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Parking Lot Layout and Dimensions

CarSim, TruckSim, and BikeSim include a group of road datasets that represent a parking lot with parking space lines suitable for simulations involving the development of controls for automated parking, blind spot and pedestrian crossing detection, etc. All animation assets are represented by the built-in auto-generated road shapes.

General Parking Lot Configuration

The parking lot is constructed using six datasets from the **Road: 3D Surface (All Properties)** library and are linked together via an **Animator: Group** dataset. The six road datasets used to assemble the parking lot scene are:

1. Parking Lot: Pavement and Topology
2. Parking Lot: East Curbs and Exterior Grass
3. Parking Lot: West Curbs and Exterior Grass
4. Parking Lot: Exterior Ring Road
5. Parking Lot: Striping
6. Props and Environmental Objects

The primary road surface is represented by the road dataset **Parking Lot: Pavement and Topology**. This includes an X-Y Reference Path, Off-Center Elevation, and road coefficient of friction (Figure 1).

A useful feature in CarSim, TruckSim, and BikeSim is the ability to define one or more roads for use in a scenario that serve as reference geometry for the tires to interact with, then define one or more paths that the vehicle will follow. Since these additional paths overlay the road geometry and we can switch between different paths while the simulation is running, we provide the vehicle with multiple options when it comes to vehicle control. This technique is used in this example: the six road datasets noted above define the road surface details; a separate path is then used for the Closed Loop Driver Model (Figure 2). More information regarding roads and paths can be found in the document *Paths and Road Surfaces*, (**Help > Paths, Road Surfaces, and Scenes**).

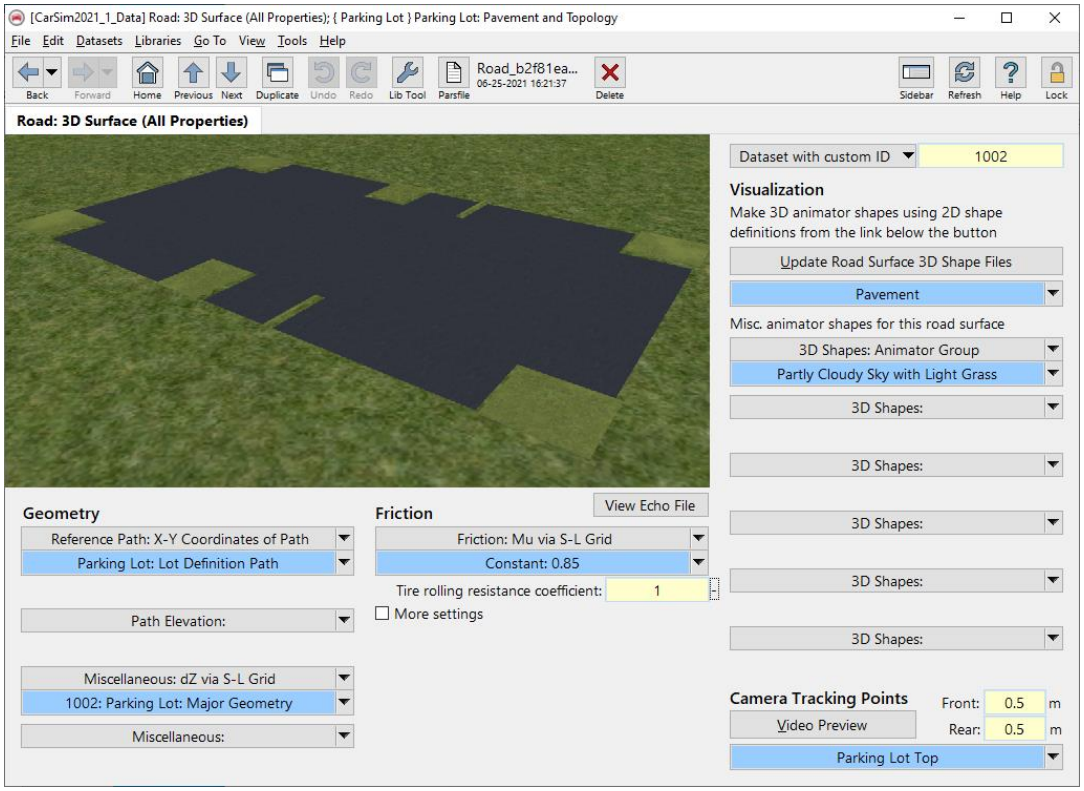


Figure 1. Road: 3D Surface (All Properties) dataset for the Pavement and Topology.

