HIGHWAY FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

Highway Attachment – FHWA-TFHRC Aggregate and Petrography Laboratory (APL) Report of Petrographic Analyses

Biloxi, Mississippi

HWY17MH010

(16 pages)

FHWA-TFHRC AGGREGATE AND PETROGRAPHY LABORATORY (APL)
REPORT OF PETROGRAPHIC ANALYSES

September 16, 2017

RE: Brief Visual Examination Report of NTSB Asphalt Pavement Cores from Biloxi, Mississippi

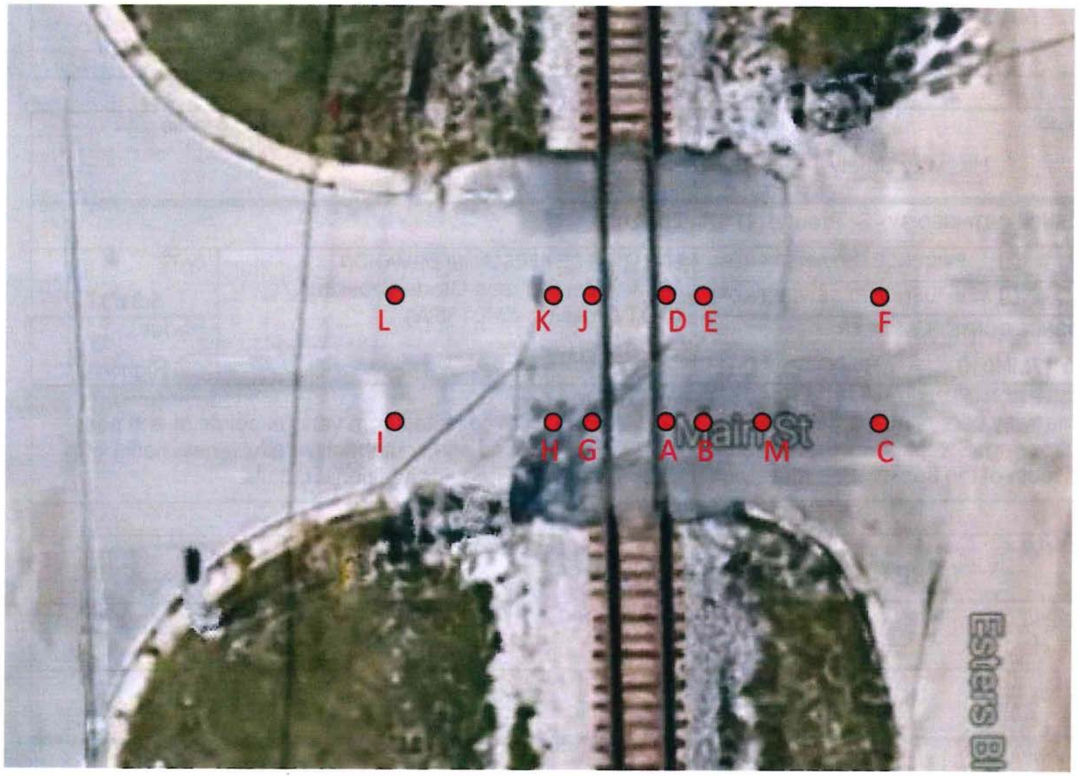
The picture included below “NTSB Evidence # HWY17MN010-HWY-001” shows the locations of the drilled core samples from the at-grade railroad crossing under investigation.

