see Figure 1. South of this area there is another section of the roadway where the pavement is bituminous concrete and traffic using this roadway section also generated high noise levels. At both locations the adjoining housing development is moderately dense with houses within 100 feet of the roadway. There is a wooded buffer zone between the roadway and the houses. These areas presently do not qualify for noise walls under the current New Jersey Highway Authority Policy for Construction of Sound Barriers.

**Application of NOVACHIP**

In the summer of 1993 the New Jersey Highway Authority was approached by a Pennsylvania materials supplier offering to try out a new resurfacing material that was developed in France in 1988 called NOVACHIP. NOVACHIP has been used extensively in France, Belgium, Sweden, United Kingdom and Germany. To date in the US it has been used in the States of Alabama, Mississippi, Pennsylvania, New Jersey and Texas. The New Jersey Department of Transportation is planning a NOVACHIP resurfacing project in 1994. NOVACHIP is used primarily for surface rehabilitation in place of chip seals, microsurfacing and thin overlays. Some advantages of NOVACHIP include: no loose aggregate which is due to excellent adhesion, reduced noise levels, good skid resistance, no tire splash during rain of moderate intensity, simplified paving operation and quick reopening to traffic. The existing pavement to be overlaid must be structurally sound since NOVACHIP does not increase the structural capacity of the pavement.

NOVACHIP is an ultra thin friction course approximately 1/2" to 5/8" thick, see Figure 2. It is an open graded hot mix asphalt placed over a relatively heavy application of polymer modified emulsified tack coat, see Figure 3 for a close up view. It is placed with specialized equipment that spreads both the tack and hot mix asphalt in a single pass, thereby simplifying the paving operation. The course aggregates are gap graded with a large portion of a single size crushed

aggregate. The aggregates are coated with a mastic of sand, filler and asphalt cement. The asphalt cement content ranges from 4.7 to 5.3 percent depending on the actual gradation of the aggregates. The NOVACHIP asphalt is produced in a conventional drum mix plant and other than the gradation, the mix is essentially the same as conventional mixes. The heart of the NOVACHIP process is the NOVACHIP paver, see Figure 4, which consists of a receiving hopper for the hot mix asphalt, a screw type conveyor, the hot mix asphalt storage bin, a tack coat storage tank, the spray bar and finally the paving screed unit, see Figure 5. All these components are mounted on a single chassis, which allows application at a rate of 20 to 25 meters per minute. The spray bar is mounted just ahead of the screed and applies the tack coat at a rate of 0.15 to 0.22 gallons per square yard, see Figure 6, which compares to an average rate of 0.05 gallons per square yard for conventional mixes. Because the thickness of NOVACHIP overlays are approximately that of the size of the course aggregate, and therefore relatively thin compared to conventional dense graded overlays, NOVACHIP overlay requires less rolling and can be opened to traffic much sooner.

Resurfacing projects on the New Jersey Garden State Parkway typically consist of a 2" nominal thickness dense graded bituminous concrete overlay. This type of overlay is constructed at an average cost of approximately \$6.00 per square yard, which includes items such as milling keyways at tie in points, resetting inlet castings, placement of topsoil along the pavement edges and tack coat. Where NOVACHIP was used we substantially reduced or even eliminated items such as milling, resetting inlet castings and tack coat. With the reduction of these items the cost of NOVACHIP overlay was \$3.18 per square yard, which is a 47 percent reduction in unit cost for resurfacing.

There is a marked difference in surface drainage when driving on NOVACHIP in the rain. Conventional bituminous concrete has a slick looking sheen when wet. NOVACHIP on the other hand has little surface water and in fact appears dry, see Figure 7. Actual skid tests have shown a 13 percent increase in skid resistance compared to conventional mixes.

Prior to applying the NOVACHIP overlay on two sections of the Garden State Parkway, our consultant Louis Berger & Associates measured the traffic noise levels on both bituminous concrete and Portland cement concrete pavements. The readings were taken at two locations simultaneously during morning and afternoon rush hours. The morning rush hours selected were on Fridays from 6:00 a.m. to 9:00 a.m. and the afternoon rush hours were on Mondays from 4:00 p.m. to 7:00 p.m. These measurements were made once before and once after the NOVACHIP resurfacing. The location of measurements, instruments and field personnel were kept the same. This was considered important because the task was to gather data that was comparable in every detail.