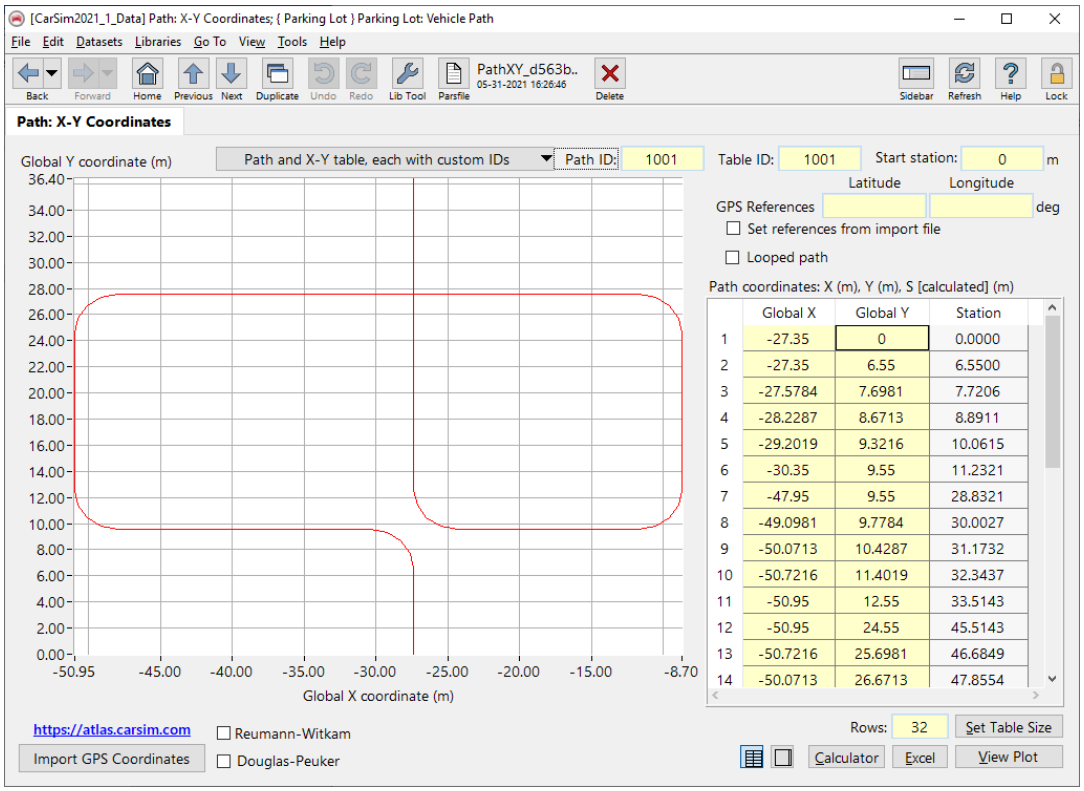


Figure 2. Closed Loop Driver Model Path used to navigate the Parking Lot.

Parking Lot Size and Layout

The parking lot is approximately 62 m long in the East-West direction and 38 m tall in the North-South direction, with the global origin (X = 0, Y = 0) near the South-Eastern corner. There are a total of 68 parking spaces: 40 spaces are oriented in an East-West direction while the remaining 28 spaces are oriented in the North-South direction. Each spot is approximately 5.1 m long x 2.4 m wide. The layout and configuration of the spaces can be seen in Figure 3.

