Cement-Based Pavement Design Methods and Tools for the Practitioner

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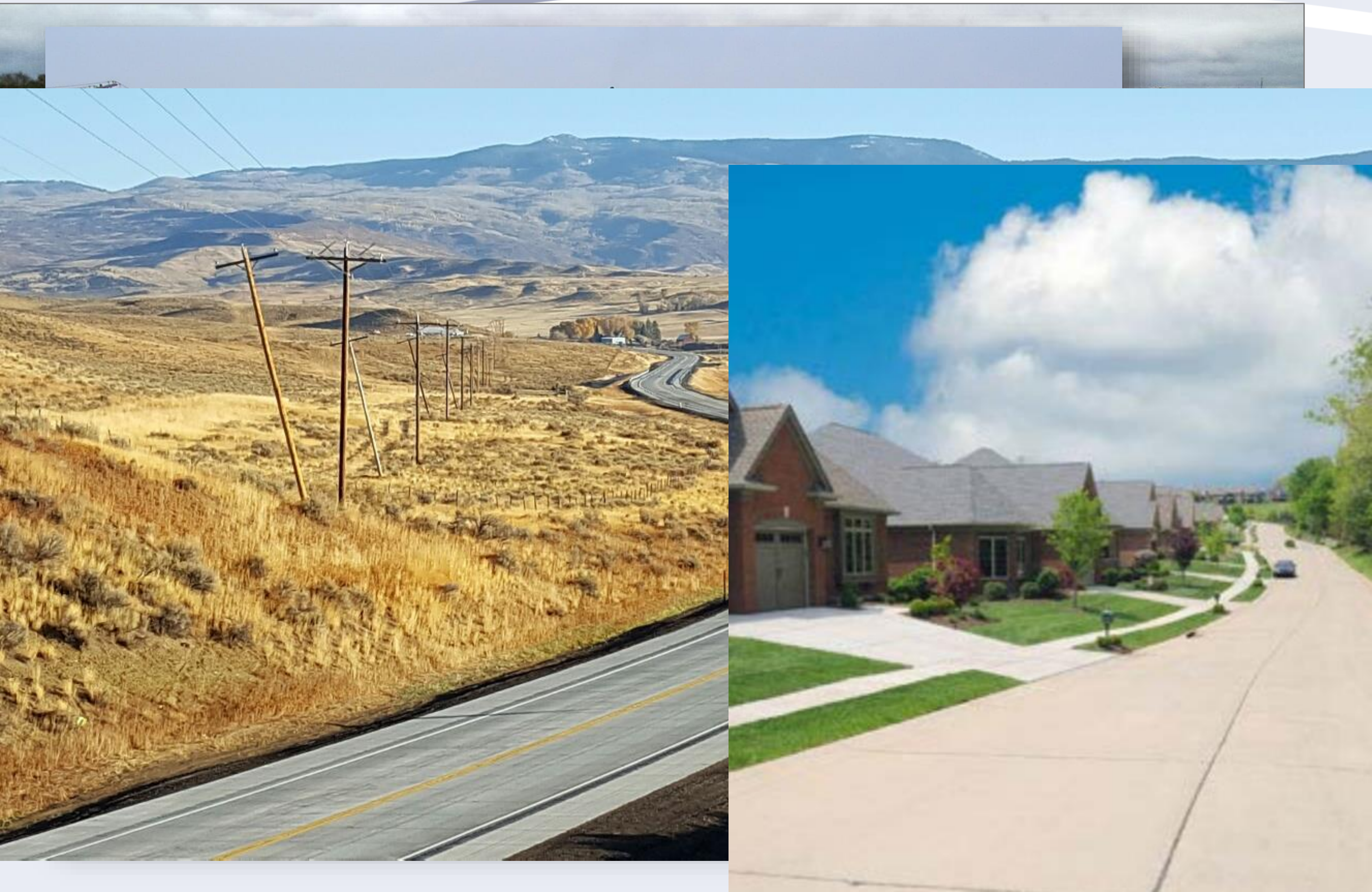
American Concrete Pavement Association

Concrete Pavement Versatility



Concrete Pavement Versatility

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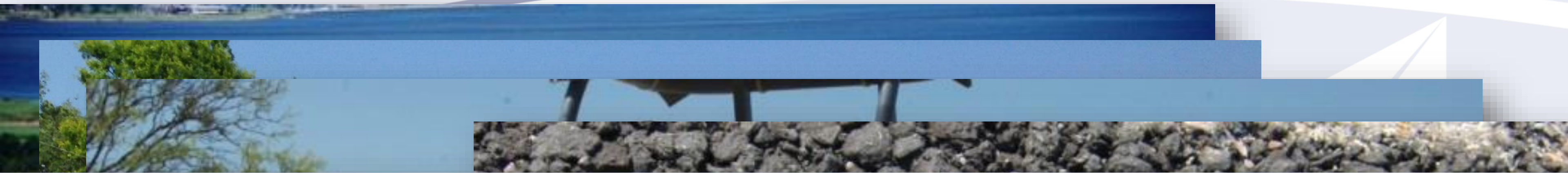


Design... for What?

Design... for What?