Thirteen asphalt core samples (Figure 1 through 7) extracted by NTSB from the above at-grade railroad crossing pavement structure were submitted to the TFHRC Aggregate and Petrography Laboratory (APL) by Mr. Mark Swanlund, FHWA-TFHRC Infrastructure Research and Development Research Program Manager. Mr Swanlund reported receiving the cores directly from the NTSB and the two boxes were opened in the presence of the NTSB investigators on July 18, 2017 during their visit to TFHRC. Following visual examination that day by Steve Prouty, NTSB; Pete Kotowski, NTSB; Chris Moale, CSX; Richard Meininger, FHWA; and Mark Swanlund, FHWA the samples were submitted to APL to identify the number of pavement layers and included lifts and their thickness in each core, as well as to determine if the mixture in each layer/lift appear to be different or the same compared to other observed layers/lifts in the same sample or other samples based upon the aggregate type(s), size, shape, abundance and distribution. The background information submitted to TFHRC including the locations of the cores and other information are given below.

Note that the terminology generally used for asphalt pavements is that pavement “layers” or “asphalt mixture layers” generally are different mixtures/materials, often placed at different times. Whereas a “lift” within a pavement layer is generally of the same or similar mixture/material placed and compacted the same day or within several days.

Summary of visual observations of the submitted asphalt core samples are presented below following the core location picture.

NTSB Evidence # HWY17MH010-HWY-001 Core Sample Locations



Sample	Distance from Nearest Rail	Distance from Main Street Painted Centerline	Approximate Core Sample Length
A	13.5 in. North	6 ft. East	8 in.
B	4 ft. North	6 ft. East	5.5 in.
C	21 ft. North	6 ft. East	11.5 in.
D	13.5 in. North	6 ft. West	9 in.
E	4 ft. North	5.5 ft. West	4 in.
F	21 ft. North	6 ft. West	12.5 in.
G	13.5 in. South	6 ft. East	8 in.
H	4 ft. South	6 ft. East	11 in.
I	28 ft. South	6 ft. East	23 in.
J	13.5 in. South	6 ft. West	7.5 in.
K	4 ft. South	6 ft. West	11.5 in.
L	28 ft. South	6 ft. West	19 in.
M	10.5 ft. North	6 ft. East	10 in.[a]

[a] - Sample drill was at a depth of 15 inches, and had not reached the bottom of the asphalt layer. Unable to effectively advance the drill any farther. Only able to recover the top 10 inches of the sample.

Summary of Visual Observation

For the convenience of presentation, the submitted core samples are presented below under two separate categories: (1) Cores extracted relatively close to the nearest rail, and (2) Cores extracted relatively far from the nearest rail.

1. **Cores Relatively Close to the Nearest Rail**

The number of observed lifts (from top to bottom) and their thickness, and information on the mixture aggregate type of each lift is given in Table 1. In this case for all the cores near the rails the asphalt mixture appears the same; and accordingly, any lift lines probably reflect different lifts of asphalt mixture placed and compacted within a short time as the pavement was reconstructed near the rails.

Table 1. Number of Lifts and Approximate Lift Thickness for Cores Relatively Close to the Rails

Core ID	Distance from the Nearest Rail	Lifts		Lift Mixture Aggregate Description (Visual) (* or #)
		Lift No. from top to bottom)	*Approximate Lift Thickness*	
Core A	342.9 mm (13.5 in) north.	Lift 1	40 mm (1.6 in.)	*Mixture appears the same in all
		Lift2	120 mm (4.7 in.)	*
		Lift3	40 mm (1.6 in.)	*
Core B	1.2 m (4ft) north			
		Lift1	40 mm (1.6 in.)	*
		Lift2	90 mm (3.5 in.)	*
Core D	342.9 (13.5 in.) north	Lift1	40 mm (1.6 in.)	*
		Lift2	120 mm (4.7 in.)	*
		Lift3	60 mm (2.4 in.)	*
Core E	1.2 m (4 ft) north	Lift1	75 mm (3.0 in)	*
		Lift2	35 mm (1.4 in)	*
Core G	342.9 mm (13.5 in) south.	Lift1	45 mm (1.8 in.)	*
		Lift2	73 mm (2.9 in.)	*
		Lift3	82 mm (3.2 in.)	*
Core H	1.2 m (4ft) south	Lift1	80 mm (3.1 in.)	*
		Lift2	60 mm (2.4 in.)	*
		Lift3	60 mm (2.4 mm)	*
		Lift4	70 mm (2.8 in.)	*
Core J	342.9 mm (13.5 in.) south	Lift1	45 mm (1.8 in.)	*
		Lift2	90 mm (3.5 in.)	*
		Lift3	55 mm (2.2 in.)	*

