EVALUATION OF TRANSTECH JOINT MAKER AND PRECOMPACTION SCREED

FINAL REPORT

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NOTICE

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INTRODUCTION

The primary objective of this evaluation is to determine the effectiveness of the Joint Maker and Precompaction Screed, both developed by TransTech Systems, Inc., in achieving higher and more uniform density across the mat of a Hot Mix Asphalt (HMA) pavement by increasing the density in the problem areas. Low-density areas and non-uniform density measured transversely across HMA mats have long been a concern and a point of weakness in HMA pavement. The major concern is the density along the longitudinal edges and wheel paths are low as compared to the rest of the cross sectional area of an HMA pavement. On the longitudinal edges, the low density is a result of not having a confined edge when using the breakdown rollers or not enough material being distributed to the edge of the screed during paving. These low densities lead to high permeability and rapid deterioration due to greater oxidation from higher air voids. In some instances, cracking and raveling is a result of this pavement deficiency. Current paving methods do not adequately address the longitudinal edge problem. Low density is also a common observance in the wheel paths of an HMA overlay. Paving a road with a uniform cross slope is adequately accomplished using current methods. The linear surface of the screed allows for asphalt to be placed parallel to the existing surface to produce a uniform thickness and density across the HMA mat. Since most road surfaces contain some degree of rutting, the linear screed distributes the HMA across a nonlinear surface. This produces a differential thickness of HMA being placed in the rutted areas. The compaction rollers bridge these areas by riding the high spots, areas adjacent to the rutted paths, and do not achieve the desired density. All this leads to consolidation of the mix in these areas under highway traffic. The low density in the wheel path areas is addressed by cold milling prior to the overlay to remove the ruts and sometimes by placing a leveling course to restore the transverse profile prior to the overlay. In the milling process, a binder course is usually required prior to the wearing course. These techniques add substantially to the cost of the overlay.

TransTech Systems, Inc. has developed these two attachments for the benefit of doing a single overlay without sacrificing the quality of density achieved in the paving process. Both devices work on the same principal, precompacting asphalt mix just ahead of the paver screed by extruding the mix under a shoe attachment bolted onto the screed. The Joint Maker is an eight inch wide attachment bolted to the paver screed extension (see figure 1). The Precompaction Screed consists of two attachments, each three feet wide, placed in front of the pavers main screed in the wheel path areas (see figure 2). The manufacturer states these devices will increase compaction by 2% to 3% in the problem areas. If this statement is accurate, these simple devices can help overcome the low-density problem and foster uniform performance of the entire pavement width. Tests in other states have shown good results.