- Streets & Local Roads
- Parking Lots
- Industrial & Trucking Facilities
- Roller-Compacted Concrete Pavement
- Pervious Concrete Pavement
- All of the above

PavementDesigner.org

Streets and Local Roads

- ACI 325 – Concrete Pavements
  - 325.12R-02: Guide for Design of Jointed Concrete Pavements for Streets and Local Roads
  - Other documents on construction, mixtures, overlays, etc.
- Other ways to design:
  - PavementDesigner
  - AASHTO 93
  - Pavement ME
  - OptiPave

Streets and Local Roads

- ACI 325.12R-02
  - Pavement Material Reqs.
  - Thickness Design
    - Traffic
    - Classification
    - Thickness Determination
    - Economic Factors

Traffic Classification		k = 100 psi/in (CBR = 3)					
		Modulus of Rupture (psi)					
		500		600		700	
		Thickness, in.	Max JS, ft	Thickness, in.	Max JS, ft	Thickness, in.	Max JS, ft
Light Residential	ADTT = 3	5.75	12	5.25	12	4.75	12
Residential	ADTT = 10	6.50	14	5.75	13	5.25	13
	ADTT = 20	6.75	14	6.00	13	5.50	13
	ADTT = 50	7.00	14	6.25	14	5.75	13
Collector	ADTT = 50	7.75	15	7.00	15	6.50	15
	ADTT = 100	8.00	15	7.25	15	6.75	15
	ADTT = 500	8.50	15	7.75	15	7.00	15
Minor Arterial	ADTT = 100	9.50	15	8.50	15	7.75	15
	ADTT = 500	10.00	15	9.00	15	8.25	15
Major Arterial	ADTT = 400	11.00	15	10.00	15	9.00	15
	ADTT = 800	11.25	15	10.25	15	9.25	15
	ADTT = 1500	11.50	15	10.50	15	9.50	15
Business	ADTT = 300	8.75	15	8.00	15	7.25	15
	ADTT = 700	9.00	15	8.25	15	7.50	15

Traffic Classification		k = 200 psi/in (CBR = 10)					
		Modulus of Rupture (psi)					
		500		600		700	
		Thickness, in.	Max JS, ft	Thickness, in.	Max JS, ft	Thickness, in.	Max JS, ft
Light Residential	ADTT = 3	5.25	10	4.75	10	4.25	9
Residential	ADTT = 10	6.00	11	5.25	11	5.00	10
	ADTT = 20	6.25	11	5.50	11	5.00	10
	ADTT = 50	6.50	11	5.75	11	5.25	11
Collector	ADTT = 50	7.25	12	6.50	12	6.00	12
	ADTT = 100	7.50	13	6.75	12	6.00	12
	ADTT = 500	7.75	13	7.00	13	6.50	12
Minor Arterial	ADTT = 100	8.50	14	7.75	14	7.00	13
	ADTT = 500	9.25	15	8.25	14	7.50	14
Major Arterial	ADTT = 400	10.00	15	9.00	15	8.25	15
	ADTT = 800	10.25	15	9.25	15	8.50	15
	ADTT = 1500	10.50	15	9.50	15	8.75	15
Business	ADTT = 300	8.00	13	7.25	13	6.50	13
	ADTT = 700	8.25	14	7.50	13	6.75	13

Streets and Local Roads

- ACI 325.12R-02 (continued)
  - Jointing
    - Slab size and load transfer
    - Transverse Joints
    - Longitudinal Joints
    - Isolation and Expansion
    - Reinforcement
    - Irregular Panels
    - Sealants
  - Soils Info

Parking Lots

- ACI 330 – Concrete Parking Lots and Site Paving
  - 330R-08 Guide for the Design and Construction of Concrete Parking Lots
- Other ways to design:
  - PavementDesigner

Parking Lots

- ACI 330R-08
  - Pavement Design
    - Stresses
    - Loads
    - Subgrade
    - PCC Properties
    - THICKNESS
    - Jointing
    - Steel Reinforcement
    - Joint Filling & Sealing
    - Grades

Parking Lots

- ACI 330R-08 (Continued)
  - Materials
  - Construction
  - Inspection & Testing
  - Maintenance & Repair
  - Cleaning

Industrial and Trucking Facilities

- ACI 330 – Concrete Parking Lots and Site Paving
  - 330.2R-17: Guide for the Design and Construction of Concrete Site Paving for Industrial and Trucking Facilities
- Other ways to design:
  - PavementDesigner
  - OptiPave
  - AirPave

Industrial and Trucking Facilities

- ACI 330.2R-17
  - Subgrades and Subbases
  - Pavement Design
    - Jointing
    - Reinforcement
    - Stability/Load Transfer
  - Materials and Mixtures
  - Construction
  - Inspection & Testing
  - Maintenance & Repair & Sustainability

Roller–Compacted Concrete Pavement

- ACI 327 – Roller-Compacted Concrete Pavements
  - 327R-14 Guide to Roller Compacted Concrete Pavements
- Other ways to design:
  - PavementDesigner

Roller–Compacted Concrete Pavement

- ACI 327R-14
  - Common Uses
  - Properties & Materials
  - Mixture Proportioning
  - Structural Design
    - StreetPave
    - RCC-PAVE
    - PCASE