### Noise Levels

Research into the sources of sideway noise levels generated by roadway vehicles identified several mechanisms that contribute to the overall noise levels impacting residential properties along roadways. These mechanisms, which may be called acoustic sources depend on the type of vehicle, its operating mode, type of power plant, level of maintenance, weather conditions, loading and road surface conditions. The simple quantitative test conducted last fall at two sites

along the Garden State Parkway was based on the assumption that free flowing peak traffic on weekdays is essentially the same from one week to the next and therefore wayside noise levels are also comparable when recorded over several weeks. Therefore it is reasonable to assume that if only one of the several noise sources, such as tire noise generated by altered road surface conditions changes, the change in measured wayside noise levels may be directly linked to the changed road surface conditions, thus establishing a cause and effect relationship.

The emerging interest in roadway surface as one of the options for reducing free flowing highway noise is not new and may be explained by the relative contribution of the tire/surface interaction source to the overall wayside noise levels. At both test sites, free flowing traffic, with Level of Service B to C, cruised by at steady speeds of approximately 55 to 65 mph. In this speed range and when travelling on a level and dry road surface at steady speed, engine and gear noise are no longer prominent and aerodynamic noise is not yet a major contributor to the overall total. Therefore our attention was focused on the tire/surface interaction as a major noise source under these regularly occurring modes of highway use. While tire surface pattern and tire side wall construction does influence roll by noise levels, a much greater improvement (3 to 6 dBA) may be achieved by changing the roadway surface. For this reason, it is generally considered that there are greater opportunities in reducing the output from the tire/surface noise source by changing the road surface texture than by a redesign of the tire itself. Types of open textured road surfaces with high acoustic absorption are being used increasingly in Europe and North America with additional benefits beside noise reduction.

The tests described here were conducted on two days in September and two days in October of last year. A traffic count was made for each of the four days at the nearby Toms River Toll Plaza and from this data the traffic volume and mix were calculated for one of the test sites to ensure that no unobserved changes took place during data collection. The traffic data showed no change for the Friday AM peak traffic hours and a decrease of 4 1/2 percent in number of vehicles for the after paving test in case of the Monday PM peak traffic hours. This 4 1/2 percent decrease in traffic volume was offset by an 3 percent increase in commercial vehicles.

In the simplified test procedure reported here a stationary monitoring technique was employed to measure wayside traffic noise levels at two separate sites 2 1/2 miles apart. One microphone was used at each site, mounted on a tripod 5 ft. above grassy surface. Both locations were next to north bound travel lanes of the Garden State Parkway, at MP 80.69 and MP 83.18. Figures 8 and 9 show the instrument set ups at each test site before repaving. Microphone distances from the edges of the nearest travel lane were 37 ft. and 23 ft., respectively. An approximately 100 ft. wide wooded strip of land provided a buffer zone between residential properties and the traffic.

Data collection was accomplished using two B&K made Type 1 (precision grade) Noise Level Analyzers programmed to continuously monitor and sum up statistical data at 15 minute intervals. No frequency analysis was done on any of the data gathered. The statistical data collected were the  $L_{01}$ ,  $L_{10}$ ,  $L_{50}$ ,  $L_{90}$ ,  $L_{99}$  and  $Leq$  descriptors. The same instruments were used by the same operators at the same location for each of the tests and a log maintained to record all events pertinent to the measurements. Figure 10 shows the test site at MP 83.18 after application of the NOVACHIP overlay.

A total of 12 data points were obtained during each of the 3 hour long tests conducted at each of the two sites. The 15 minute Leq noise levels and the time of the day were plotted for each test site to show the difference between noise levels recorded before and after repaving. Figures 11 through 14 show the Results of the 8 sets of data that were collected and plotted on a set of histograms. The values shown on the vertical axis are actual values, but their significance in this test is only to indicate the proximity of the microphone to the line of traffic.

The test results presented here are site dependent because of the type of road surface before the resurfacing. At the bituminous concrete roadway segment tested at MP 80.69 the average noise level reduction achieved was 1.4 dB during the morning and 2.1 dB during the afternoon rush hours, see Figures 11 and 12. Considering that for broadband noise, such as steady traffic heard at a distance, only a 3 dB or greater change is noticeable, the change achieved at this location may not be significant to residents living next to the roadway. However, at the other site further north at MP 83.18, where a Portland cement concrete road surface was overlayed with NOVACHIP, the difference amounted to 3.2 dB in the morning and 4.1 dB in the afternoon, see Figures 13 and 14. The improvement would have been greater were it not for the fact that of the 3 travel lanes only the middle and the left (fast) lane were concrete slab before repaving. The nearest lane already had a relatively smooth bituminous overlay similar to the one at the alternate test site before overlay. The test results reported here compare favourably with the NOVACHIP developer's data who reported a 2.6 dBA reduction at 56 mph and a 3.1 dBA reduction at 68 mph.