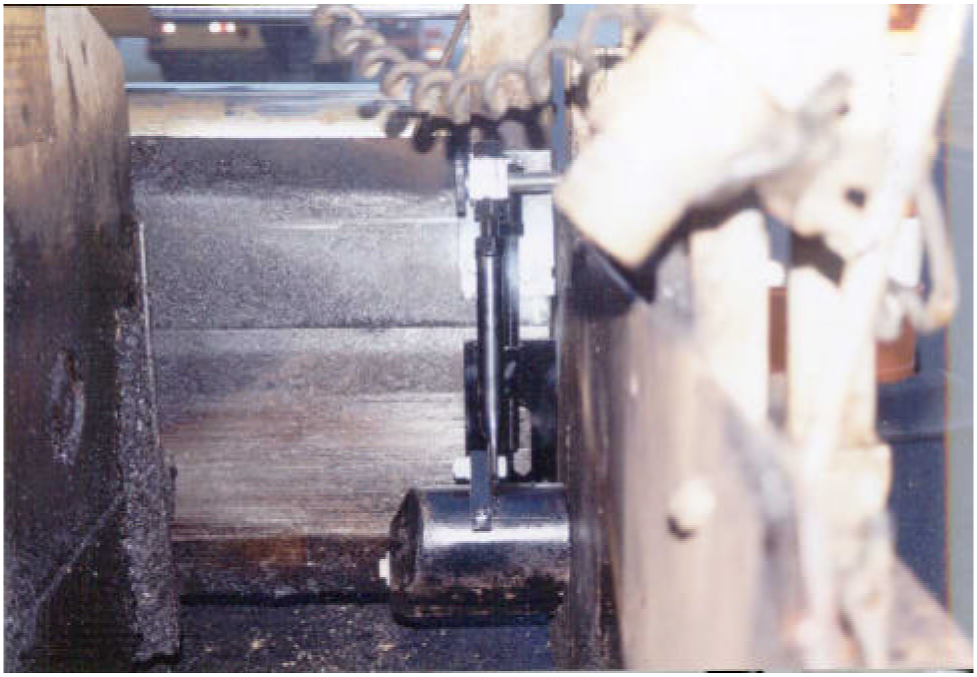

Figure 1. Joint Maker attached to screed extension.

Figure 2. Precompaction Screeds.

ESTABLISHING ANALYSIS SECTIONS AND EVALUATION PLAN

A roadway section in need of rehabilitation on U.S. Highway 82 East (US82E) in Lowndes County was chosen as the site for monitoring the performance of the Precompaction Screed and the Joint Maker. This section was chosen because of the amount of rutting that existed and the willingness of the contractor, APAC-Mississippi, Inc., to allow the placements of the attachments onto their paving screed. Three sections were established for this analysis, a Control section, a TransTech section and an extended Joint Maker section. The Control and the TransTech sections are approximately one mile in length. The Control section is from Sta. 570+00 to Sta. 622+50 and the TransTech section is located between Sta. 700+00 to Sta. 752+00. The Control section will be paved without any use of the precompaction devices. The TransTech section will utilize the devices and be compared with the Control section. The extended Joint Maker section will extend past the previous two from Sta. 810+00 to Sta. 820+00. The purpose of this section is to obtain some outside edge density readings after the Joint Maker is installed on the outside edge of the paver. The 11ft spreader lacked enough width to install the Joint Maker on both sides of the spreader at the same time, therefore the TransTech section will have the Joint Maker on the inside edge.

This analysis will concentrate on two different comparisons. One comparison is to determine if the density in the areas of the wheel path and unbound edge increase from that of the Control sections respective areas. Also, a comparison of uniform density will be observed. The uniformity of the density measured transversely across the mat of the TransTech section should improve from that of the Control section. Density measurements will be taken in each section at 250 ft intervals with a nuclear gauge testing device. There will be five readings taken across the mat at each station of data collection (see figure 3 and figure 4). Notice there is a one-foot overlap of the centerline of the original road which explains the reason for the 1 ft, 2 ft, 5 ft, 8 ft and 10 ft readings. Normally, the measurements would originate from the centerline at 1 ft (left edge reading), 3 ft (left wheel path), 6 ft (center of lane), 9 ft (right wheel path) and 11 ft (left edge reading).

