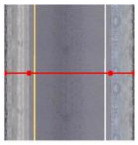
Road Surface Material Code Modifications to LRI

National Advanced Driving Simulator



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National Advanced Driving Simulator
The University of Iowa
2401 Oakdale Blvd.
Iowa City, IA 52242-5003

contacts@nads-sc.uiowa.edu
Ph: 319-335-4673
Fax 319-335-4658

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Table of Contents

Introduction

This document describes the files and methods for modifying road surface materials within the LRI file, changing the friction coefficient values on the MiniSIM™, and information about where the data is specified and located among various source files. Good working habits are essential to avoid errors: always create a backup of any file to be modified. Get into this habit early, and it will be possible to easily recover from any problems that might arise due to modifications.

NOTE: Because all meta-data is an attribute, changing surface material codes in the source files (PET, PATH, LAT, LRI, etc.) will not cause any corresponding change in the visual database. In order to change the visual database, changes must be made to the visual database geometry using a 3D editor.

File Overview

Within the NADS MiniSim™ architecture, several files are used to provide input data to a complete roadway specification including surface material type:

a) .path file; this file contains ordered centerline data and is used to describe the overall shape or topology of the road surface. This file contains attributes local to the tile.

b) .corr file; this file contains ordered intersection corridor data and is used to define the connection between road lanes to each other through an intersection. Corridors do not currently use a lateral profile tag since their width is explicitly defined. This file contains attributes local to the tile.

c) .pet file; this is an input file that contains attributes (tags) for all objects and entities, including road specifications. This file contains attributes local to the tile and specifies global configuration files.

d) .lat lateral profile file; this is a global library file that all roads access to define their surface characteristics when the LRI is created.

e).LRI file; this is the correlated virtual database file generated by the Tile Mosaic Tool. The LRI file is an ASCII file that contains the logical representation of the simulation environment. It is important to understand that making changes to the LRI file will not alter the visual appearance of the visual database. Changes to logical information will only affect attributes and characteristics, unless the lateral curve, intersection corridor or road path source data is modified.

It is not recommended that changes be made to LRI files using these manual editing techniques except for the limited cases of changing the road surface material described in this document.

For a complete description of the road tag and LRI file format, please see the LRI Specification Document.

Surface Change Process Overview

Changing the surface material for a road will require the following steps, described in greater detail later in this document:

1. Identify a tile road location in the database using the Tile Mosaic Tool™.
2. Build a scratch database that consists of the isolated tile from step 1.
3. Identify the road from step 2 using the ISAT™.
4. Locate the tile from step 1 on the hard drive.
5. Identify a location using the road data and ISAT™.
6. Adding a new unique lateral profile to the road identified in step 3.
    a. If the surface change is intended to be isolated to a particular region, identify another location downstream from the new profile and return the road to its original profile, thus restoring surface characteristics to their normal default.
7. Add the new profile from step 6 to the global latProfileCurve.lat file, using a unique surface code from the master surface list (Appendix A).
8. Generate another version of the scratch database to verify changes using ISAT™.
9. Verify/add the surface code to the MiniSIM™ coefficient of friction files.
10. Verify the changes by building a database or using the scratch database and drive it on the MiniSIM™, and verify the changes.

Anatomy of a Road Tag within the .PET File

The following table contains a road definition contained within a .pet file:

Description	Tag data
Location (uses a local origin)	**VertexList 4453.052116 2207.605456 0.000000**
Lateral Profile data file, curve name	**DefLatCrvFile r1 LatProfileList.lat LatCrvName LN4**
Road name, data file, intersection	**RoadDef RoadName r1 RdwayCrv urban_4ln_10x8_01_r1.path Int2 int1**
Lane definition	**LaneDef 12.000000 P DefLaneAttr LaneChangeRules 2 0.000000**
Lane definition	**LaneDef 12.000000 P DefLaneAttr LaneChangeRules 1 0.000000**
Lane definition	**LaneDef 12.000000 N DefLaneAttr LaneChangeRules 2 0.000000**
Lane definition	**LaneDef 12.000000 N DefLaneAttr LaneChangeRules 1 0.000000**

Default speed limit	**DefRdAttr SpeedLimits 55.000000 0.000000**

Note the tag contains nothing to explicitly describe surface characteristics for the road. That information is encoded within the .lat file, and is accessed by the Lateral Profile portion of the tag.