In summary, the test results show that a significant reduction in noise levels can be achieved on existing Portland cement pavement by using the NOVACHIP ultra-thin overlay. Noise reduction was less impressive with NOVACHIP on existing bituminous concrete. It is clear that NOVACHIP shows some promise in the reduction of noise levels; however, additional studies are required before this type of pavement can be recommended as an alternate noise abatement method with specific reduction in noise levels.

### Conclusions

The experimental work reported here focused on the influence of a specific road surface on the roll by noise levels of typical, free flowing highway traffic. The test results indicate that for free flowing highway traffic at cruising speeds, the road surface can reduce the wayside noise levels and thus the need for additional mitigating measures. Sources in literature indicate that the higher the cruising speed within the permitted speed limits the greater the influence of the tire noise component on the overall noise levels.

An evaluation of the variables of highway traffic suggests that the higher the percentage of light vehicles in a given traffic the greater the change in noise levels that may be achieved by altering the road surface. This is because commercial vehicles have a much stronger engine/gear noise generated component added to the total noise level at cruising speeds, which component is independent of the road surface the vehicles are travelling on.

It is worth to note that future alternatives for highway noise abatement may well include quieter road surfaces with the potential to lower the height of noise barriers or, in borderline cases, eliminate the need for barriers altogether. And with the expected introduction of active noise control for commercial vehicles, a triad of highway noise mitigating measures will hopefully become available to officials responsible for traffic noise abatement.

The change in measured wayside noise levels indicates that any computerized highway noise prediction model in the future should include data on the effect of road surface. Such refinement would present an expanded range of options in the search for finding the best combination of mitigating measures to reduce highway noise impacts.

This concludes our presentation.