Pervious Concrete Pavement

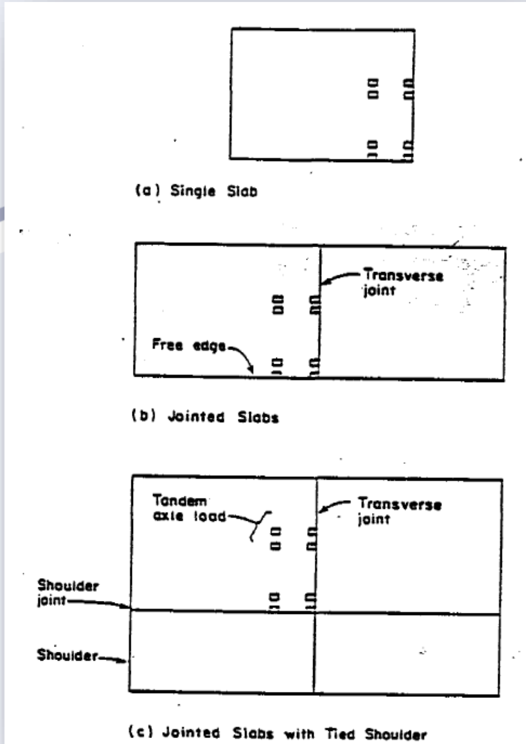
- ACI 522 – Pervious Concrete
  - ACI 522R-10 Report on Pervious Concrete
  - ACI 522.1-13 Specification for Pervious Concrete Pavement
- Other ways to design:
  - PerviousPave
  - PavementDesigner

Pervious Concrete Pavement

- ACI 522R-10
  - Applications
  - Materials
  - Properties
  - Mixture Proportioning
  - Pavement Design
    - Structural
    - Stormwater Management

Pervious Concrete Pavement

- ACI 522R-10 (continued)
  - Construction
    - Prep
    - Placing Consolidation
    - Jointing
    - Curing
  - QC/Inspection
  - Performance
  - Limitations
  - Environmental



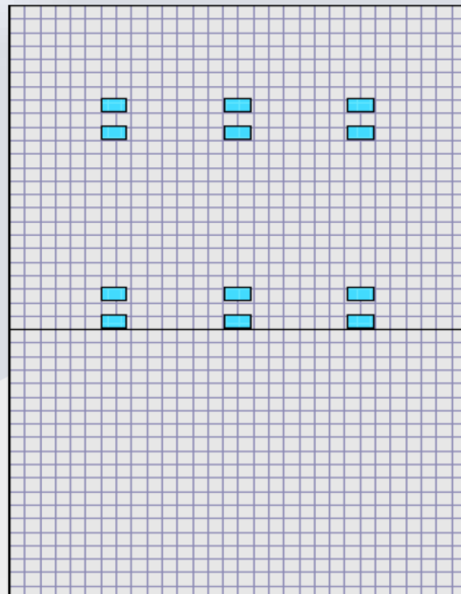


Figure 7. FE model of tridem axle edge loading (lane with tried concrete shoulders).

PavementDesigner.org

PavementDesigner Background

- A free tool designed to simplify concrete pavement design for:
  - Parking lots
  - Roadways
    - JPCP, RCC, CRCP
    - Overlays (bonded and unbonded)
    - Composite pavements
  - Industrial / Intermodal yards
    - Forklifts and other odd loadings

PavementDesigner.org

Evolution of Industry Designs

- 1960's PCA Method
- 1980's Erosion Model Introduced
- 2005 StreetPave software released
- 2012 Major Revamp of StreetPave software
- 2018 PavementDesigner Released
  - Incorporated other design methodologies

PavementDesigner.org

Industry Design Methods

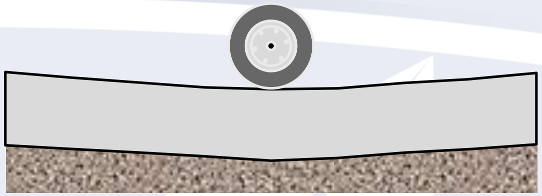
- PCA Methodology originally began in 1960's
- Mechanistic based
- Tailored for streets and roads
- Failure modes are cracking and faulting

Traffic Spectrum + Counts

Single Axles		Tandem Axles	
Axle Load (kip)	Axles/1,000 Trucks	Axle Load (kip)	Axles/1,000 Trucks
34	0.19	60	0.57
32	0.54	56	1.07
30	0.63	52	1.79
28	1.78	48	3.03
26	3.52	44	3.52
24	4.16	40	20.31
22	9.69	36	78.19
20	41.82	32	109.54
18	68.27	28	95.79
16	57.07	24	71.16

- Total trucks in design lane over the design life…
  calculated from trucks/day (2-way), traffic growth rate (%/yr), design life (yrs), directional distribution (%) and design lane distribution (%)

Traffic Loads Generate Stresses



- Equivalent stress at the slab edge:

$$\sigma_{eq} = \frac{6 * M_e}{{h_c}^2} * f_1 * f_2 * f_3 * f_4$$

M_e = equivalent moment, psi; different for single, tandem, and tridem axles, with and without edge support - func on radius of relative stiffness, which depends on concrete modulus, Poisson's ratio, and thickness and the k-value

h_c = pavement thickness, in.