Anatomy of a Lateral Profile Curve within the .LAT File

The specification of a lateral curve can be considered a cross-section "slice " through the roadbed, perpendicular to the direction of travel. The format of the lateral curve definition is the keyword CurveName, followed by a unique name. This name is used in the road definition tag found in the .pet file, followed by the total width of the road.

It is possible for roads to specify multiple Lateral Profiles. If this is the case, it will be clear from the data within the <tile>.pet file due to multiple declarations for any given road.

Note the roadbed can be considerably wider than the actual visible road, and if the surface is properly defined it will not interfere with lane-keeping variables during data collection. This is especially useful for applications where the driver might leave the roadway, as in testing stability control or anti-lock brake components, and the simulation must continue.

Lateral profiles are always specified about a roadbed origin at the mid-point (center) of the roadbed. Although it is possible to create a lateral profile with an offset (such as a freeway entrance or exit ramp), keep in mind that changing the profile within the .lat file will not change the visual database. It is possible to shift the location of road lanes by changing the lateral profile data, which in all likelihood will create an invalid road network.

Data points are specified for horizontal offset from the center of the roadbed, and define elevation or material changes.

The field which is possible for the end-user to change is the surface material type, which is the last value on each Data line of the lateral profile. Surface materials are documented within Appendix A. Deviating from these published values may cause the Audio Engine to malfunction, since that subsystem depends on previously defined values. Changing the surface material type for any lateral profile curve will cause all roads that reference it to also change, although it is possible to specify alternative lateral profile files for different projects.

The following table is a Lateral Profile Curve definition for a LN4 type road that is 68 feet wide:

CurveName LN4 Width 68
Data -34.0 0.00 265
Data -25.5 0.00 265
Data -25.5 0.00 262
Data 25.5 0.00 262
Data 25.5 0.00 265
Data 34.0 0.00 265

Note there is nothing here to describe road lanes or a location. The Lateral Profile is designed to be reused as much as possible, and should be considered more of a global roadway classification rather than a specific road. Any changes to an entry in the Lateral Profile .lat file will change all databases that are generated from that time forward.
The string format is:

Data (required keyword) < offset from center> <elevation> <SurfaceCode>

Anatomy of the Lateral Profile Curve Header within a LRI File

All lateral profile curves that are used within a database are stored in a LAT_CURVES header region of the LRI file:

```
{
 LAT_CURVES
 {
  RURAL_LN2 { 51.00  0.00 -25.50 14  0.00 -13.94 14  0.00 -13.94 10  0.00 13.94 10
        0.00 13.94 14  0.00 25.50 14 }
  LN4 { 80.00  0.50 -40.00 99  0.50 -34.00 99  0.50 -34.00  1  0.50 -26.00  1
        0.00 -25.50  1  0.00 -25.50 10  0.00 25.50 10  0.00 25.50  1
        0.50 26.00  1  0.50 34.00  1  0.50 34.00 99  0.50 40.00 99 }
  SVC_1 { 26.00  0.00 -13.00 14  0.00 -8.66 10  0.00  8.66 10  0.00 13.00 14 }
 }
```

Note: Although curve data may span multiple lines, the lateral profile header must be enclosed within curly braces.

This header region of the LRI file contains all the lateral profile curve specifications for the database, which is essentially a direct copy of the lateral profile curve entries within the .LAT library file. Making changes to the surface materials here will affect only the changed database. However, these changes will not be visually evident in the visual terrain database. Surface material

values can be previewed within the ISAT by including the %m display qualifier. Changes must be valid surface material values (see Appendix A).