Figure 1 - Portland cement pavement prior to NOVACHIP overlay

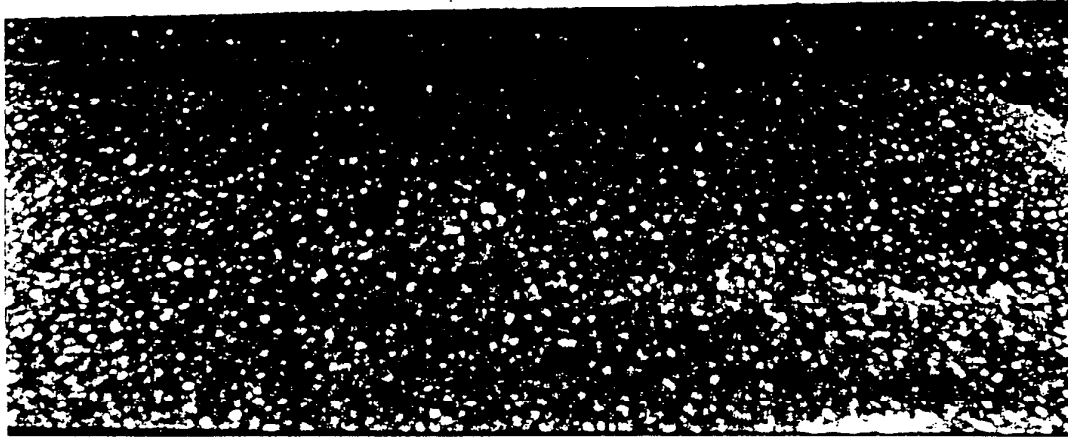


Figure 2 - Relatively thin lift of NOVACHIP over bituminous concrete

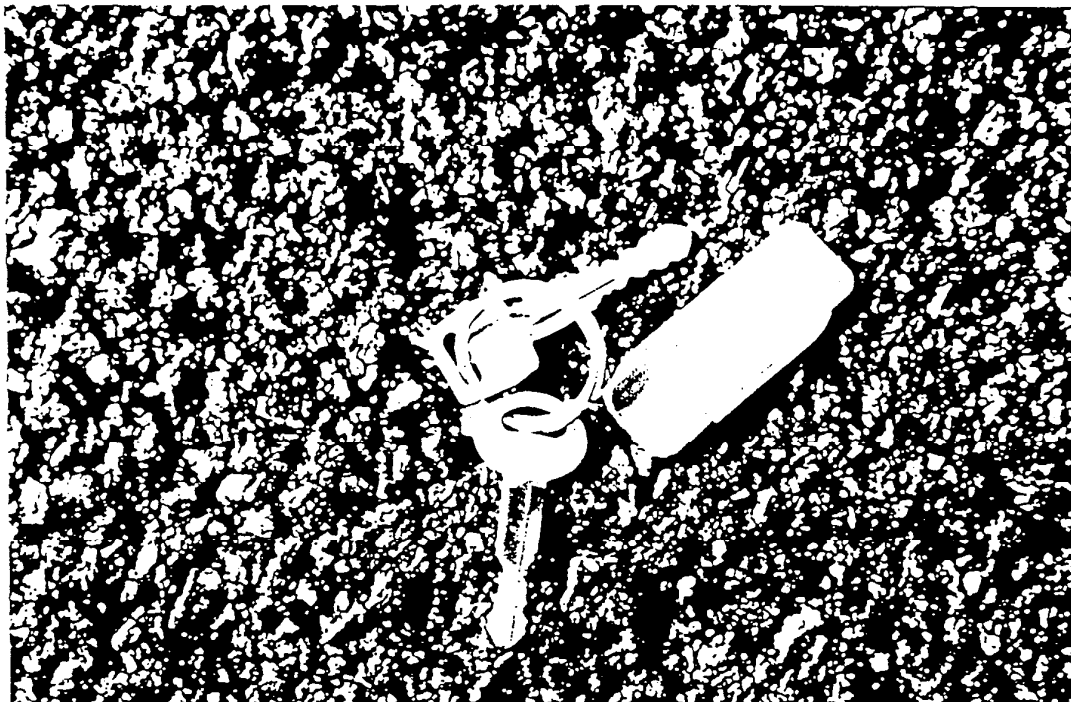


Figure 3 - Open graded mix of NOVACHIP pavement