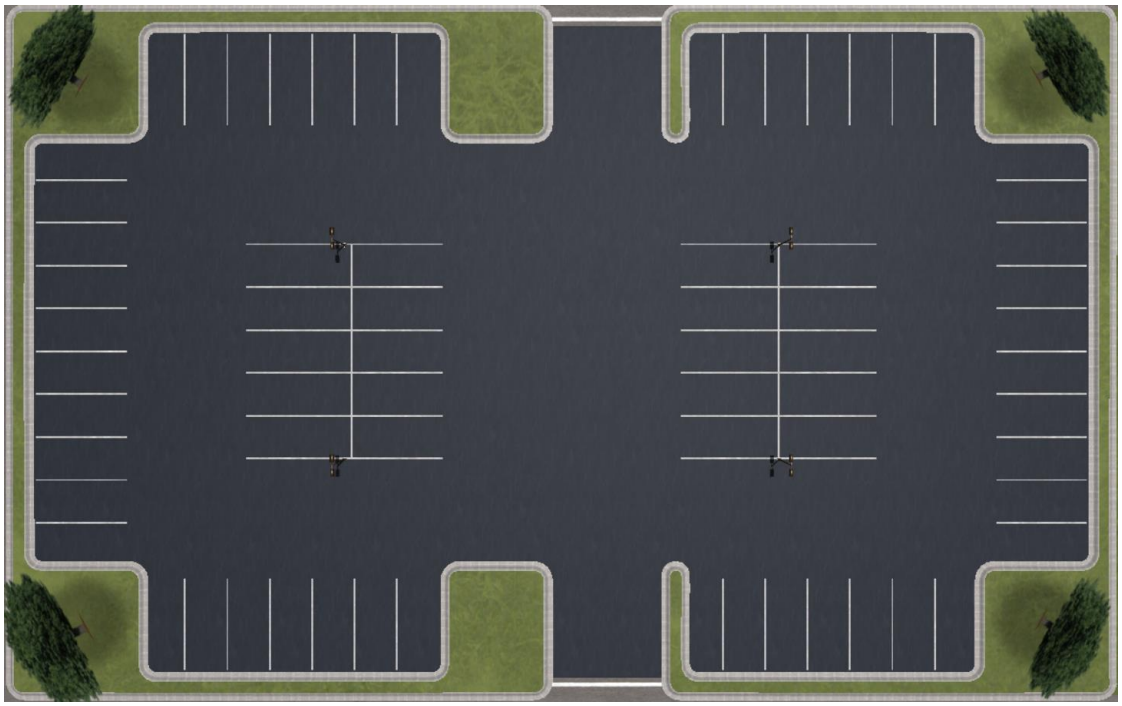


Figure 3. Parking Lot Layout, Top View.

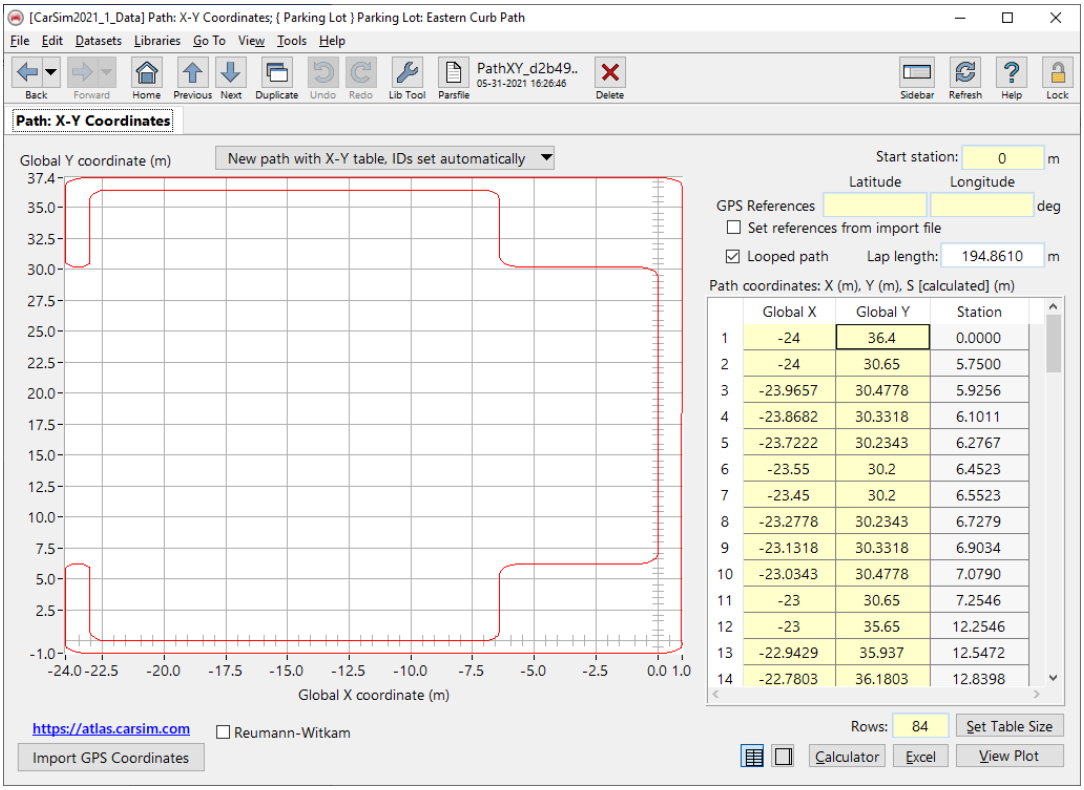
Reference Paths and Parking Space Configurations