Global Friction Changes for All Databases

Changing the MiniSIM™ files will affect all installed and future databases.

MiniSIM™ Friction Configuration Files

There are two coefficient of friction (CoF) configuration files on the MiniSIM™ that are used to fully configure the dynamics engine with coefficient of friction values for each road surface ID: surfaceType2frictionID.dat and tprindex2frcoef.dat.

surfaceType2frictionID.dat

This file is located under each MiniSIM™ version root in the <minisim_version_root>\data directory. This file is structured in a tab-delimited form. The first column is an index number, the second column is a TPR Index ID. The 3rd column Is not currently used, and the commented string describes the surface.

```
# SurfaceIndex NadsDynaIndex Coeff(not used: Here for clarity)
0       1       0.85    # Default Condition
1       2       0.90    # Cement Continuous - more grip
2       2       0.90    # Cement Slabbed - more grip
3       2       0.90    # Cement Grooved - more grip
6       30      0.75    # Gravel Loose - little wet
9       1       0.85    # Asphalt Smooth - default
10      10      0.85    # Asphalt mild "washboard" - default
11      11      0.50    # Shoulder
14      14      0.50    # Gravel
20      20      0.65    # Wet surface
21      21      0.55    # Very wet surface.
```

tprindex2frcoef.dat

This file is located under each MiniSIM™ version root in the <minisim_version_root>\data\nadsdyna\<vehicle_model> directory. The format of this file should be carefully adhered to. The first column is the TPR Index ID, and the 2nd column is the surface coefficient of friction value. A text descriptor follows each ID/value for reference.

```
V1.09
Number of surfaces, we can have up to 100 surface conditions
26
TPRindex -> FRICTIONcoefficient
1  0.85  [This #1 is the default normal condition, do not change it]
3  0.50  snow
4  0.85  normal condition
5  0.85  normal condition
6  0.90  more grip
7  0.90  more grip
8  0.70  wet
9  0.30  ice
10 0.65  Normal Road
11 0.50  Gravel
12 0.60  very wet
13 0.45  snow
14 0.50  Gravel
15 0.50  snow
16 0.80  normal condition and rainy (wet)
17 0.40  icy
18 0.30  very icy
19 0.15  extremely icy
20 0.65  Wet
21 0.55  Very wet
25 0.50  offroad
30 0.75  little wet
47 0.92terrain mild snow
55 0.80  normal condition
60 0.15cement smooth icy
67 0.50  shoulder mild snow
```

Changing An Existing Coefficient of Friction

Making an isolated change to a database will involve modifying several source files. You will be able to verify that material changes have made their way into the database by reviewing the changed database location in ISAT™ and checking the reported material code, which is reported on the ISAT™ status line.

The process to make a change to a tile road surface coefficient of friction is long and will require many steps, and it will be necessary to carry some information through the process.

Localized Changes to A Tile

Since tiles are a shared resource, it is not possible at this time to create a localized change to any one tile without affecting new databases published after the edit that contain that tile. In other words, surface materials are not currently a reconfigurable resource, but are considered part of the base template data. Any database that uses a modified CoF tile will also use the modified CoF.

Identify A Database Location to Change Materials

The typical need for a surface change is within a database is to make an isolated change at one location. In order to accomplish this, the database must use only one instance of a tile at the desired location. If there are multiple tiles contained within the database, all instances of that tile will change. In the event the database layout cannot be changed, it may be necessary to duplicate the tile in order to allow one unique instance of the tile to be modified. Duplicating a tile requires making a copy of an existing tile and renaming all the duplicated files to a unique file name, and then adding this new file into the TMT™ configuration files (alltiles.txt, tileSizes.txt).

Changes to tiles are global in scope and will affect all future databases built using the modified tile.