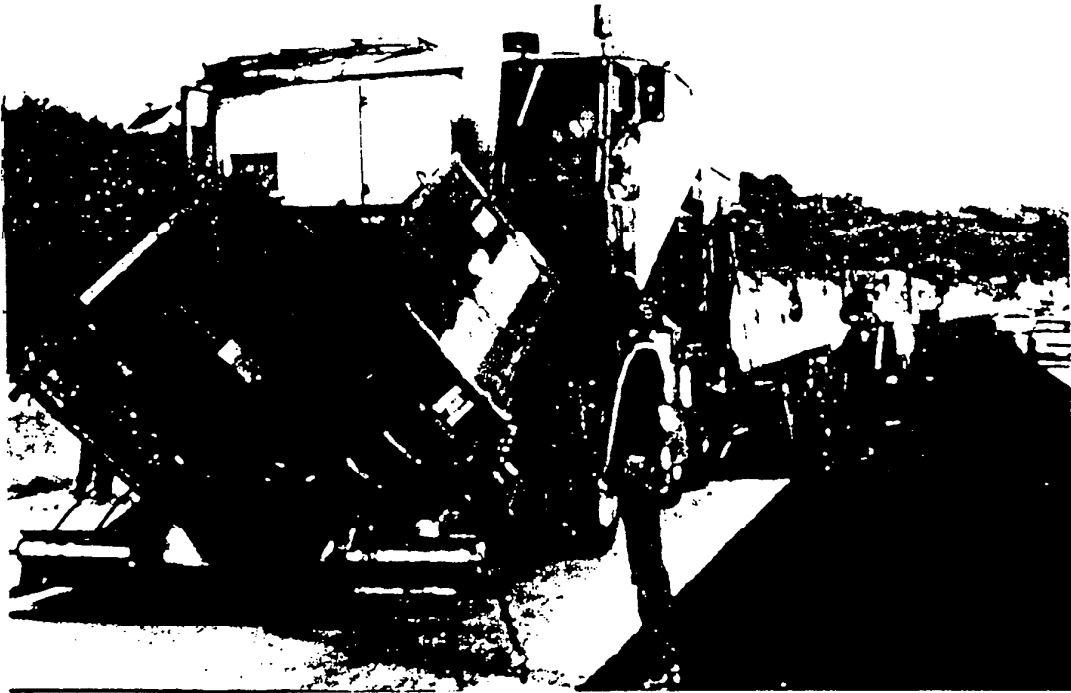


Figure 4 - Receiving hopper of the NOVACHIP paver

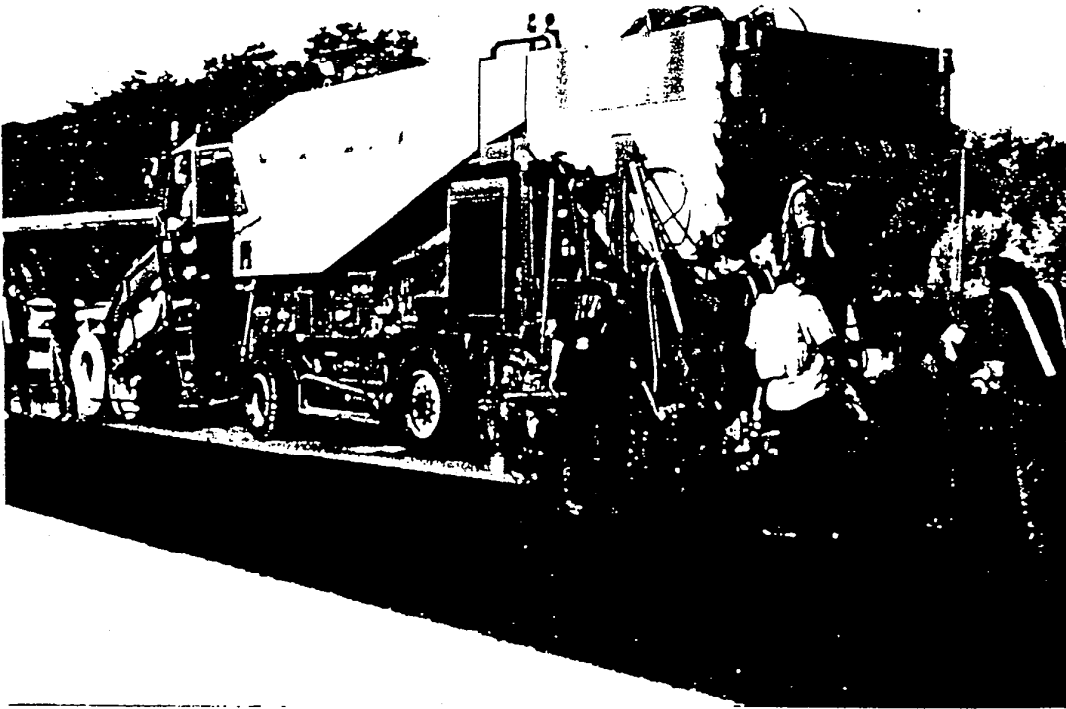


Figure 5 - Back end of the NOVACHIP paver-note silver tanks for tack coat storage