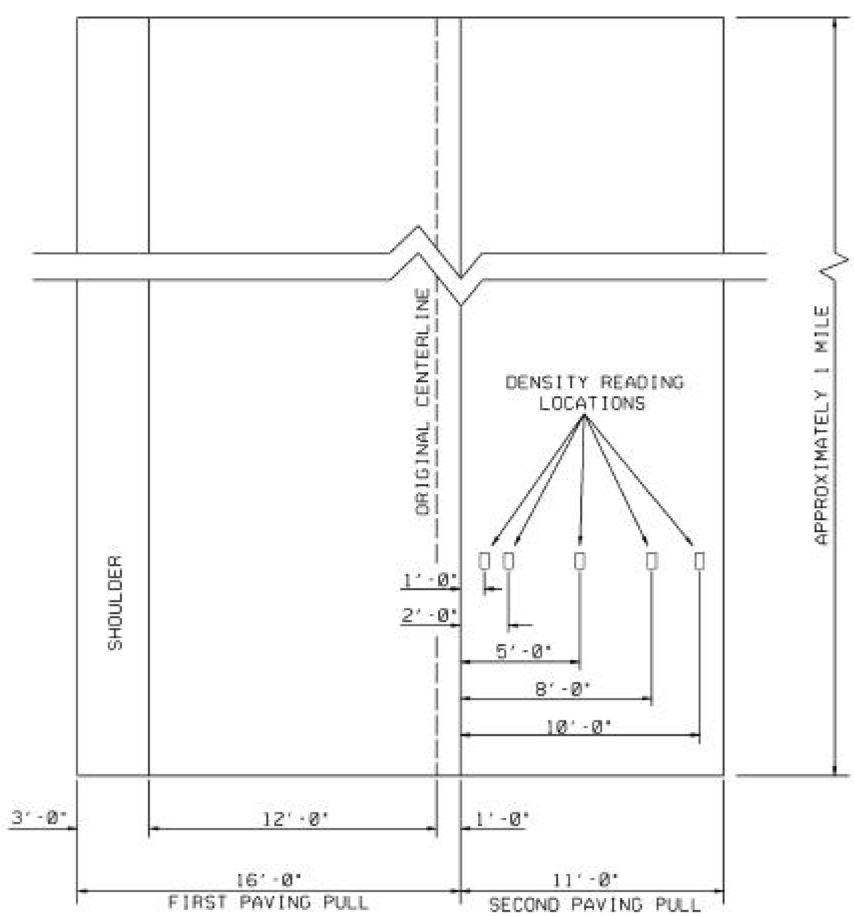

Figure 3. Nuclear Density Gauge reading locations for both sections

Figure 4. Rear view of location of nuclear density readings.

CONSTRUCTION AND DATA COLLECTION

Construction of the analysis sections commenced on September 25, 1999 with the paving of a three-inch binder course on the existing rutted pavement of US82E in Lowndes County. Before the actual paving began, rut data was collected (see table 1). When analyzing the data, it is important to compare locations of the two sections with the same degree of rutting. The analysis sections are in the outside lane of the eastbound direction of US82E. The inside lane, a three-foot shoulder and an extra foot overlapping the centerline of the original surface was paved first (see figure 3). The first of the two sections paved was the Control section. The Control section was paved with no attachments on the paver. The purpose is to provide a "control" section for comparison to the TransTech and extended Joint Maker section. A windrow paving technique was utilized for the paving on this project (see figure 5). Behind the spreader, mat temperature readings were collected in case any out lying data was present (see table 2). After overlaying the mix, breakdown rollers achieved density through a previously established rolling pattern. The mat was allowed to cool for several hours. Density readings commenced on each section and were completed the same day. Table 3 contains the density readings for the Control section and Table 4 for the TransTech section. Table 5 reflects the density readings collected from the extended Joint Maker section in the area of the outside edge of the pavement.

Figure 5. Windrow paving process.

Table 1. Rutting in 1/16 of an inch increments for each section.

Control Section

Station	Left Wheel Path (1/16 in)	Right Wheel Path (1/16 in)
570+00	4	5
572+50	3	3
575+00	3	4
577+50	PATCH	
580+00	3	5
582+50	4	3
585+00	3	5
587+50	3	3
590+00	4	2
592+50	3	5
595+00	5	6
600+00	5	4
602+50	3	1
605+00	3	3
607+50	3	5
610+00	5	4
612+50	3	3
615+00	3	6
617+50	3	4
622+50	4	4

TransTech Section

Station	Left Wheel Path (1/16 in)	Right Wheel Path (1/16 in)
700+00	5	4
702+50	4	3
705+00	4	9
707+50	6	7
710+00	4	7
712+50	5	6
715+00	6	6
717+50	4	7
720+00	6	6
722+50	7	8
725+00	5	5
730+00	6	5
732+50	4	4
735+00	4	4
737+50	6	6
740+00	6	8
742+50	7	6
745+00	4	4
747+50	5	6
752+50	4	7

Table 2. Ambient air temperatures and mat temperatures behind paver.