Core K	1.2 m (4 ft) north	Lift1	60 mm (2.4 in.)	*
		Lift2	90 mm (3.5 in.)	*
		Lift3	50 mm (2.0 in.)	*
		Lift4	70 mm (2.8 in.)	*
* Mixture appears the same in all cores and lifts				

The lift lines observed in almost all of the cores relatively close to the nearest rail (Cores: A, B, D, E, G, H, J, and K) are not clearly traceable around the cylindrical cored surfaces and often are undulatory and discontinuous. Due to this reason, lift thickness provided in Table 1 above for these samples should be considered as rough estimates. If tracing the exact locations of each lift line, and thus accurate lift thickness measurements are needed, these cores need to be sawed longitudinally and observation and measurements need to be conducted on the freshly cut cross-sectional surfaces. Based upon visual observation, all the observed lifts in each core appears to have similar aggregate types. While the coarse aggregates are partially crushed dominantly natural siliceous aggregates, the fine aggregates are dominantly crushed limestone particles with angular and equant to somewhat elongate shapes. Cores A, B, E, G, and K exhibit larger crushed coarse aggregate ballast aggregate particles attached or loose at the bottom ends of the cores (Figures 1 through 4). This is consistent with the possibility that all eight of these close-in cores are from an asphalt pavement layer placed at about the same time with the same asphalt mixture, with the lift lines present just showing the several lifts of mixture compacted in place during manual replacement of the pavement close to the rails. It appears that this mixture was placed on top of the ballast aggregate and ends of the wooden cross ties, as evidenced by pieces of large ballast aggregate at the bottom of several cores and a piece of wood at the bottom of Core D.

2. **Cores Relatively Far from the Nearest Rail**

Most of the core samples that fall under this category contain clearly different pavement layers which show variability in aggregate type, size, abundance and distribution. The number of observed layers and pavement lifts (from top to bottom) and their thickness, and information on the mixture aggregate type based upon the visual observation is given in Table 2 below.

Table 2. Layers/Lifts and Approximate Thickness for Cores Relatively Far From the Nearest Rail (more than 4 ft.)

Core ID	Distance from the Nearest Rail	Layer		Lift Mixture Aggregate Description (Visual)
		Layer No.(top to bottom)	*Approximate Layer Thickness*	
Core C (Note – F and C are adjacent to each other on the north/ Esters side of the track. Overall, they have similar layers; it is likely paving layers were added sequentially at these two locations at the same time.)	6.4 m (21 ft) north.	Layer 1 C-1	40 mm (1.6 in.)	Predominantly smaller natural siliceous aggregate with observed maximum size of about 8 mm (0.31 in.).
		Layer 2 C-2	65 mm (2.6 in.)	Aggregate in this layer is partially crushed dominantly siliceous natural aggregate with the observed maximum size of 12.5mm (1/2 in.).
		Layer 3; C-3	65 mm (2.6 in.)	Same as layer 2.
		Layer 4; C-4	About 130 mm (5 in.)	Same as layers 2 and 3 – with two or three lifts of similar materials.
Core F Core came broken into three pieces. (** Layer F-1 is deteriorated and mostly missing, with a few coarser aggregate particles visible.)	6.4 m (21 ft) north.	Layer 1; F-1	About 40 mm (1.6 in.)? **	All the layers in this core appear to have similar aggregate types and distribution: Relatively well distributed siliceous natural aggregates with lesser amounts of coarse sand fractions. (And these layers are similar to layers 2, 3, and 4 of Core C.)
		Layer 2; F-2	70 mm (2.7 in.)	
		Layer 3; F-3	80 mm (3.1 in.)	
		Layer 4; F-4	130 mm (5 in.), with 2 or 3 lifts	
Core I Core received broken into three pieces	8.5 m (28 ft south	Layer 1 Layer I-1	30 mm (1.2 in.) Similar to L-1	Consists of crushed aggregate with observed maximum size of about 7 mm (0.3 in.).
		Layer 2; I-2	40 mm (1.6 in.) Similar to L-2, M-2, C-1, F-1	Partially crushed smaller size dominantly siliceous gravel with an observed maximum size of about 7 mm (0.3 in.)
		Layer 3; I-3	60 mm (2.4 mm) Similar to L-3	A mixture of crushed lighter gray what appears to be cinders? and siliceous gravels (max observed size of aggregate is about 7 mm (0.3 in.).
		Layer 4; I-4	60 mm (2.4 in.)	Similar to layer 3 above and L-4.
		Layer 5; I-5	30 mm (1.2 in.)	Smaller aggregates consisting dominantly of what appears to be crushed cinders (?) with lesser amounts of smaller size siliceous aggregates.
		Layer 6; I-6	90 mm (3.5 in.) Two lifts of about 60 and 30 mm, respectively.	Aggregates, especially the coarser ones are dominantly the lighter gray what appears to be cinders? with scarce amount of siliceous aggregate particles.
		Layer 7; I-7	110 mm (4.3 in.)	This layer consists of relatively lower volume siliceous aggregate particles;