In CarSim, TruckSim, and BikeSim, a road is represented by a global X-Y reference path and a road coefficient of friction; it may also contain detail for the elevation. If no elevation datasets are provided, the default condition is that the road is flat. A second, local coordinate system — Station and Lateral Position (S & L) — is used by the Closed Loop Driver Model and the auto-generated road shapes. This section of the document provides an overview of the roads and reference paths and the locations of the parking spaces.

Roads and Reference Paths

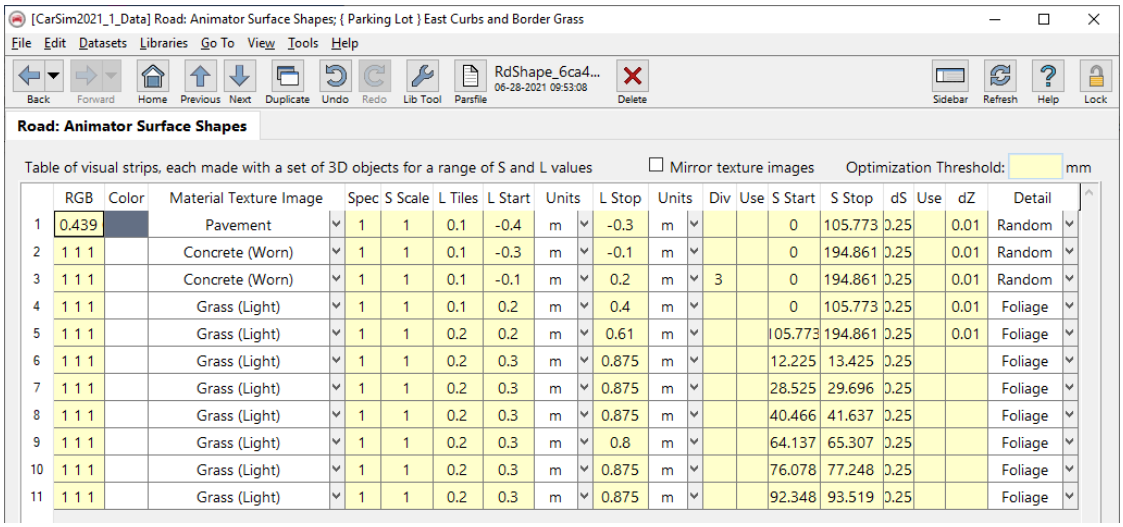
As noted above, the parking lot uses six road datasets, each with a corresponding X-Y reference path. The main road and reference path, represented by the road dataset **Parking Lot: Pavement and Topology,** defines the primary global X-Y reference path for the example and includes a dataset from the **Road: Off-Center Elevation Map, S-L Grid** library that defines various curbing within the parking lot. A **Road: Animator Surface Shapes** dataset defines the animation assets used to render the sections of the parking lot that are either pavement or grass. This path begins at the global origin (X, Y) = (0, 0) meters and extends North.

The next two roads — **Parking Lot: East Curbs and Grass** and **Parking Lot: West Curbs and Grass** — define the curb geometry that surrounds the parking lot. Each of these roads are represented by datasets from the following two libraries: **Path: X-Y Coordinates of Path** (Figure 4) and **Road: Off-Center Elevation Map, S-L Grid** (Figure 6 and Figure 7). Splitting the curbing data between two roads makes it more convenient to enter and manage the data.



	Global X	Global Y	Station
1	-24	36.4	0.0000
2	-24	30.65	5.7500
3	-23.9657	30.4778	5.9256
4	-23.8682	30.3318	6.1011
5	-23.7222	30.2343	6.2767
6	-23.55	30.2	6.4523
7	-23.45	30.2	6.5523
8	-23.2778	30.2343	6.7279
9	-23.1318	30.3318	6.9034
10	-23.0343	30.4778	7.0790
11	-23	30.65	7.2546
12	-23	35.65	12.2546
13	-22.9429	35.937	12.5472
14	-22.7803	36.1803	12.8398

Figure 4. Path: X-Y Coordinates for Eastern Curbing.