Control Section

Station	Date	Air (°F)	Mat (°F)
570+00	09/27/99	84	297
572+50		84	296
575+00		84	297
577+50	**PATCH**		
580+00		84	285
582+50		83	297
585+00		83	287
587+50		83	306
590+00		83	307
592+50		83	309
595+00		83	298
597+50		84	305
600+00		84	304
602+50		84	292
605+00		84	290
607+50		84	297
610+00		84	304
612+50		84	285
615+00		84	297
617+50		84	319
620+00		84	309
622+50		83	318

TransTech Section

Station	Date	Air (°F)	Mat (°F)
700+00	09/28/99	76	331
702+50		76	280
705+00		76	290
707+50		76	267
710+00		76	307
712+50		76	287
715+00		76	305
717+50		76	279
720+00		79	298
722+50		79	288
725+00		79	289
727+50		79	300
730+00		79	280
732+50		79	288
735+00		79	294
737+50		83	289
740+00		83	286
742+50		83	294
745+00		83	300
747+50		83	287
750+00		83	309
752+50		83	300

Table 3. Density readings (lb/cf), averages (lb/cf) and standard deviations for Control Section.

Station	Density Reading Location					Average	Standard Deviation
	1 ft	2 ft	5 ft	8 ft	10 ft		
570+00	134.4	136.7	136.4	136.0	132.1	135.1	1.9
572+50	136.9	137.6	135.7	133.4	132.7	135.3	2.1
575+00	136.1	135.4	134.3	132.3	128.7	133.4	3.0
577+50	**PATCH IN ROAD**						
580+00	139.4	134.9	135.1	132.7	131.4	134.7	3.0
582+50	136.3	134.4	135.7	136.5	131.6	134.9	2.0
585+00	133.4	135.3	136.5	135.8	131.0	134.4	2.2
587+50	137.3	135.9	139.6	137.4	133.6	136.8	2.2
590+00	137.3	137.7	140.2	140.6	133.7	137.9	2.8
592+50	137.1	136.8	138.5	136.4	133.4	136.4	1.9
595+00	134.6	134.9	136.7	134.9	133.1	134.8	1.3
597+50	135.8	135.7	138.9	138.7	133.4	136.5	2.3
600+00	135.3	134.4	136.4	136.2	133.7	135.2	1.6
602+50	133.1	135.2	135.2	135.5	132.6	134.3	1.4
605+00	127.2	128.3	130.9	130.6	130.6	129.5	1.7
607+50	131.5	131.9	133.0	133.1	130.0	131.9	1.3
610+00	133.4	134.6	134.5	137.3	133.8	134.7	1.5
612+50	133.0	133.4	133.9	133.7	130.2	132.8	1.5
615+00	134.5	133.5	132.6	132.8	130.9	132.9	1.3
617+50	134.7	134.3	135.6	134.9	134.3	134.8	0.5
620+00	133.4	132.7	135.7	133.6	131.6	133.4	1.5
622+50	131.5	132.2	133.9	133.6	129.4	132.1	1.8
Total Avg.	**134.6**	**134.6**	**133.9**	**135.7**	**135.0**	**134.4**	**1.8**

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Table 4. Density reading (lb/cf), averages (lb/cf) and standard deviations for TransTech Section.