				maximum observed size of aggregate is about 12.5 mm (1/2 in.).
		Layer 8; I-8	55 mm (2.2 in.)	This layer exhibits sparsely distributed coarser size aggregates (max. observed size of about 15 mm ([0.6 in.]) with traces of lighter gray what appears to be cinder particles?
		Layer 9; I-9	60 mm (2.4 in.)	This layer exhibits relatively high aggregate volume (siliceous aggregates with traces of smaller size cinders?).
		Layer 10; I-10	110 mm (4.5 in.) With 2 layers or lifts apparent that may have been placed at the same time?	The observed aggregate in this layer is somewhat similar with the aggregates observed in layer 8. Locally relatively large coarse aggregate size observed (19.4 mm [3/4 in.]).
Core L Core received broken into three pieces.	8.5 m (28 ft) south	Layer 1 Layer L-1	15 mm (0.6 in.)	Crushed limestone with maximum observed size of about 6 mm (0.2 in.)
Core L (Continued)		Layer 2; L-2	23 mm (0.9 in.)	Partially crushed dominantly siliceous natural aggregate with a maximum observed size of about 5 mm (0.2 in).
		Layer 3; L-3	70 mm (2.8 in.)	Aggregates are a mixture of somewhat porous aggregate (cinders?) and siliceous natural aggregates.
		Layer 4; L-4	80 mm (2.9 in.)	Aggregates are similar to layer 3.
		Layer 5; L-5	35 mm (1.8 in.)	Dominantly lighter gray smaller size somewhat porous aggregates (cinders?) mixed with lesser amount of siliceous aggregates.
		Layer 6; L-6	70 mm (2.8 in.)	Aggregate types similar to the layer 5 but in this layer aggregate particles are relatively larger (observed maximum size of 12.5 mm (1/2 in.)
		Layer 7; L-7	70 mm (2.8 in.)	Dominantly siliceous gravel (maximum observed size of about 12.5 mm) with traces of lighter gray smaller aggregate particles.
		Layer 8; L-8	55 mm (2.1 in.)	Dominantly siliceous aggregates with traces of lighter gray smaller aggregate particles; maximum observed aggregate size is 18 mm (0.70 in.).
		Layer 9? Layer L-9?	60 mm (2.4 mm)	Sample broken off the bottom of layer 8 and it is likely the it was broken along a layer/lift line? Aggregate is similar to layer 8.