1. Identify a Tile

The first step to changing a surface requires identifying a single unique tile and identifying that tiles parent category. This information is necessary to locate the file on the hard drive. Modify the attributes of the <tile>.pet file to read/write and edit the file. Open the TMT, locate the area to make a surface change, select a tile then right-click and choose “Placed Tile Properties…” which will bring up the following dialog:

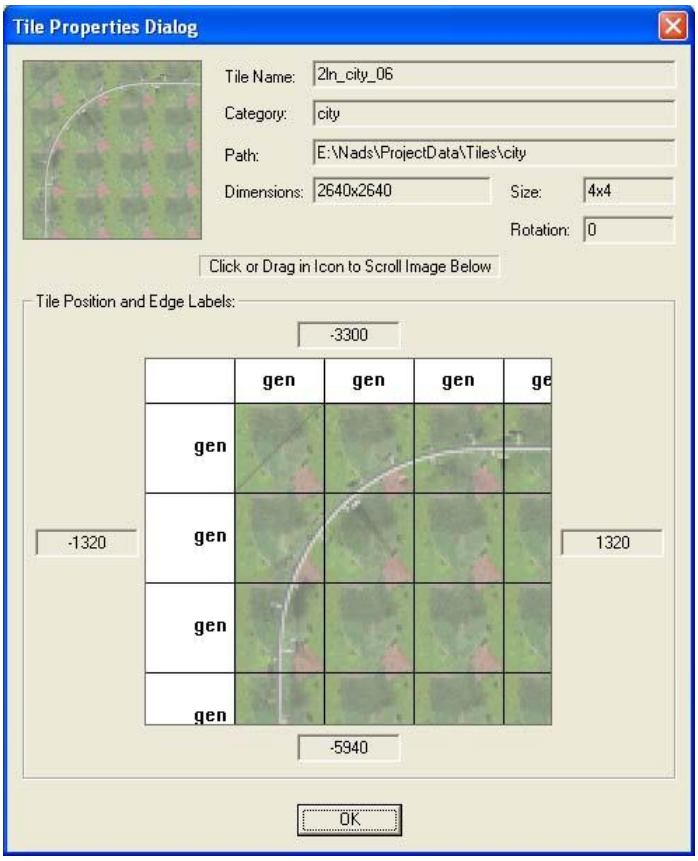

Fig 1 Placed Tile Properties

The dialog will show the tile name and the tile category. These two pieces of information will allow the user to find the tile source files on disk. Following the example, the user would navigate to the tile directory by drilling down from the TMT root directory to ProjectData>>Tiles>>city>>2ln_city_06.

2. Identify a Particular Road

If the tile contains multiple roads, it may be necessary to create a scratch database using the TMT and to generate a BLI in order to identify precisely which roads exist within the tile, and what they are called. For example, all tiles containing an intersection will have multiple roads, and it is not always possible to determine from the tile file name whether it contains multiple roads or not.