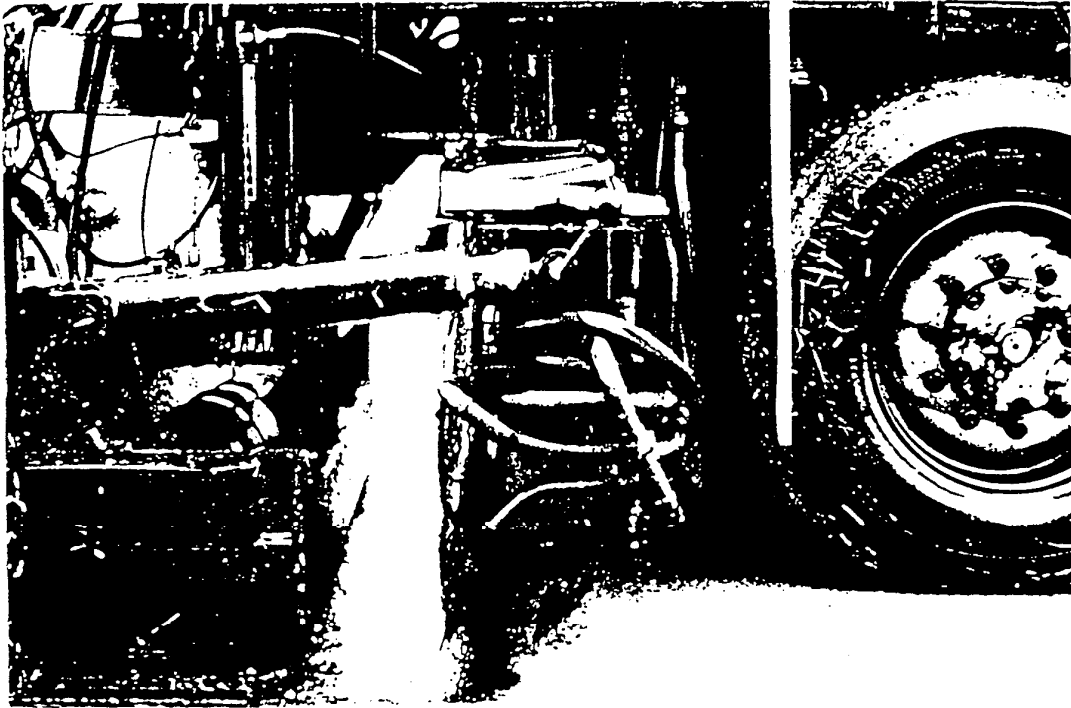


Figure 6 - Application of the tack oil just ahead of the screed



Figure 7 - Finished NOVACHIP pavement in the vicinity of Pleasant Plains State Police Barracks in Toms River



Figure 8 - Test site at MP 80.69 ready for measurements before paving



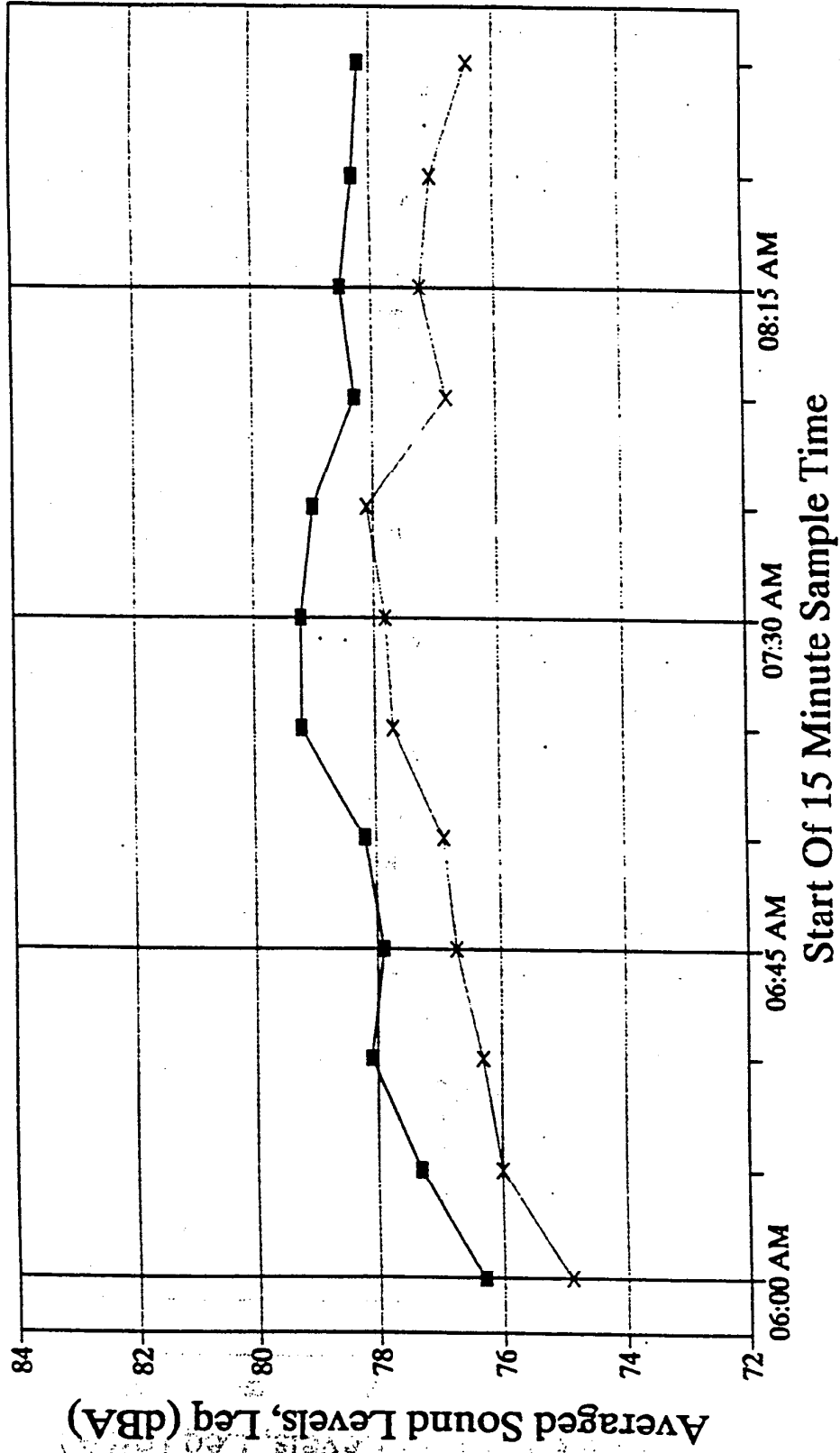
Figure 9 - Test site at MP 83.18 ready for measurements before paving