Core M Core received broken into four pieces.	3.2 m (10.5 ft) north	Layer 1 Layer M-1	30 mm (1.2 in.)	This layer is somewhat similar to the aggregate types described for cores closer to the rails (Cores A, B, D, E, H, G, K, and J)- Siliceous coarse aggregates with crushed smaller limestone fine aggregates. This is consistent with the core location picture showing feathering of top asphalt layer near the rails out to include Core location M.
		Layer 2; M-2	30 mm (1.2 in.)	Smaller size dominantly siliceous aggregates (max. observed size of about 8 mm). This is similar to layer 2 for Cores L and I, and layer1 of C and F.
		Layer 3; M-3	70 mm (2.8 in.)	This layer consists relatively coarser dominantly siliceous natural aggregates with an observed maximum size of an aggregate is about 12.5 mm (1/2in.). This is similar to layer 2 for Cores C and F.
		Layer 4; M-4	50 mm (2.0 in.)	Aggregates are similar to the layer 2.
		Layer 5; M-5	70 mm (2.8 in.)	Dominantly siliceous aggregates similar to layer 3. Note that the core did not extend to the bottom of the pavement.

As shown in Table 2, asphalt cores extracted relatively far away from the rails are thicker with the number of layers ranging from four to ten. Based upon the similarities of the observed layers and their aggregate types, Core I and Core L appear to have a similar placement/construction history (Figure 6). For the same reasons, Core C and Core F also show a similar placement/construction history (Figure 5). Figure 8 (as a separate Word file) shows Cores L, I, M, C, and F lined up, with the core-tops up and with approximate layer lines and lift lines also shown. Should you have any questions regarding this information, please do not hesitate to contact us.

Sincerely,

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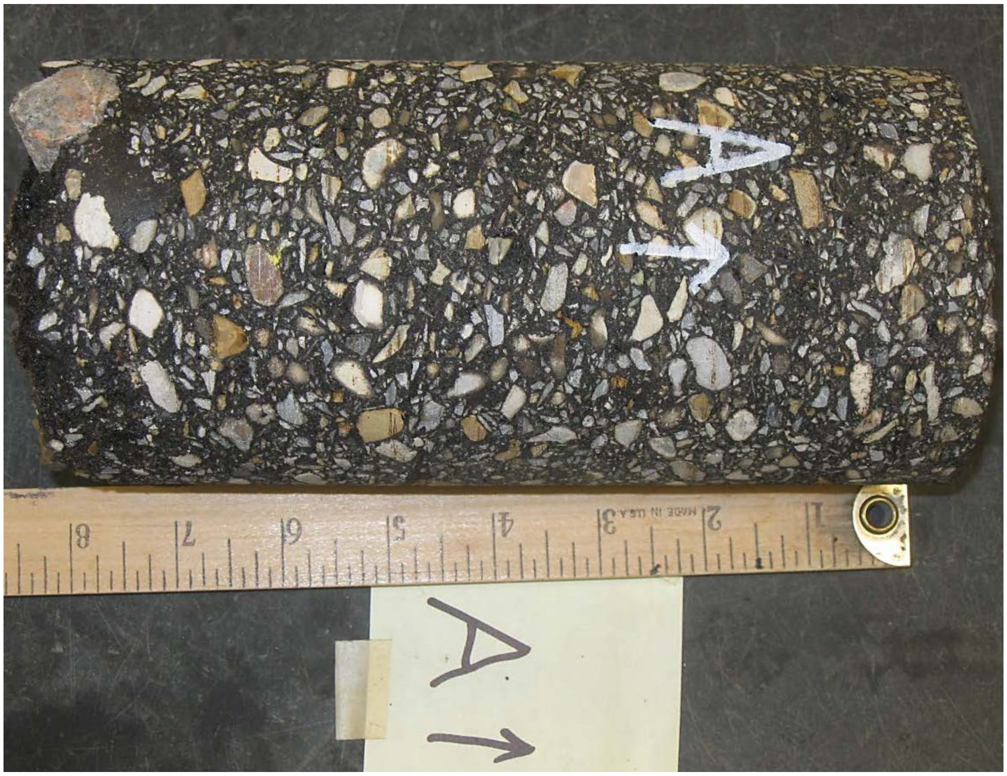


Figure 1. Photographs of cores A and B as-received for visual examination. Top end in each core placed to the right.