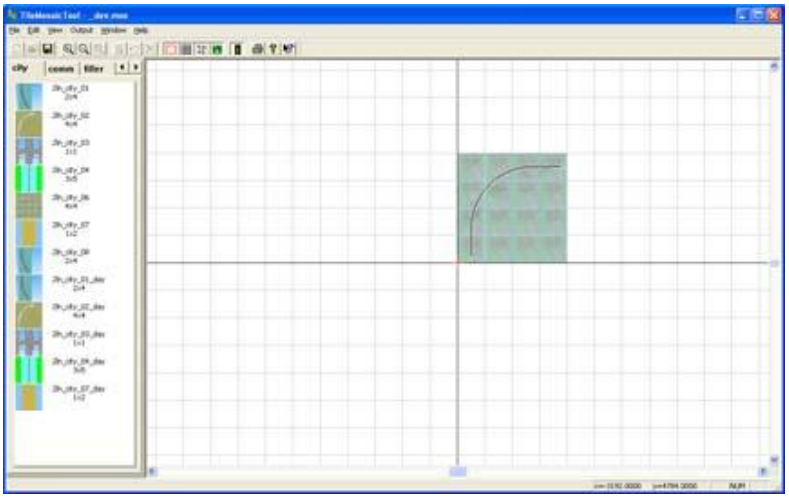

Fig 2 Scratch database with selected tile

In the event there are multiple roads contained within a chosen tile, build a scratch database containing only that tile. It will not matter where the tile is located within the Region of Interest (ROI), but the tile should be placed using its default orientation. Generate an LRI file. It is not necessary to generate the visual database or the SCL configuration file. Build the BLI file using the command line script mlri. Open that BLI file in ISAT to identify the tile roads. The user should be able to slowly move the mouse over each road, which will be reported by ISAT on the status bar. Make a note of the road name.

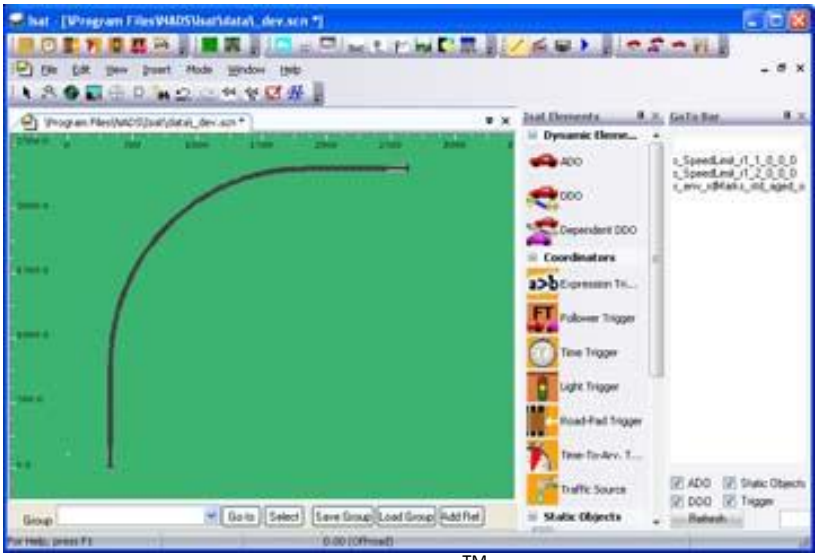

Fig 3 Scratch BLI in ISAT™

The database in Figure 3 shows 3 roads and two intersections, which was not obvious when viewing the tile in the TMT. The largest road segment is the curved road, which is road R2.

3. Modify Tile .PET File to Change Road Lateral Profile

Make a backup of the <tile>.pet file then change its file attribute to read/write and open it, then locate the road declaration for the desired road, which was reported in ISAT™. The correct declaration will contain a specification for a lateral profile curve file, and a lateral profile name.