f_1 = adjustment for the effect of axle loads and contact area

f_2 = adjustment for a slab with no concrete shoulder

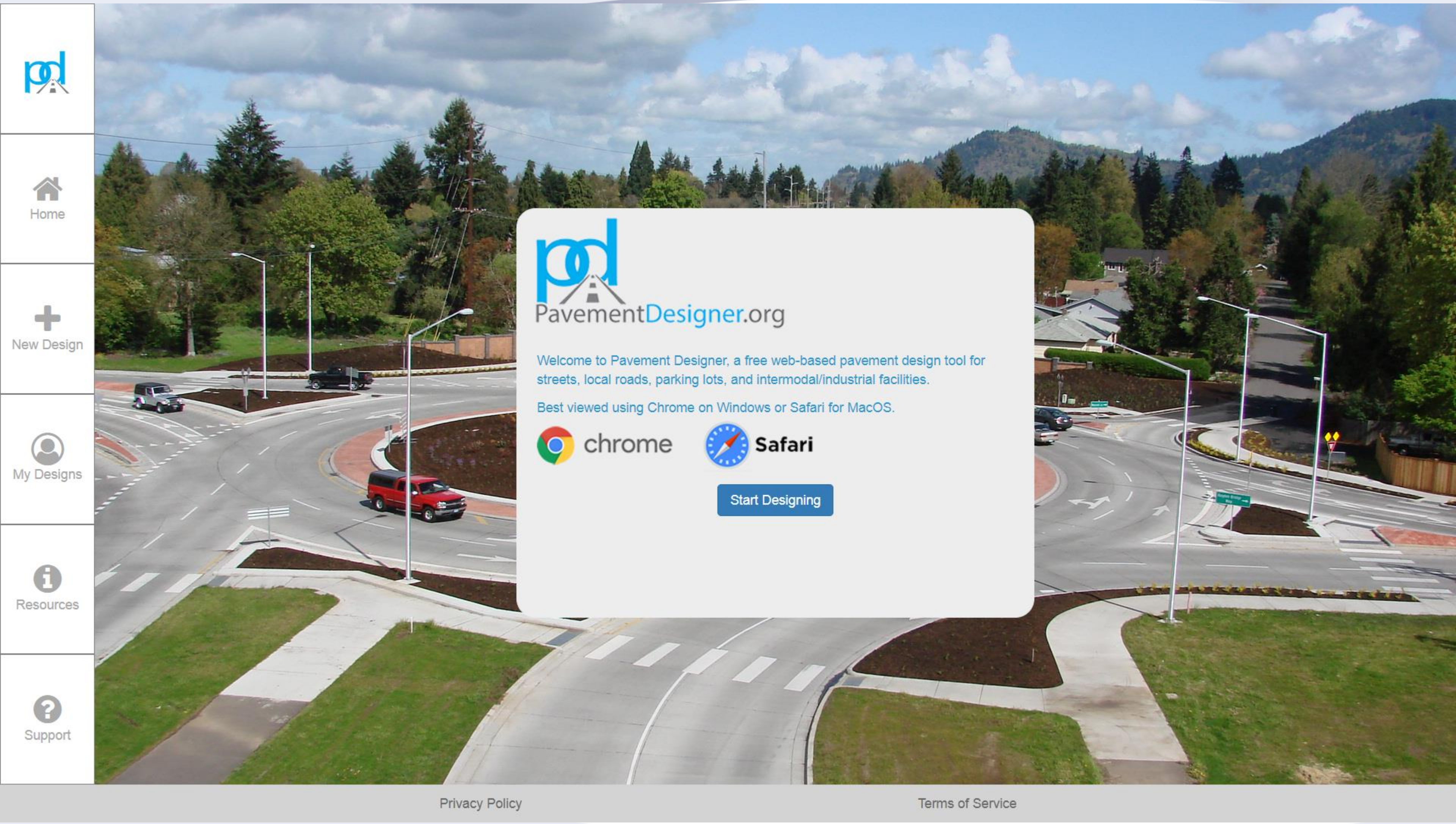
f_3 = adjustment to account for the effect of truck (wheel) placement at the slab edge