Figure 10 - Test site at MP 83.18 after paving

# Measured Sound Levels Before and After Milepost 80.69 - Northbound Side - AM

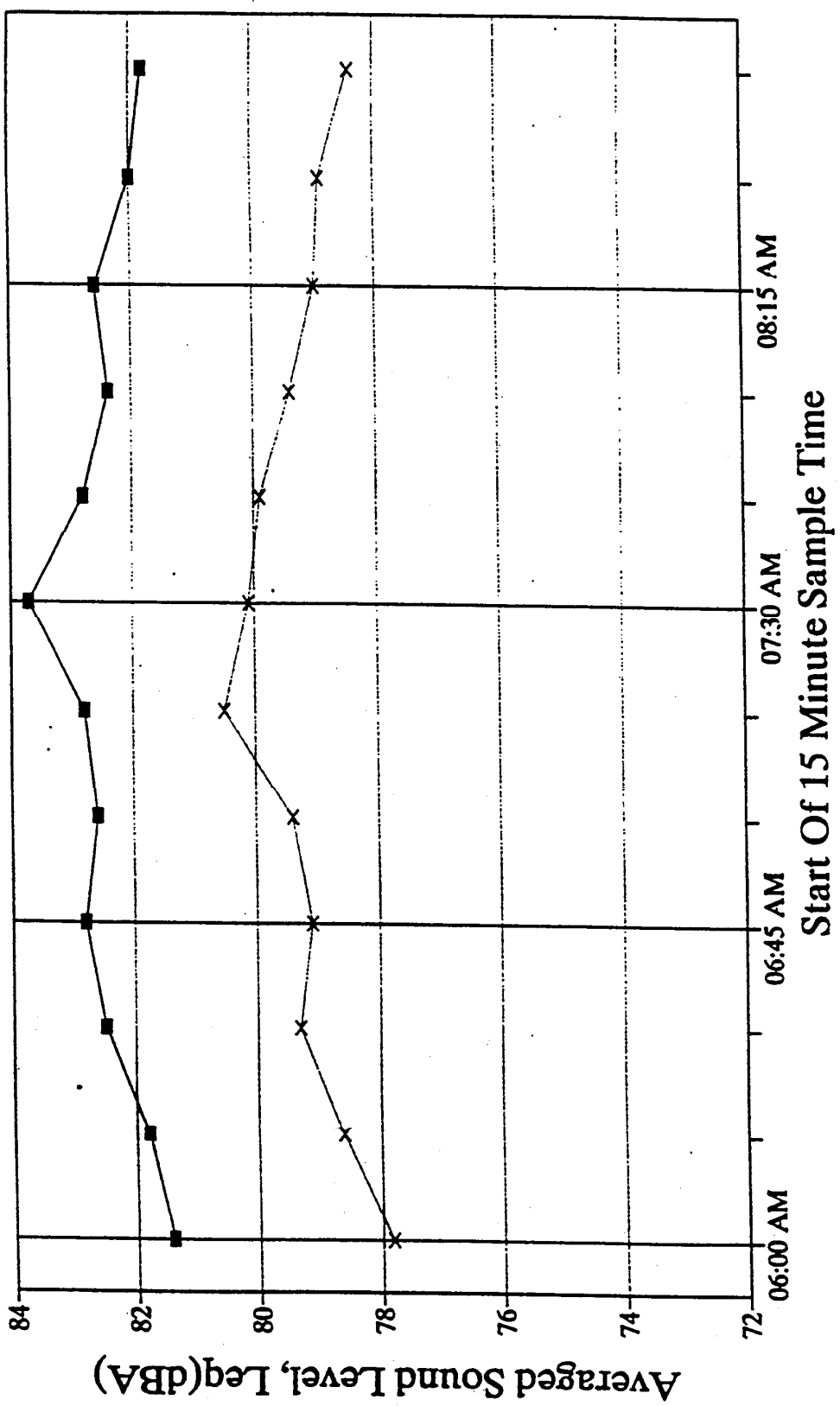
Figure 11



—■— Before Paving    - - - x - - - After Paving

# Measured Sound Levels Before and After