

Ay HELIAN CANTER, SALE	Phone	Email	Date		
		patrick.baer@FCAgroup.com	2 22 2016		
FromName & Department			CIMS Number		
	Specialist	800 Chrysler Drive	482-01-13		
Patrick Baer	Adv Engine Mechanical Dev	Auburn Hills, MI 48326			

MDF Track Surface Prep – Matrix Grip Summary

Background/Purpose

Prior to building "Thunder Road" – a CNC routed slot car layout on MDF – a matrix of surface finishes were evaluated for grip.

Basic Test Plan

Two surface appearances were evaluated:

- A "marble" look to simulate a worn road surface or one with aggregate.
- A "uniform" finish to simulate fresh seal coat or concrete.

4 variations of each surface were made with different combinations of oil based primer, foam brush or roller type, whether to sand between layers, colors, etc.

The "grip" was evaluated by placing a Ninco '56 Corvette chassis on the various patches of prepped surface and seeing at what angle the car could hold without sliding down, (static test).

Conclusions

Uniform Finish

- The most grip with least amount of final finish work was test case #1. Ra = 0.98 um.
 - \circ The two sanded smooth final coat finishes were a close 2nd.
 - Sanded smooth spray final coat test case #4 was smoother and had slightly more grip than rolled test case #2, (Ra = 0.28 um vs. 0.64 um respectively).
- The roughest finish (spray texture) was the worst for grip and correlated to the roughest Ra value of 2.86 um.

Marble Finish

- The sprayed grey Rustoleum filler primer provided slightly more grip than either spray or rolled black finishes.
 Removing more of the grey filler primer to expose the black mid-coat reduced grip.
- The slightly textured marble finish provided the most grip of all the surfaces, (but it has to be noted that this was a static test, and the slight texture provided a "ledge" that kept the tires from slipping down the surface).
 - Running cars would definitely prefer a super smooth surface (like #4, Ra = 0.22 um) to eliminate chatter.

<u>Tires</u>

- SuperTires 1204RC provided more grip than Indy Grip 2002's on the finishes evaluated.
- An increase in normal force from the addition of 7 g lead weight increased grip.

Recommendations

- A 400 grit wet sanded smooth oil based primer finish provides the best base surface.
 - It won't raise the grain or swell the MDF like a water based primer/paint.
 - o A sprayed Automotive filler primer will require the least amount of wet sanding.
- A sprayed Automotive filler primer for a finish coat will provide the most grip when sanded smooth.
 - A 3/16" nap roller is a good option for those that don't want to spray the finish coat. It resulted in the same or better grip than a wet sanded smooth finish coat, (with much less final finish work).
- A Marble finish results in a more realistic (worn road surface) look, but requires careful finish sanding.
- A smooth finish (Ra < 0.3 um) provides the most grip.
- A rough textured spray finish not only had low grip, it was extremely "tacky" to clean resulting in trapped lint and/or dust.

Test Matrix

1/2"MDF Sealed edges with DAP filler Dusted surface with 400 grit to aid primer adhesion

Marble	e Looking Finish	Uniform	Uniform Finish				
Roll-on	Zinsser oil based primer	Spray-on	Spray-on automotive filler primer (grey)				
FB 1	No prep		1	Sand w/400			
	Roll-on black			Roll-on black			
		No prep		No prep			
		Spray Grey					
		Wet					
		Sand					
FR 2	No prep		2	Sand w/400			
	Spray black			Roll-on black			
				Wet			
		No prep		sand			
		Spray Grey					
		Wet					
		Sand					
FR 3	Sand w/400		3	Sand w/400			
				Spray textured			
	Roll-on black			black			
		No prep		No prep			
		Spray Grey					
		Wet					
	c //oo	Sand		c l (100			
FB 4	Sand w/400		4	Sand w/400			
	Spray black			Spray black			
				Wet			
		No prep		sand			
		Spray Grey					
		wet					
		Sand					

Notes: The original plan was to roll the Zinsser oil based primer with a foam roller (FR) for all 4 marble bases. However, the foam roller left a very rough finish. So after rolling one small section, it was abandoned for a foam brush, (FB). This resulted in very different looks between the 4 marble test cases.