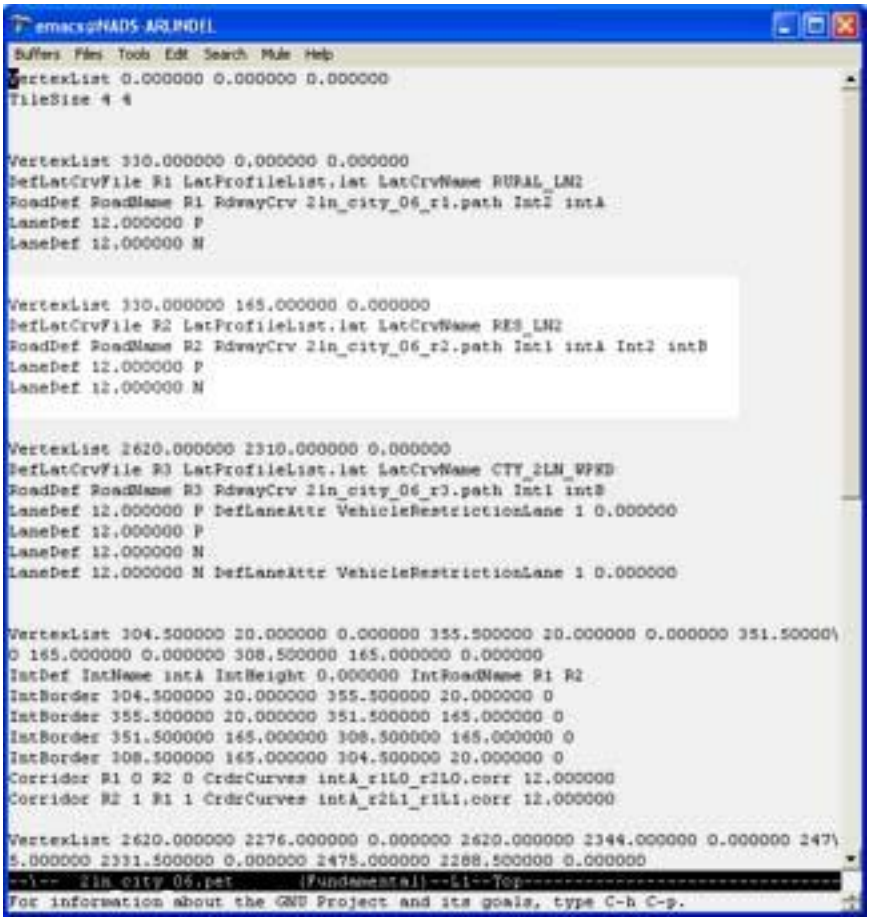

Fig 4 Scratch database tile: 2ln_city_06.pet file

Figure 4 shows road R2 highlighted. Identify the existing lateral profile name, and then change it to a unique string. The lateral profile name should not begin with a number. Make a note of the new profile name, and save and close the modified <tile>.pet file.

a. Adding a New Lateral Profile to an Existing Road

It is possible for a road to contain multiple lateral profiles. All lateral profiles must be specified on the road spline, or it may cause an error. In order to add a new lateral profile to a road, a location must be determined from the road data. Data for each road is contained within a <road>.path file. This file is specified within the <tile>.pet file. In the example above, for road R2, the data file is

2ln_city_06_r2.path. If you open the <road>.path file you will see all the data points explicitly defined.

b. Existing Road Data File

ROAD_ID: R94.0
ROAD_TYPE: Curve
ARC_RADIUS: 1500.000000
SPIRAL_LEN1: 0.000000
SPIRAL_LEN2: 0.000000
SUPERELEVATION: 0.000000
CONTROL_POINT: 330.000000 2310.000000 0.000000
VCURVE_LEN: 400.000000
VCURVE_MIN: 20.000000
SLOPE1: 0.000000
SLOPE2: 0.000000
PROFILE_POINT: 6.000000 0.000000
PROFILE_POINT: -6.000000 0.000000
WIDTH: 12.000000
CENTER2LEFT: 6.000000
NUM_LANES: 0
SPEED: 0.000000
NO_PASSING: FALSE
STORE_HPR: TRUE
NUM_POINTS: 25
POINT: 330.000000 165.000000 0.000000 0.000000 0.000000 0.000000
POINT: 330.000000 810.000000 0.000000 0.000000 0.000000 0.000000
POINT: 333.653925 914.634711 0.000000 4.000000 0.000000 0.000000
POINT: 344.597897 1018.759651 0.000000 8.000000 0.000000 0.000000
POINT: 362.778599 1121.867536 0.000000 12.000000 0.000000 0.000000
POINT: 388.107456 1223.456034 0.000000 16.000000 0.000000 0.000000
POINT: 420.461069 1323.030215 0.000000 20.000000 0.000000 0.000000
POINT: 459.681814 1420.104965 0.000000 24.000000 0.000000 0.000000
POINT: 505.578611 1514.207344 0.000000 28.000000 0.000000 0.000000
POINT: 557.927856 1604.878896 0.000000 32.000000 0.000000 0.000000
POINT: 616.474508 1691.677878 0.000000 36.000000 0.000000 0.000000
POINT: 680.933335 1774.181415 0.000000 40.000000 0.000000 0.000000
POINT: 750.990299 1851.987556 0.000000 44.000000 0.000000 0.000000
POINT: 826.304090 1924.717238 0.000000 48.000000 0.000000 0.000000
POINT: 906.507787 1992.016130 0.000000 52.000000 0.000000 0.000000
POINT: 991.210645 2053.556359 0.000000 56.000000 0.000000 0.000000
POINT: 1080.000000 2109.038106 0.000000 60.000000 0.000000 0.000000
POINT: 1172.443280 2158.191069 0.000000 64.000000 0.000000 0.000000
POINT: 1268.090110 2200.775782 0.000000 68.000000 0.000000 0.000000
POINT: 1366.474508 2236.584774 0.000000 72.000000 0.000000 0.000000
POINT: 1467.117157 2265.443589 0.000000 76.000000 0.000000 0.000000
POINT: 1569.527733 2287.211630 0.000000 80.000000 0.000000 0.000000
POINT: 1673.207305 2301.782843 0.000000 84.000000 0.000000 0.000000
POINT: 1830.000000 2310.000000 0.000000 90.000000 0.000000 0.000000
POINT: 2475.000000 2310.000000 0.000000 90.000000 0.000000 0.000000