	RGB	Color	Material Texture Image	Spec	S Scale	L Tiles	L Start	Units	L Stop	Units	Div	Use	S Start	S Stop	dS	Use	dZ	Detail
1	0.439		Pavement	1	1	0.1	-0.4	m	-0.3	m			0	105.773	0.25		0.01	Random
2	1 1 1		Concrete (Worn)	1	1	0.1	-0.3	m	-0.1	m			0	194.861	0.25		0.01	Random
3	1 1 1		Concrete (Worn)	1	1	0.1	-0.1	m	0.2	m	3		0	194.861	0.25		0.01	Random
4	1 1 1		Grass (Light)	1	1	0.1	0.2	m	0.4	m			0	105.773	0.25		0.01	Foliage
5	1 1 1		Grass (Light)	1	1	0.2	0.2	m	0.61	m			105.773	194.861	0.25		0.01	Foliage
6	1 1 1		Grass (Light)	1	1	0.2	0.3	m	0.875	m			12.225	13.425	0.25			Foliage
7	1 1 1		Grass (Light)	1	1	0.2	0.3	m	0.875	m			28.525	29.696	0.25			Foliage
8	1 1 1		Grass (Light)	1	1	0.2	0.3	m	0.875	m			40.466	41.637	0.25			Foliage
9	1 1 1		Grass (Light)	1	1	0.2	0.3	m	0.8	m			64.137	65.307	0.25			Foliage
10	1 1 1		Grass (Light)	1	1	0.2	0.3	m	0.875	m			76.078	77.248	0.25			Foliage
11	1 1 1		Grass (Light)	1	1	0.2	0.3	m	0.875	m			92.348	93.519	0.25			Foliage

Figure 5. Road: Animator Surface Shapes dataset for Eastern Curbing.