Figure 2. Photographs of cores D and E as-received for visual examination. Top end in each core placed to the right.

Figure 3. Photographs of cores G and H as-received for visual examination. Top end in each core placed to the right.

Figure 4. Photographs of cores J and K as-received for visual examination. Top end placed to the right. Note the crushed coarse aggregate ballast attached to the bottom end of the core K (left end).

Figure 5. Photographs of cores C and F as-received for visual examination. Top end in each core placed to the right. Core 5 received broken in three pieces.

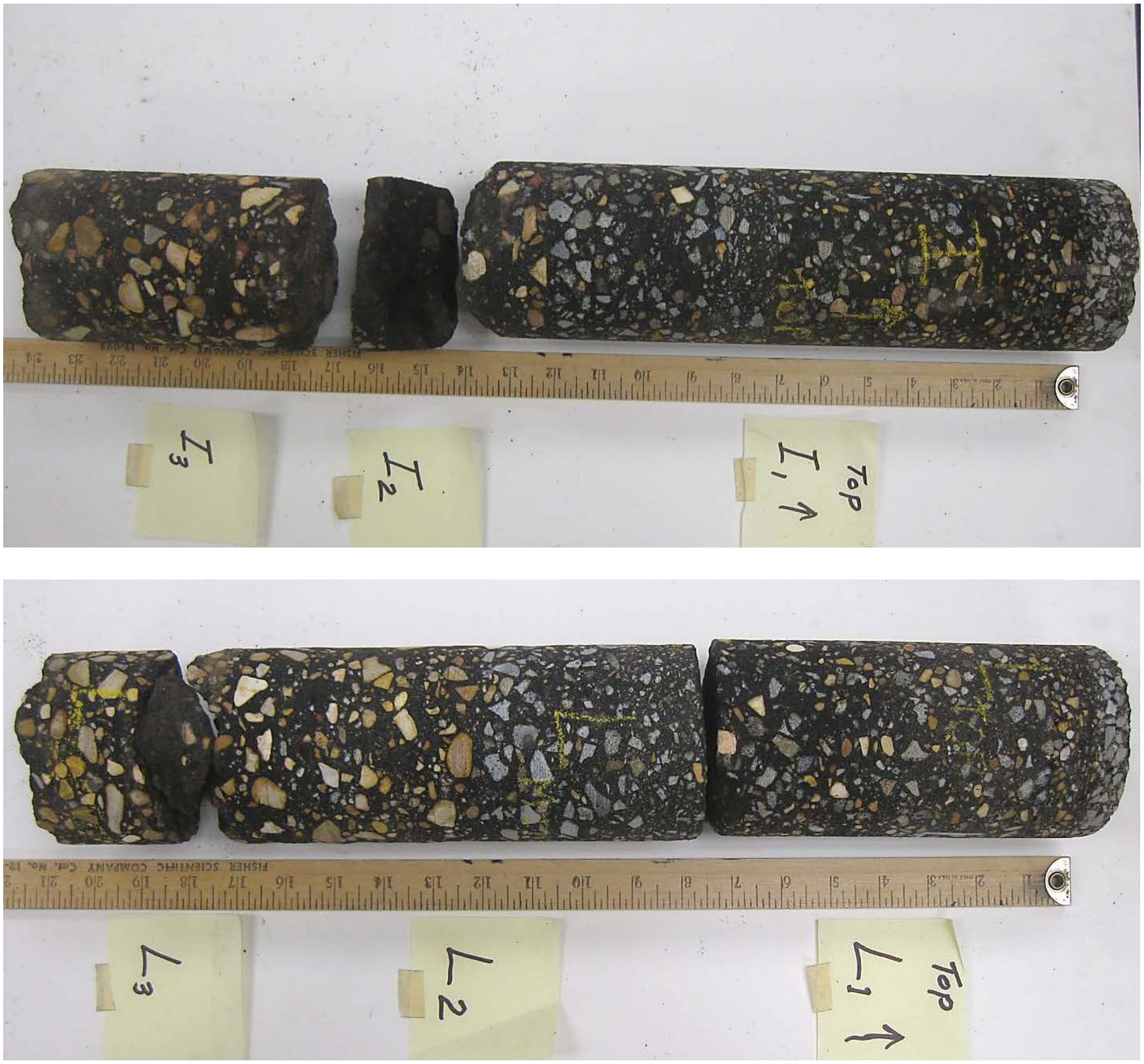
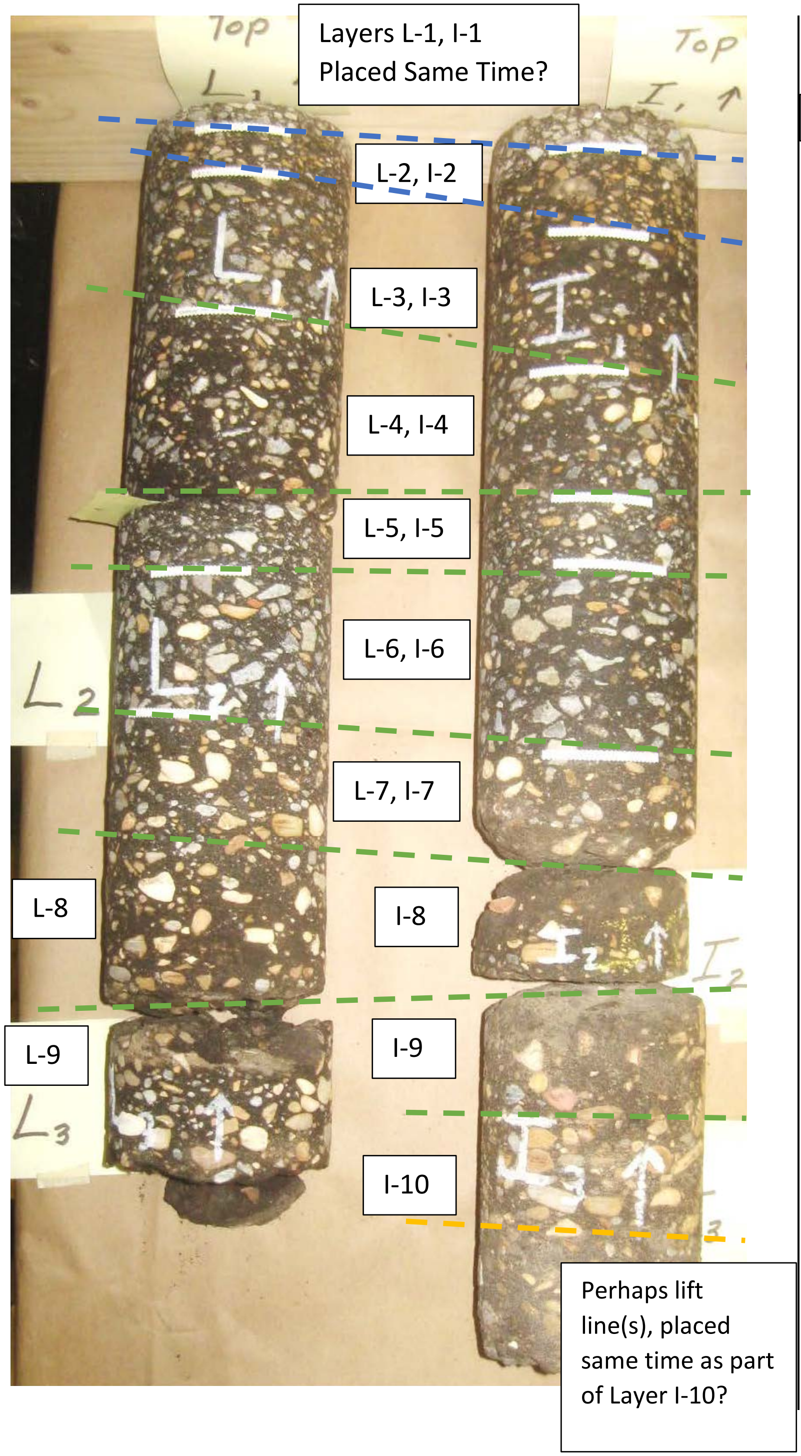