Materials

- Zinsser Cover Stain, white (tintable), product #03501, 1 gallon can
- Rust-oleum Painter's touch, sandable grey primer, 249088, 12 oz spray can
- Behr Premium Plus, exterior satin enamel deep base, tinted lamp black, 9340, 29 oz can
- Rust-oleum satin protective enamel, satin black 7777, 12 oz spray can
- Rust-oleum Specialty Textured Paint for Plastic, textured black 223717, 12 oz spray can
- Foam brush & roller
- Wooster woven 9" x 3/16" nap Pro Classic roller, 25926
- 3M Wetordry Tri-M-ite 400 grit sand paper

Objective



There is less difference betrween cement (upper left) and worn blacktop (upper right) pavement than you would expect. Both are "marbled", with the main difference being the color of the substrate holding the aggregate together. So if you scaled the aggregate to 1/32 actual size, it would show as small speckles.



Master modeler Jimmy Attard with the Thunder Road pit wall shows what 1/32 scale cement should look like.

Process Description



DAP Patch-N-Paint was used to seal the edge of the ½" MDF sheet. It is just smeared on with your finger, and then the excess sanded off. I used a 3M sanding pad with 400 grit wet paper. Two primer/sealers were used for the experiment – Zinsser oil based and Rust-oleum spray can sandable primer.



MDF is not perfectly flat. The unpainted MDF that I started with had an average surface finish of 4.31 um, (in the direction of slip). You can see the small ripples in the sheen of the spray can primer. I sprayed several thin coats of primer, wet sanded with 400 paper until the base MDF was just visable in a number of spots, then sprayed a couple of more heavier coats and wet sanded again. Note I was only using half of a 2' x 4' section of board – making 4 sections of 1' x 2' for the 8 test surface finish cases.

Process Description



I thought a foam roller would provide the smoothest finish for the Zinsser primer/sealer. Wrong – it made a very textured pattern (bottom left). So I used a foam brush to prime/seal the other side, which left the small streak lines like a regular paint brush (bottom right). I wanted some texture for the marble look finish, but even wet sanding the foam roller side left a relatively rough surface.



Zinsser primer/sealer with foam roller (left) vs. foam brush (right). Both are base coats for the marble finish tests, prior to any sanding.

MDF Track Surface Prep – Matrix Grip Summary

Process Description

I learned that a 3/16" nap roller leaves a very flat surface. It was used for the black finish coats for 2 of the uniform tests and mid-layers for 2 of the marble finish tests. The particular roller that I used was a Wooster woven 9" x 3/16" nap Pro Classic roller, #25926.

Obviously, the flattest surface finishes resulted from multiple sprayed and sanded layers of paint.



Marble finish #1 (above left) was Zinsser spread with a foam brush, roll on black and spray on grey filler primer as a finish coat. All of the marble finished surfaces had wet sanded final coats, thus they were all relatively smooth. Marble finish #2 (above right) had the Zinsser base applied with the foam roller, resulting in a very rough base texture which showed through with quite a bit of white with the sprayed on black and grey. I think it was the most "realistic" looking finish, however it was quite busy looking. It ended up being the roughest of the marble finishes because of the 3 under layers breaking through. Depending on where I measured, I could get as high as Ra = 1.18 um, which was still way smoother than the textured black uniform finish which measured Ra = 2.86 um.



Marble finish #3 (left) started with a sanded smooth Zinsser base with rolled black mid-coat and sprayed grey filler primer. To get it relatively smooth overall, (Ra = 0.38 um), quite a bit of black showed through. Marble finish #4 (right) had just a wisp of black showing through where I over-sanded. It was the smoothest finish of the 8 test cases, (Ra = 0.22 um). An additional smattering of white/taupe/black and additional coat of filler primer would have made it perfect. Under dynamic test conditions, it would have likely produced the highest grip results.