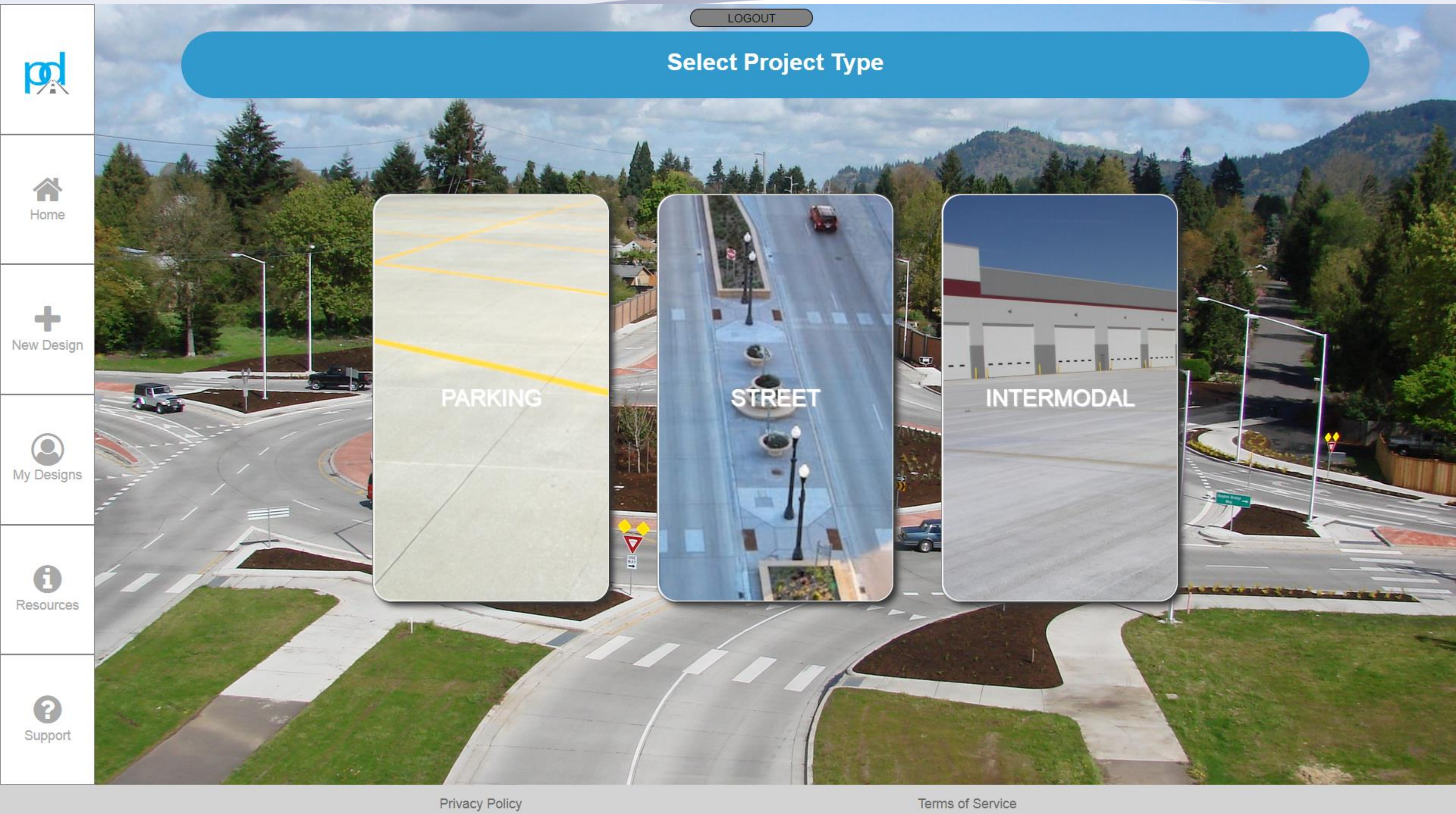
f_4 = adjustment to account for approximately 23.5% increase in concrete strength with age after the 28th day and reduction of one coefficient of variation (COV) to account for materials variability

Erosion Model Introduced

- If dowels used, faulting mitigated & fails by cracks
- No faulting data collected at the AASHO road test so model developed in 1980s using field performance data from WI, MN, ND, GA, and CA
- Similar to cracking models, the pavement is made thicker, as necessary, until faulting model predicts that the pavement will not fail by faulting during the design life
- PD's weak point