Figure 6. Photographs of cores I (eye) and L as-received for visual examination. Top end in each core placed to the right. Note that both cores received broken into three pieces.

Figure 7. Photograph of core M as-received for visual examination. Top end placed to the right. Note the core was received broken into four pieces.



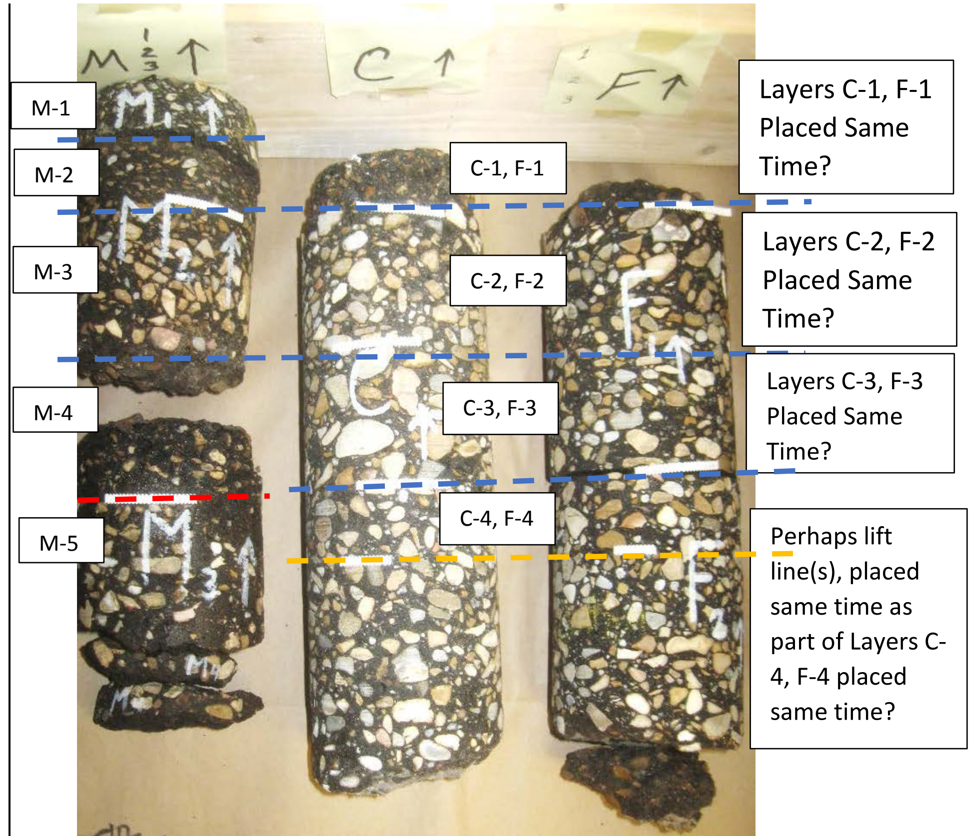


Figure 8 – Shows Biloxi NTSB Cores Away from the Rails; Cores L, I, M, C, and F lined up, with the core-tops up and with approximate layer lines and lift lines also shown.