Uniform finish #1 (upper left) was the absolute least amount of work – spray on filler primer and rolled on black finish coat. It provided remarkably good grip at a relatively high Ra = 0.98 um. Uniform finish #2 (upper right) is sanded smooth after rolling on the black top coat. You can see from the edge of the picture that the rolled top coat left texture that sanded out reasonably well.



Uniform finish #3 (left) was not smooth, it was texture spray paint. The rough texture paint, (Ra = 2.86 um), was the absolute worst for grip. Spray finish (right) over the sanded smooth spray filler primer and then final sanded was among the smoothest of all, (Ra = 0.28 um). It had the best grip among the black, uniform finishes.

Overall I was a bit disappointed with the look of all of the finishes. I really want a grey finish track so that black cars don't disappear. However, I have still to find the right color of grey – an automotive filler primer just doesn't do it for me. The Behr lamp black exterior satin is a reasonably nice color, especially after sanding. It has a grey hue about it, but still needs to be lighter to highlight a black car.

Grip Results

The table below lists the results as a factor of surface finish number, board angle, tire, weight (resultant normal force) on tires for each axle. Often the results were very close. Overall, the grey filler primer final finish provided the best grip, as did the smoothest finishes and SuperTires silicones. "H" = Hold, "S" = Slide, "V" = on verge of slip, "C" = creep.

Parameter	Marble Finish				Uniform Finis	h							
Angle, (degrees)	56.7	66.5	66.5	66.5	41	47.9	47.9	56.7	56.7	56.7	56.7	66.5	66.5
Rear Tires	IG 2002	IG 2002	ST1204RC	ST1204RC	Rubber	Rubber	IG 2002	IG 2002	IG 2002	ST1204RC	ST1204RC	ST1204RC	ST1204RC
Frong Tires	ST1204RC	ST1204RC	ST1204RC	ST1204RC	IG 2002	IG 2002	ST1204RC	IG 2002	ST1204RC	ST1204RC	IG 2002 + 7 g	ST1204RC	ST1204RC
Rear Weight	20.3	14.8	14.8	16.3	27.8	24.8	24.8	20.3	20.3	20.3	20.3	14.8	16.3
Front Weight	14.3	10.4	19.4	13.2	19.6	17.4	17.4	14.3	14.3	14.3	19.2	10.4	13.2
Surface Finish 1	h	s	h	h	h	rv	h	fs	h	h	fv	4c	4c
Surface Finish 2	4wv	s	h	h	h	h	h	fs	4wv	h	fv	fs	fc
Surface Finish 3	s	s	fc	4c	fs	s	s	s	s	s	s	s	s
Surface Finish 4	h	s	fc	fc	h	h	h	fs	4wv	h	fc	fs	fc
	Best grip overall						Best grip for the least amount of final finish work. Solid color				olor		

Note: Weight is resultant normal force, or simply the cos of angle x weight of vehicle measured at each axle.



A Ninco '56 Corvette chassis was chosen because it had the same size wheels front/rear, so the same silicone tire could be put on all 4 corners. Also, it takes one of the narrowest silicone tires available, so it would be more prone to slip. The chassis is relatively heavy due to the long can "Speeder" motor. Adding 7 gm ahead of the front axle gave almost exactly the same normal force on the front tires as the rear. The tires evaluated were SuperTires 1204RC and Indy Grip 2002. A Mitutoyo digital protractor was used to measure the board angle. A Mahr Federal pocket surf was used to measure surface finish, (not shown). The Mahr Federal pocket surf was calibrated at 3.0 um, so on the high end of the measurements taken.

Grip Results



Yep, it is remarkable how much grip a clean silicone tire can provide on a painted surface. Here the Ninco Corvette chassis is holding onto uniform finish #1. The guide is flipped out front, since no groove was cut in the surface. No guide allowed the front or rear to break-away independently. Adding weight ahead of the front axle increased the normal force on the tire to better match the rear, (greater normal force on rears due to weight of long can "Speeder" motor being biased towards rear of car).



Left front tire was not quite touching with the steeper board angles. Car was on the verge of flipping over at 66.5 degrees.