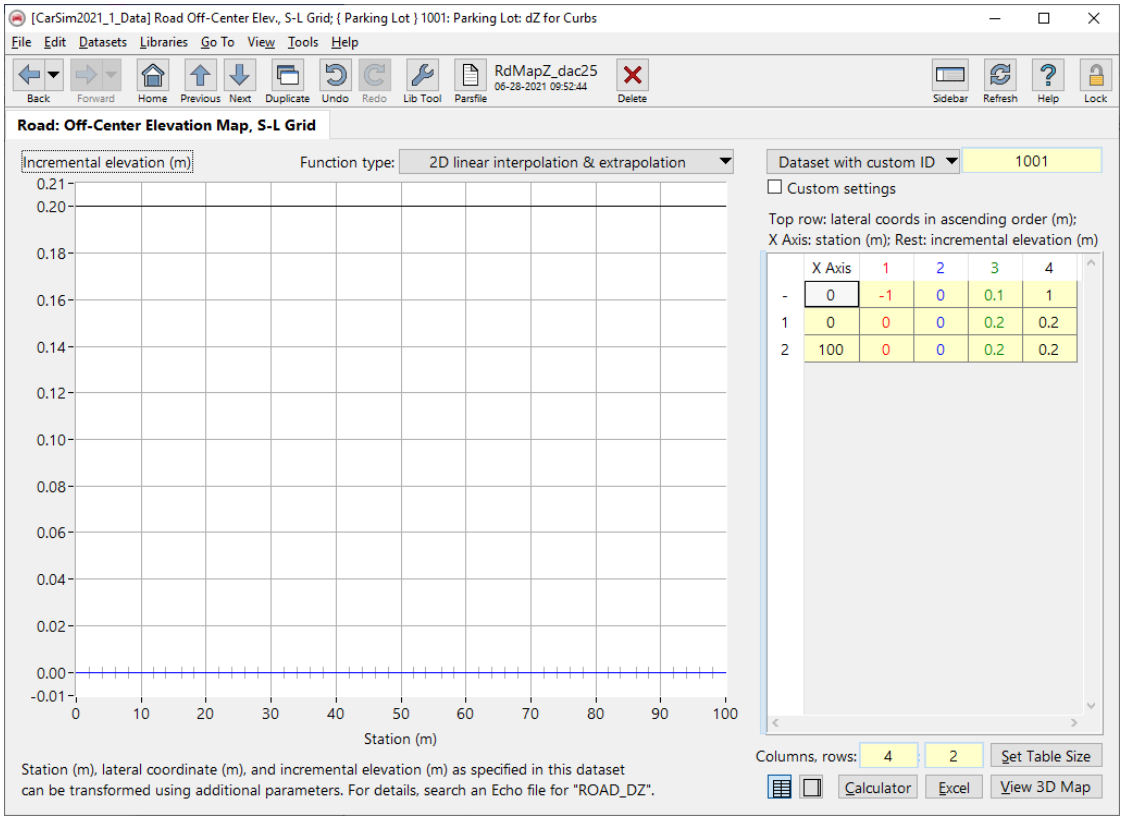


Figure 6. Road: Off-Center Elevation dataset for Eastern Curbing.

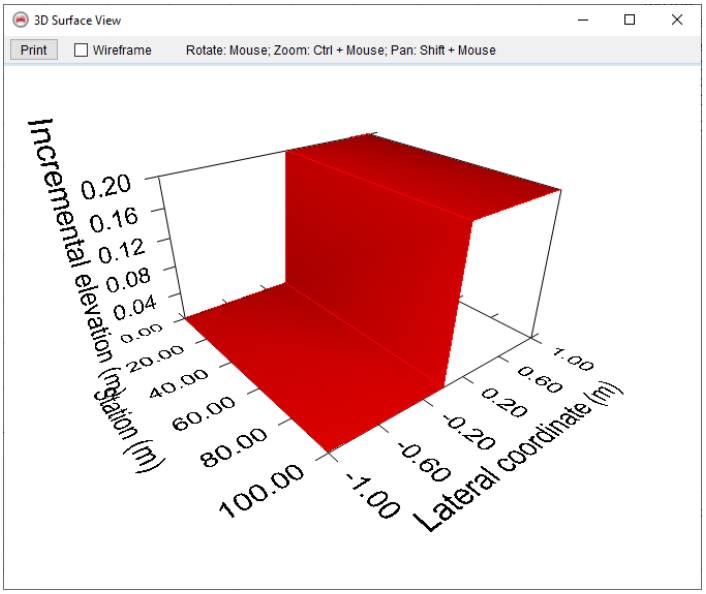


Figure 7. 3D Surface View of the Off-Center Elevation.

The next road dataset is the **Parking Lot: Exterior Ring Road** (Figure 8). This road surrounds the parking lot and allows the vehicle to drive to and from it, utilizing either of the two entry / exit points. It is flat with a constant coefficient of friction.