Station	Density Reading Location					Average	Standard Deviation
	1 ft	2 ft	5 ft	8 ft	10 ft		
700+00	134.4	136.1	135.8	136.6	131.7	134.9	2.0
702+50	134.6	135.2	138.0	134.6	130.6	134.6	2.6
705+00	135.5	137.5	138.2	138.2	135.7	137.0	1.3
707+50	134.1	137.6	137.2	135.5	133.6	135.6	1.8
710+00	136.0	136.8	137.8	137.7	134.5	136.6	1.4
712+50	137.6	138.8	137.3	135.2	133.9	136.5	2.0
715+00	133.6	135.3	137.8	137.5	132.8	135.4	2.2
717+50	137.5	136.7	139.8	136.6	132.1	136.5	2.8
720+00	135.4	137.3	138.7	136.6	134.1	136.4	1.8
722+50	132.4	136.0	137.2	134.5	132.2	134.5	2.2
725+00	138.1	137.6	139.9	138.6	136.8	138.2	1.2
727+50	135.5	136.4	137.6	138.6	136.1	136.8	1.2
730+00	136.0	138.3	142.4	139.9	134.4	138.2	3.2
732+50	135.9	139.6	142.3	138.7	135.2	138.3	2.9
735+00	136.0	137.6	138.1	136.6	132.1	136.1	2.4
737+50	140.1	140.5	140.2	135.8	134.1	138.1	3.0
740+00	141.5	140.4	142.7	140.8	139.4	141.0	1.2
742+50	138.2	141.4	142.9	141.6	136.3	140.1	2.7
745+00	139.2	139.5	142.7	141.1	138.3	140.2	1.7
747+50	139.1	139.2	141.1	137.4	136.6	138.7	1.8
750+00	138.9	141.0	142.2	140.8	136.6	139.9	2.2
752+50	138.2	138.3	140.0	139.3	136.0	138.4	1.5
Total Avg.	**136.7**	**138.1**	**139.5**	**137.8**	**134.7**	**137.4**	**2.1**

Table 5. Density readings (lb/cf) for outside edge of extended Joint Maker Section.

Station	Density Reading Location					Average	Standard Deviation
	1 ft	2 ft	5 ft	8 ft	10 ft		
810+00					134.9		
811+00					135.7		
812+00					136.8		
813+00					135.2		
814+00					137.2		
815+00					136.4		
816+00					137.1		
817+00					136.8		
818+00					136.2		
819+00					135.1		
820+00					137.2		
Total Avg.					**136.2**		

RESULTS AND SUMMARY

Initially, the standard deviation of the density across the mat at each station was to be the basis in proving a more uniform compacted asphalt mat. After calculating the standard deviation at each station, an average of these values was calculated for each section. A smaller value of the average was anticipated for the TransTech section over the Control section. This proved false and should indicate less uniformity across the mat of the TransTech section. One potential reason for the lower standard deviation in the Control section could be that no attachments were placed before the paving screed to predensify any part of the mat. The asphalt is being distributed with the same consistency across the mat. Even though ruts exist, a more uniform density was provided for the Control section as compared to the TransTech section. The TransTech section also had a Joint Maker on the inside edge next to the existing mat edge of paving. The outside edge, not having a Joint Maker due to lack of width on an 11ft spreader, had a significant drop off in density compared to the rest of the mat. This would produce a higher standard deviation for this section.

Before comparing each sections respective density areas to the other, a comparison was observed within each section. The Control section's average density in the ruts was actually higher than the average density in the middle of the lane for this section. From one school of thought, this is due to the capability of achieving higher density in thicker layers of asphalt. It was the opposite in the TransTech section. The middle of the lane had a higher density than that of the rutted locations. This could possibly be explained by the Precompaction Screeds edge being ½ ft on both sides of the center lane density location. The adjacent compacting screeds effected the density in the middle by raising the value.

After observing the data, the best comparison for establishing the effectiveness of the Precompaction Screeds is to observe the average density values of the wheel paths for each section and compare the two. A total average of all the density in the rutted areas for each section was calculated and compared (see table 6). With the understanding that some ruts are deeper in spots than others, equivalent rut areas were sorted and a comparison was made. This will eliminate factors of differential thickness when comparing the densities.

Table 6. Comparison of Rut Area Densities (lb/cf).