Identify a location on the road using ISAT™ if necessary. Select a data point from the road file that will be used for an absolute location and note that coordinate. Add the new lateral profile definition to the <tile>.pet file. By convention add the new lateral profiles in relative order at the bottom of the file and use the following convention for the attribute record:

VertexList <X_coordinate Y_coordinate Z_coordinate>
DefLatCrvFile_ <road_name> _<lateral_profile_file>_<profile_name>

The name string for <profile_name> should be a unique name in order to isolate the surface characteristics to a unique location. Save the modified <tile>.pet file.

4. Add New Lateral Profile to Configuration File

Open the LatProfileList.lat file. To ensure the surface is consistent with its physical characteristics, duplicate the curve entry that uses the original profile name and paste it at the end of the file. Rename the lateral curve name to the new name. You may now edit the surface codes for the new profile and it will remain unique to the road of the changed tile. If the user has changed a road segement by inserting a secondary profile to return the road to its original configuration, the unique surface will be highly localized. Any new surface IDs implemented will require adding them into the MiniSIM™ CoF files, otherwise unrecognized surface codes will have the default CoF applied.

Appendix A: Surface Material Classification Codes

	dec	hex		dec	hex		dec	hex
Base Composition			**Texture (surface)**			**Environment**		
Terrain	1	01	Smooth	0	0	dry	0	00000
Sand	2	02	Mild	256	1	wet	4096	00001
Sidewalk	3	03	Grooved	512	2	icy	8192	00002
Cement	4	04	Loose	768	3	snow	16384	00004
Gravel	5	05	Rough	1024	4	water	32768	00008
Asphalt	6	06	Severe	1792	7	wet patch	65536	00010
Dirt	7	07				Oil patch	131072	00020
Sod	8	08				Gravel Patch	262144	00040
Shoulder	9	09				Sand patch	524288	00080

DEC Surface type = Base + Texture + (Env1+Env2+..+Envx)
4+8=C
HEX Surface type = 0x(Env1+Env2+..+Envx)·Texture·Base
2+4+8=E