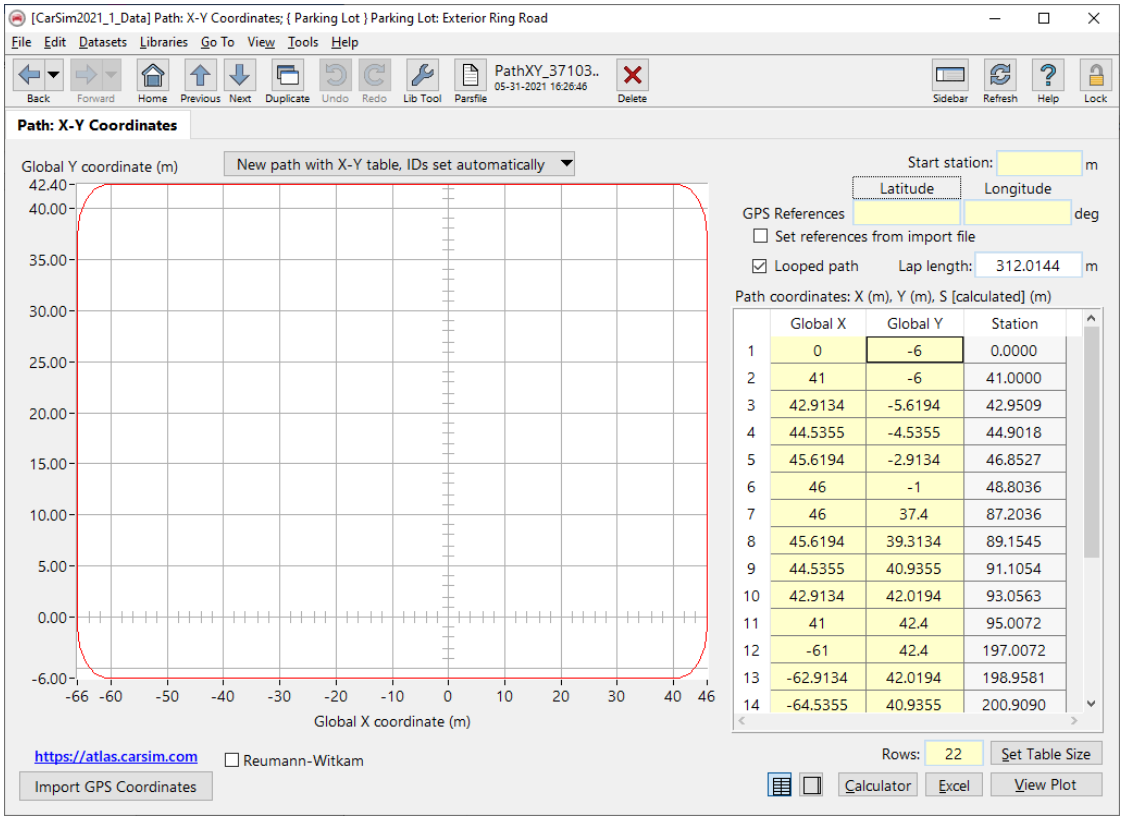


Figure 8. Path: X-Y Coordinates for Exterior Ring Road.

The road dataset **Parking Lot: Striping** shares its Path: X-Y Coordinates dataset with several other roads and is used to define the parking space stripes shown in the animation. Although the parking space lines are for animation purposes only and do not interact with the vehicle (Figure 9), it is necessary to define a road dataset to set up the auto-generated road shapes.

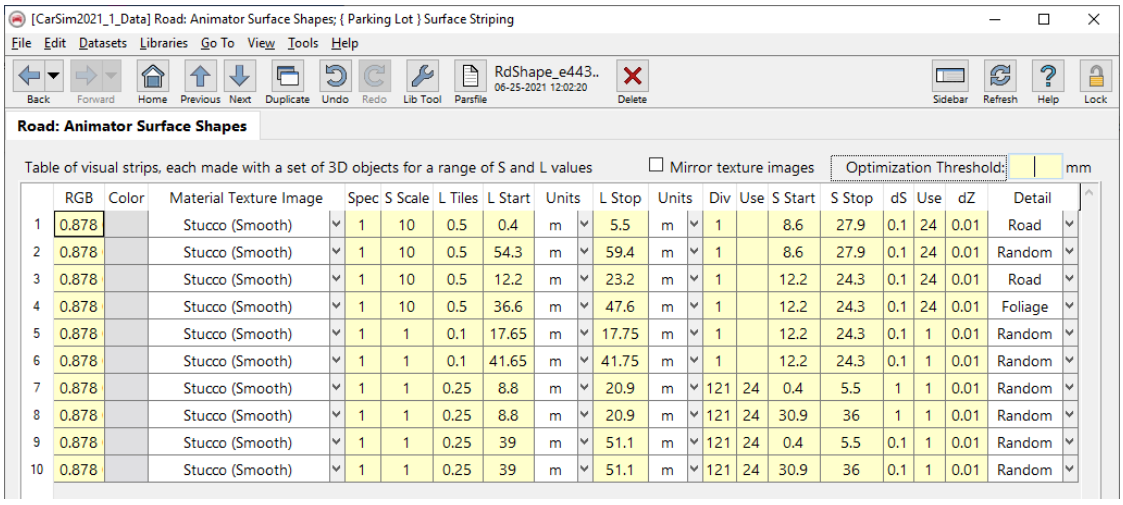


Figure 9. Road: Animator Surface Shapes dataset for parking space striping.

The final road — **Props and Environmental Objects** — is used as a reference for locating moving objects in the North-South oriented parking spaces (figure not shown). Its Path X-Y and Off-Center Elevation datasets are shared with the primary road, **Parking Lot: Pavement and Topology.**

Parking Space Locations

Referring to Figure 3, the parking spaces are organized into groups based on their location in the parking lot. Their locations are provided as Station and Lateral position (S & L), serving as convenient references when placing objects using the **Multiple Moving Objects** library.