Milepost 83.18 - Northbound Side - AM

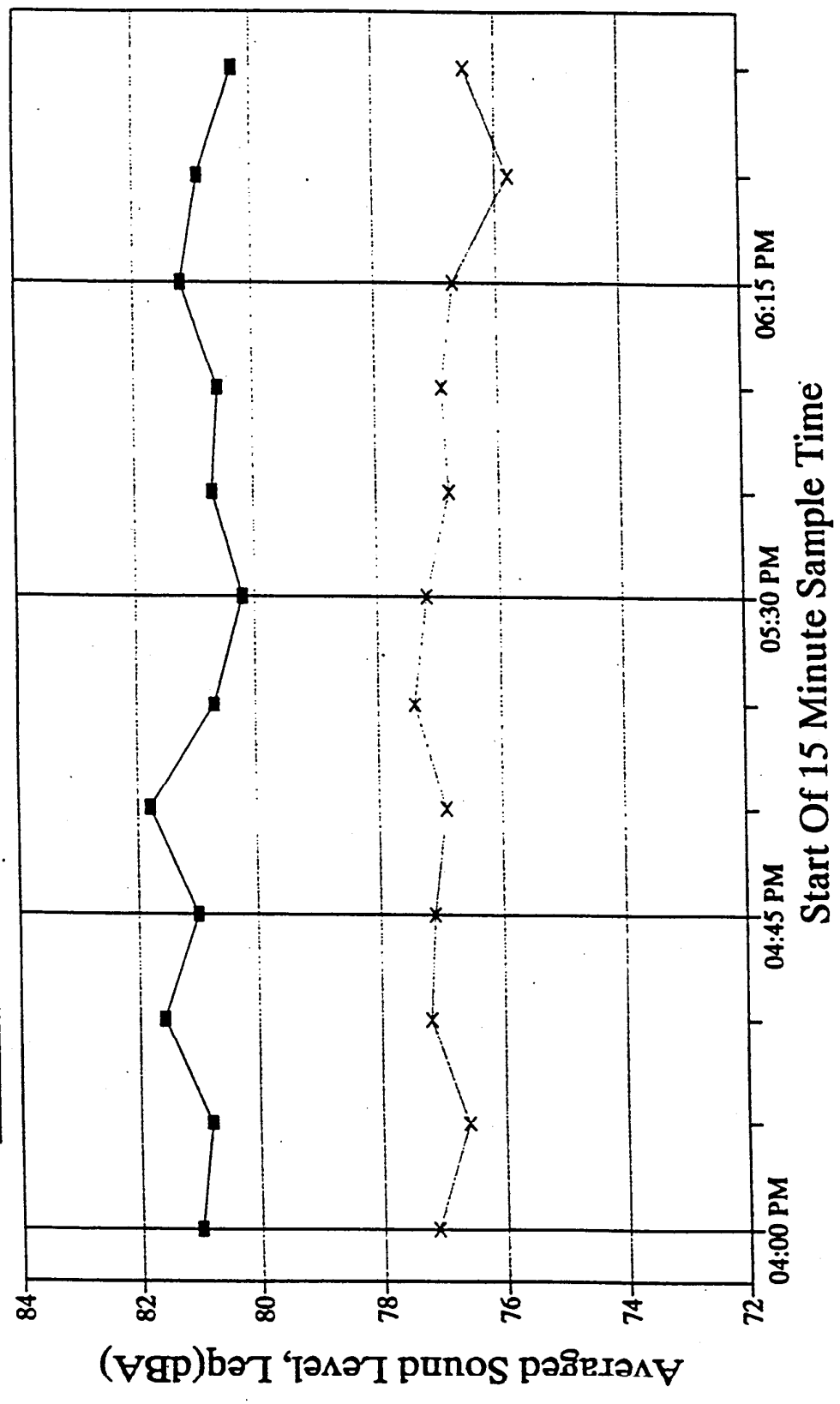
Figure 13



—■— Before Paving ...x... After Paving

**Measured Sound Levels Before and After  
Milepost 83.18 - Northbound Side - PM**

Figure 14



—■— Before Paving    ····×··· After Paving