PavementDesigner.org

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STREET
INTERMODAL
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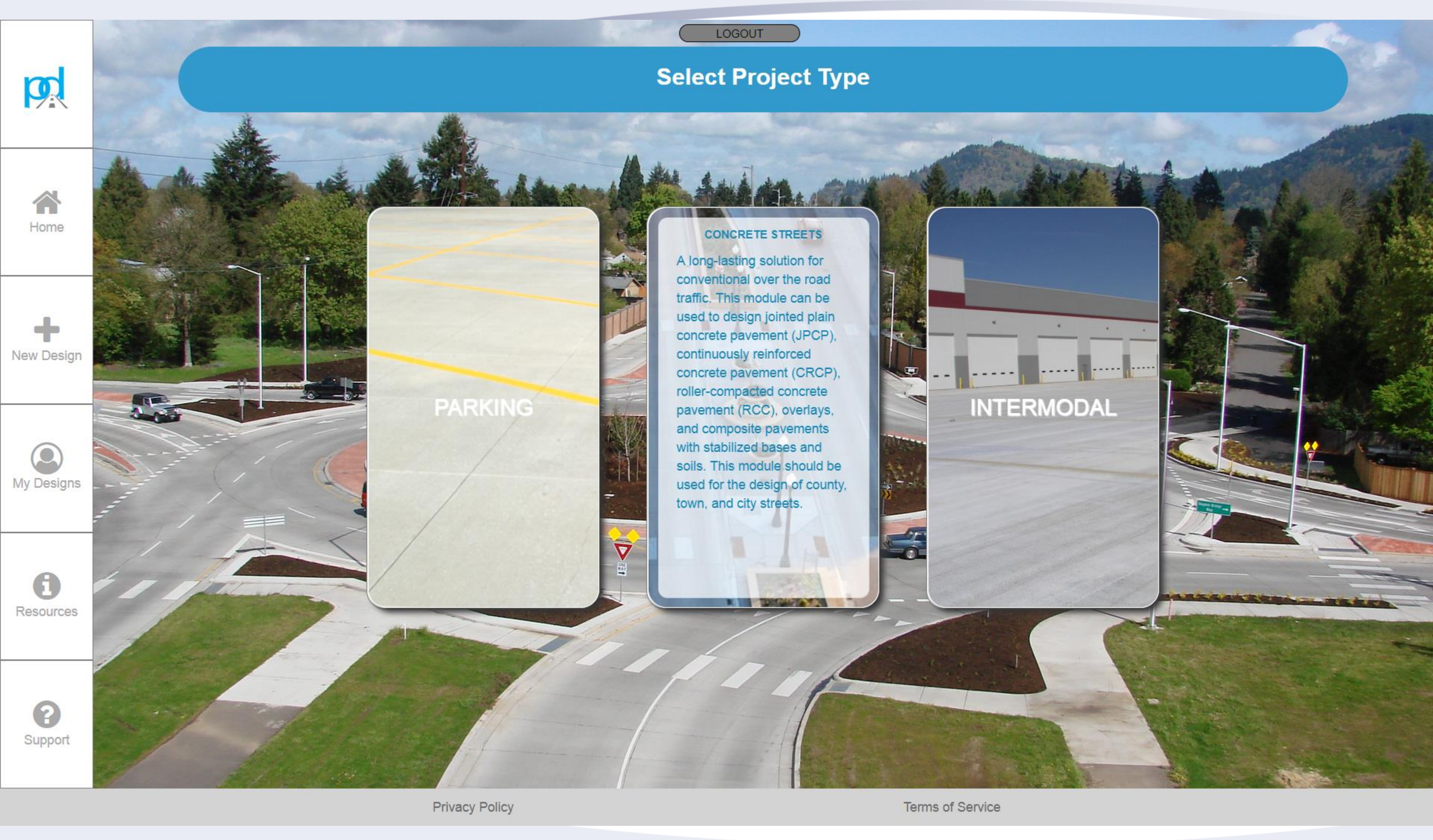
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PARKING
CONCRETE STREETS
A long-lasting solution for conventional over the road traffic. This module can be used to design jointed plain concrete pavement (JPCP), continuously reinforced concrete pavement (CRCP), roller-compacted concrete pavement (RCC), overlays, and composite pavements with stabilized bases and soils. This module should be used for the design of county, town, and city streets.
INTERMODAL
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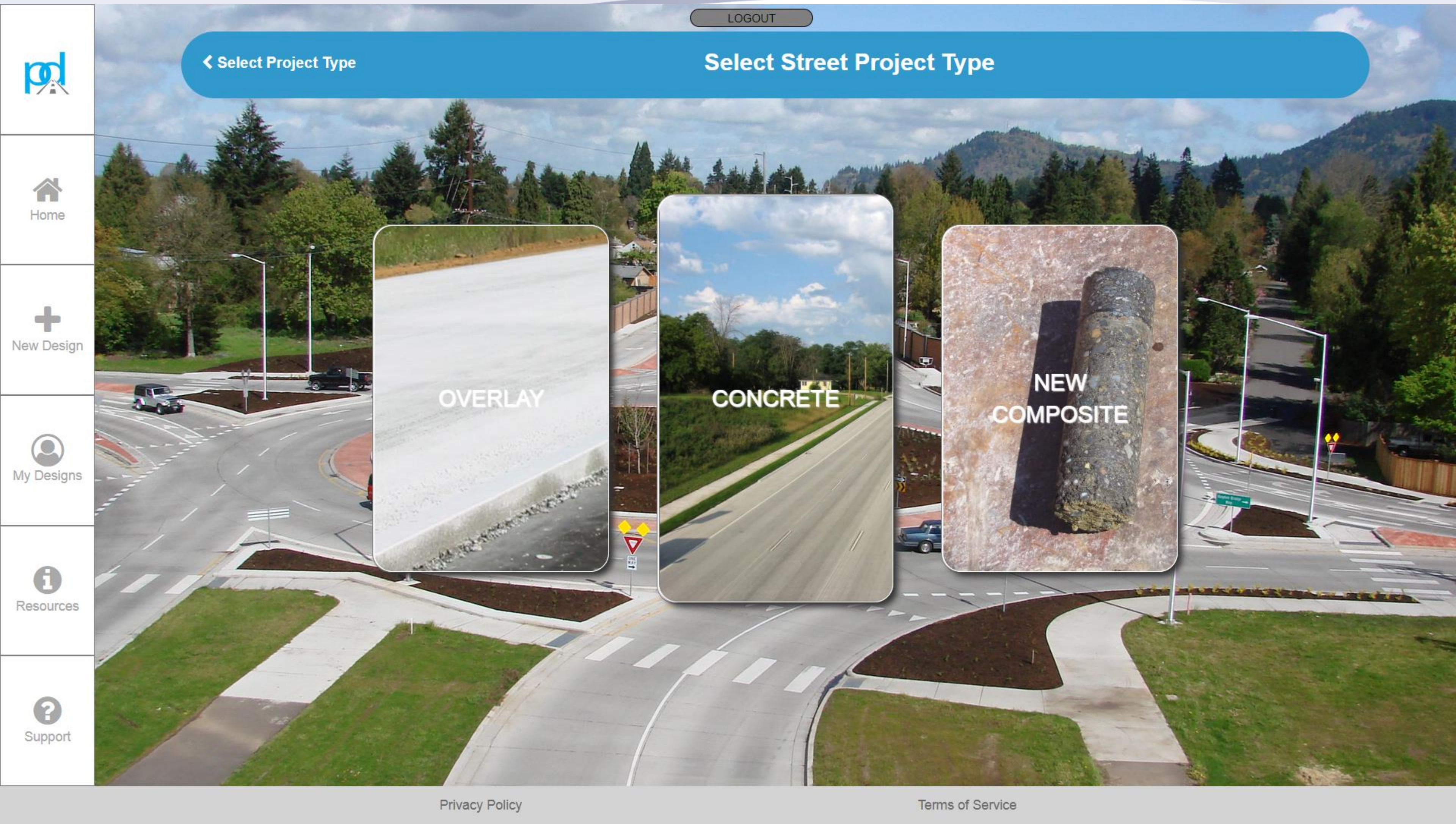
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CONCRETE