The S & L origins for these groups are in the southeastern corner, with increasing path station either north or west.

East End, Facing West

Table 1 shows the 10 parking spaces located in the eastern end of the parking lot and face west. Path increases north.

Table 1. East End, Facing West.

Parking Space	Location (S, L), meters
1	(7.4, 4.5)
2	(9.8, 4.5)
3	(12.2, 4.5)
4	(14.6, 4.5)
5	(17.0, 4.5)
6	(19.4, 4.5)
7	(21.8, 4.5)
8	(24.2, 4.5)
9	(26.6, 4.5)
10	(29.0, 4.5)

East-Center, Facing East

Table 2 shows the five parking spaces located in the center of the parking lot, towards the eastern end, and all face east. Path increases north.

Table 2. East Center, Facing East.

Parking Space	Location (S, L), meters
1	(13.45, 13.5)
2	(15.85, 13.5)
3	(18.25, 13.5)
4	(20.65, 13.5)
5	(23.05, 13.5)

East-Center, Facing West

Table 3 shows the five parking spaces located in the center of the parking lot, towards the eastern end, and all face west. Path increases north.

Table 3. East Center, Facing West.

Parking Space	Location (S, L), meters
1	(13.45, 22.25)
2	(15.85, 22.25)
3	(18.25, 22.25)
4	(20.65, 22.25)
5	(23.05, 22.25)

Northeast, Facing South

Table 4 shows the seven parking spaces located in the northeast section of the parking lot. Path increases west.

Table 4. Northeast, Facing South.

Parking Space	Location (S, L), meters
1	(7.6, -31.5)
2	(10.0, -31.5)
3	(12.4, -31.5)
4	(14.8, -31.5)
5	(17.2, -31.5)
6	(19.6, -31.5)
7	(22.2, -31.5)

Northwest, Facing South

Table 5 shows the seven parking spaces located in the northwest section of the parking lot. Path increases west.

Table 5. Northwest, Facing South.

Parking Space	Location (S, L), meters
1	(37.8, -31.5)
2	(40.2, -31.5)
3	(42.6, -31.5)
4	(45.0, -31.5)
5	(47.4, -31.5)
6	(49.8, -31.5)
7	(52.2, -31.5)

Southeast, Facing North

Table 6 shows the seven parking spaces located in the southeastern section of the parking lot. Path increases west.

Table 6. Southeast, Facing North.

Parking Space	Location (S, L), meters
1	(7.6, -4.5)
2	(10.0, -4.5)
3	(12.4, -4.5)
4	(14.8, -4.5)
5	(17.2, -4.5)
6	(19.6, -4.5)
7	(22.2, -4.5)

Southwest, Facing North

Table 7 shows the seven parking spaces located in the southwestern section of the parking lot. Path increases west.

Table 7. Southwest, Facing North.

Parking Space	Location (S, L), meters
1	(37.8, -4.5)
2	(40.2, -4.5)
3	(42.6, -4.5)
4	(45.0, -4.5)
5	(47.4, -4.5)
6	(49.8, -4.5)
7	(52.2, -4.5)

West End, Facing East

Table 8 shows the 10 parking spaces located in the western end of the parking lot and face east. Path increases north.

Table 8. West End, Facing East.

Parking Space	Location (S, L), meters
1	(7.4, 55.3)
2	(9.8, 55.3)
3	(12.2, 55.3)
4	(14.6, 55.3)
5	(17.0, 55.3)
6	(19.4, 55.3)
7	(21.8, 55.3)
8	(24.2, 55.3)
9	(26.6, 55.3)
10	(29.0, 55.3)

West-Center, Facing East

Table 9 shows the five parking spaces located in the center of the parking lot, towards the western end, and all face east. Path increases north.

Table 9. West-Center, Facing East.

Parking Space	Location (S, L), meters
1	(13.45, 37.25)
2	(15.85, 37.25)
3	(18.25, 37.25)
4	(20.65, 37.25)
5	(23.05, 37.25)

West-Center, Facing West

Table 10 shows the five parking spaces located in the center of the parking lot, towards the western end, and all face west. Path increases north.

Table 10. West-Center, Facing West.

Parking Space	Location (S, L), meters
1	(13.45, 47.0)
2	(15.85, 47.0)
3	(18.25, 47.0)
4	(20.65, 47.0)
5	(23.05, 47.0)