Example surface material:
Cement rough snow ice

*Hwy is not used

	Decimal	Hex
	dec: 25604	
	Hex: 0x00006404	
Terrain, smooth, dry	1	1
Terrain, mild, dry	257	101
Terrain, mild, wet	4353	1101
Terrain, mild, icy	8449	2101
Terrain, mild, snow	16641	4101
Terrain, rough, dry	1025	401
Terrain, rough, wet	5121	1401
Terrain, rough, icy	9217	2401
Terrain, rough, snow	17409	4401
Terrain, Loose, dry	769	301
Terrain, Loose, wet	4865	1301
Terrain, Loose, icy	8961	2301
Terrain, Loose, snow	17153	4301
Terrain, Loose, water	33537	8301
Sidewalk,smooth, dry	3	3
Sidewalk, smooth, wet	4099	1003
Sidewalk, smooth, icy	8195	2003
Sidewalk, smooth, snow	16387	4003
Sidewalk,mild, dry	259	103
Sidewalk, mild, wet	4355	1103
Sidewalk, mild, icy	8451	2103
Sidewalk, mild, snow	16643	4103
Shoulder, Mild, dry	265	
Shoulder, Mild, wet	4361	
Shoulder, Mild, icy	8457	
Shoulder, Mild, snow	16649	
Shoulder, Loose, dry	777	309
Shoulder, Loose, wet	4873	1309
Shoulder, Loose, icy	8969	2309
Shoulder, Loose, snow	17161	4309

Note: in hex
1+4=5
2+8=A
1+2+4+8=F
1+4+8=D
1+2+8=B
10+1=11
21+80=A1
42+88=CA

Asphalt, smooth, dry	6	6
Asphalt, smooth, wet	4102	1006
Asphalt, smooth, icy	8198	2006
Asphalt, smooth, snow	16390	4006
Asphalt, mild, dry	262	106
Asphalt, mild, wet	4358	1106
Asphalt, mild, icy	8454	2106
Asphalt, mild, snow	16646	4106
Asphalt, grooved, dry	518	206
Asphalt, grooved, wet	4614	1206
Asphalt, grooved, icy	8710	2206
Asphalt, grooved, snow	16902	4206
Asphalt, rough, dry	1030	406
Asphalt, rough, wet	5126	1406
Asphalt, rough, icy	9222	2406
Asphalt, rough, snow	17414	4406
Cement, smooth, dry	4	4
Cement, smooth, wet	4100	1004
Cement, smooth, icy	8196	2004
Cement, smooth, snow	16388	4004
Cement, mild, dry	260	104
Cement, mild, wet	4356	1104
Cement, mild, icy	8452	2104
Cement, mild, snow	16644	4104
Cement, grooved, dry	516	204
Cement, grooved, wet	4612	1204
Cement, grooved, icy	8708	2204
Cement, grooved, snow	16900	4204
Cement, rough, dry	1028	404
Cement, rough, wet	5124	1404
Cement, rough, icy	9220	2404
Cement, rough, snow	17412	4404
Gravel, smooth, dry	5	5
Gravel, smooth, wet	4101	1005
Gravel, smooth, icy	8197	2005
Gravel, smooth, snow	16389	4005
Gravel, mild, dry	261	105
Gravel, mild, wet	4357	1105
Gravel, mild, icy	8453	2105
Gravel, mild, snow	16645	4105
Gravel, grooved, dry	517	205
Gravel, grooved, wet	4613	1205
Gravel, grooved, icy	8709	2205
Gravel, grooved, snow	16901	4205
Gravel, rough, dry	1029	405
Gravel, rough, wet	5125	1405
Gravel, rough, icy	9221	2405
Gravel, rough, snow	17413	4405
Gravel, severe, dry	1797	705
Gravel, severe, wet	5893	1705

Gravel, severe, icy	9989	2705
Gravel, severe, snow	18181	4705
Dirt, smooth, dry	7	7
Dirt, smooth, wet	4103	1007
Dirt, smooth, icy	8199	2007
Dirt, smooth, snow	16391	4007
Dirt, mild, dry	263	107
Dirt, mild, wet	4359	1107
Dirt, mild, icy	8455	2107
Dirt, mild, snow	16647	4107
Dirt, grooved, dry	519	207
Dirt, grooved, wet	4615	1207
Dirt, grooved, icy	8711	2207
Dirt, grooved, snow	16903	4207
Dirt, rough, dry	1031	407
Dirt, rough, wet	5127	1407
Dirt, rough, icy	9223	2407
Dirt, rough, snow	17415	4407