	Control Section		TransTech Section	
Total Density Average	135.2		138.0	
4/16 inch Rut Density Average	135.0		138.4	High
			137.1	Low
5/16 inch Rut Density Average	135.4	High	138.4	
	134.2	Low		

Note: A high average and a low average is being calculated for the TransTech 4/16 inch and for Control 5/16 inch rutted areas. This is due to one section having more data points, therefore, a high and a low with the same number of data points was calculated to keep the comparison even.

An overall average comparison was observed for the Joint Maker areas also (see table 7). The Joint Maker was placed on the inside edge in the TransTech section and was compared to the inside edge of the Control section. The Joint Maker was then placed on the outside edge for the extended section and density data was collected.

Table 7. Comparison of Joint Edge Densities (lb/cf).

	Control Section	TransTech Section	Extended Section
Inside Edge Average Density	134.6	136.7	
Outside Edge Average Density	135.0		136.2

Note: Only the values from the sections of comparison are listed for this analysis.

In summary, the TransTech Precompaction Screeds and the Joint Maker do provide for a higher compacted density in the areas of concern for asphalt paved mats. A more uniform density across the mat may have not been achieved in these test sections, but other variables as stated before could be the cause. A section where the Joint Maker could be installed on both sides while paving would be a better section for uniformity analysis when comparing to a Control section. The average density across all the ruts was 135.2 lb/cf in the Control section. The average density was 138.0 lb/cf in the TransTech section. This is a 2.1% increase from the Control to the TransTech section in the density value measured. This equates to a 2.0% increase in percent density achieved relative to the mix design of this particular job. When making a comparison between equal rutted area, an increase is observed in the 4/16 inch ruts from 135.0 lb/cf in the Control section to a high value of 138.4 lb/cf or a low value of 137.1 lb/cf in the TransTech section. Both the high and the low averages of the TransTech section was higher than the Control sections average density for asphalt placed in 4/16 of an inch ruts. There were more data points with 4/16 of an inch rut in the TransTech section than that of the Control section. The same number of points, as in the Control section, was taken out of the TransTech section while eliminating the high and low values. This is to make sure the worst case scenario of the TransTech, the low values, is still higher than the average density of the Control section. When comparing to the low, there was a 1.6% increase in the value. This equates to an increase of 1.5% increase in percent density achieved relative to the mix design of this particular job. The high and the low of the 5/16 of an inch in the Control section were lower than that of the TransTech section. The Control section in this case happened to be the section with the most data points, therefore, the high values for the Control section will be compared to the values of the TransTech section. The high value for the Control section was 135.4 lb/cf and 138.4 lb/cf for the TransTech section. This is a 2.2% increase in the value for density and a 2.1% increase in percent of density achieved for this particular mix. For the edge values, the inside edge for the Control section had an average density value of 134.6 lb/cf and 136.7 lb/cf for the inside edge of the TransTech section. This is a 1.6% increase in value and a 1.4% increase in percent of maximum density achieved for the mix. The outside edge has an average value of 135.0 lb/cf for the Control section and 136.2 lb/cf for the section extended to obtain these measurements with the use of the Joint Maker on the outside edge. The is an increase of 0.9% in the value and a 0.8% increase in maximum density achieved for this particular mix design.

In all cases compared, the TransTech attachments increased the densities. Hopefully, this will result in less potential for rutting and fatigue distresses in the wheel paths as well as fewer distresses on the joint edges of a paved mat.

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15. Supplementary Notes

16. Abstract

The primary objective of this evaluation is to determine the effectiveness of the Joint Maker and Precompaction Screed, both developed by TransTech Systems, Inc., in achieving higher and more uniform density across the mat of a rehabilitated Hot Mix Asphalt pavement by increasing the density in the problem areas. The problem areas consist of the rutted areas and the longitudinal joint edges. TransTech Systems, Inc. has developed these two attachments for the benefit of doing a single rehabilitation overlay without requiring preparatory work to the problem areas. The major advantage would be derived from not having to cold mill or preliminarily level the existing rutted areas prior to the surface overlay. This would ultimately reduce project costs.

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