NEW COMPOSITE
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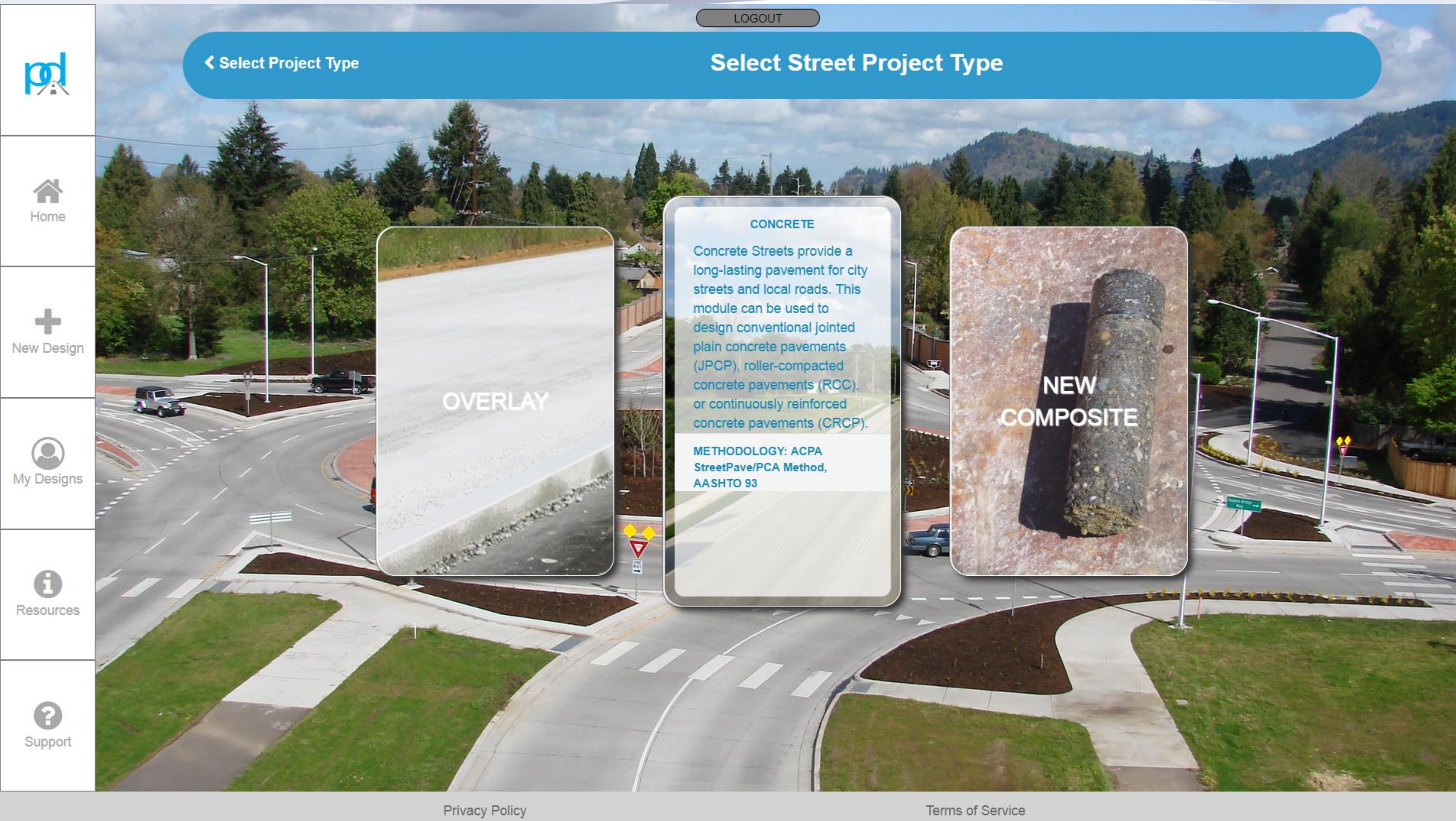
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OVERLAY
CONCRETE
Concrete Streets provide a long-lasting pavement for city streets and local roads. This module can be used to design conventional jointed plain concrete pavements (JPCP), roller-compacted concrete pavements (RCC), or continuously reinforced concrete pavements (CRCP).
METHODOLOGY: ACPA StreetPave/PCA Method, AASHTO 93
NEW COMPOSITE
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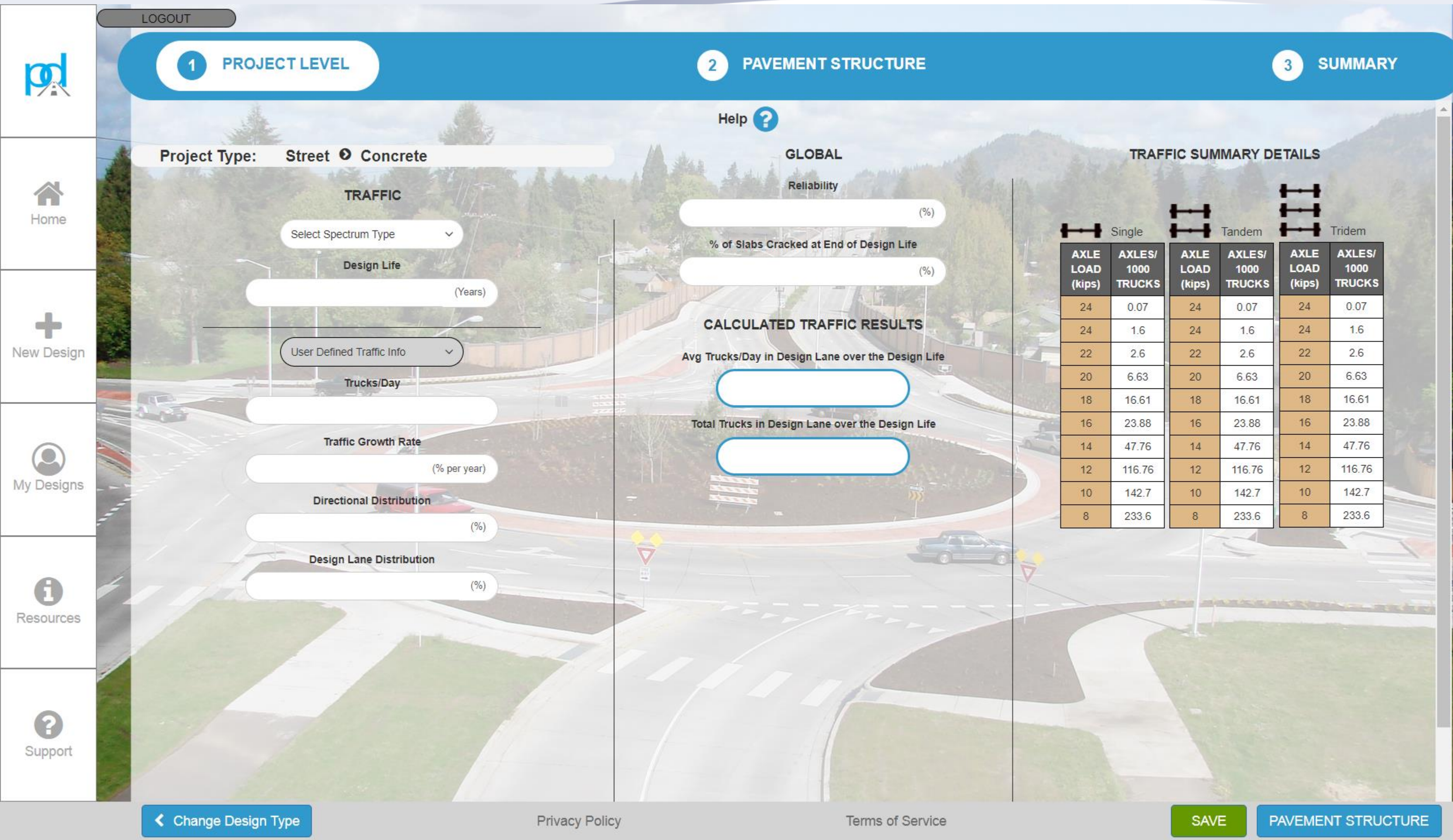
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Project Type: Street Concrete
TRAFFIC
Select Spectrum Type
Design Life
(Years)
User Defined Traffic Info
Trucks/Day
Traffic Growth Rate
(% per year)
Directional Distribution
(%)
Design Lane Distribution
(%)
GLOBAL
Reliability
(%)
% of Slabs Cracked at End of Design Life
(%)
CALCULATED TRAFFIC RESULTS
Avg Trucks/Day in Design Lane over the Design Life
Total Trucks in Design Lane over the Design Life
TRAFFIC SUMMARY DETAILS
Single
Tandem
Tridem

Single: AXLE LOAD (kips)	Single: AXLES/ 1000 TRUCKS	Tandem: AXLE LOAD (kips)	Tandem: AXLES/ 1000 TRUCKS	Tridem: AXLE LOAD (kips)	Tridem: AXLES/ 1000 TRUCKS
24	0.07	24	0.07	24	0.07
24	1.6	24	1.6	24	1.6
22	2.6	22	2.6	22	2.6
20	6.63	20	6.63	20	6.63
18	16.61	18	16.61	18	16.61
16	23.88	16	23.88	16	23.88
14	47.76	14	47.76	14	47.76
12	116.76	12	116.76	12	116.76
10	142.7	10	142.7	10	142.7
8	233.6	8	233.6	8	233.6

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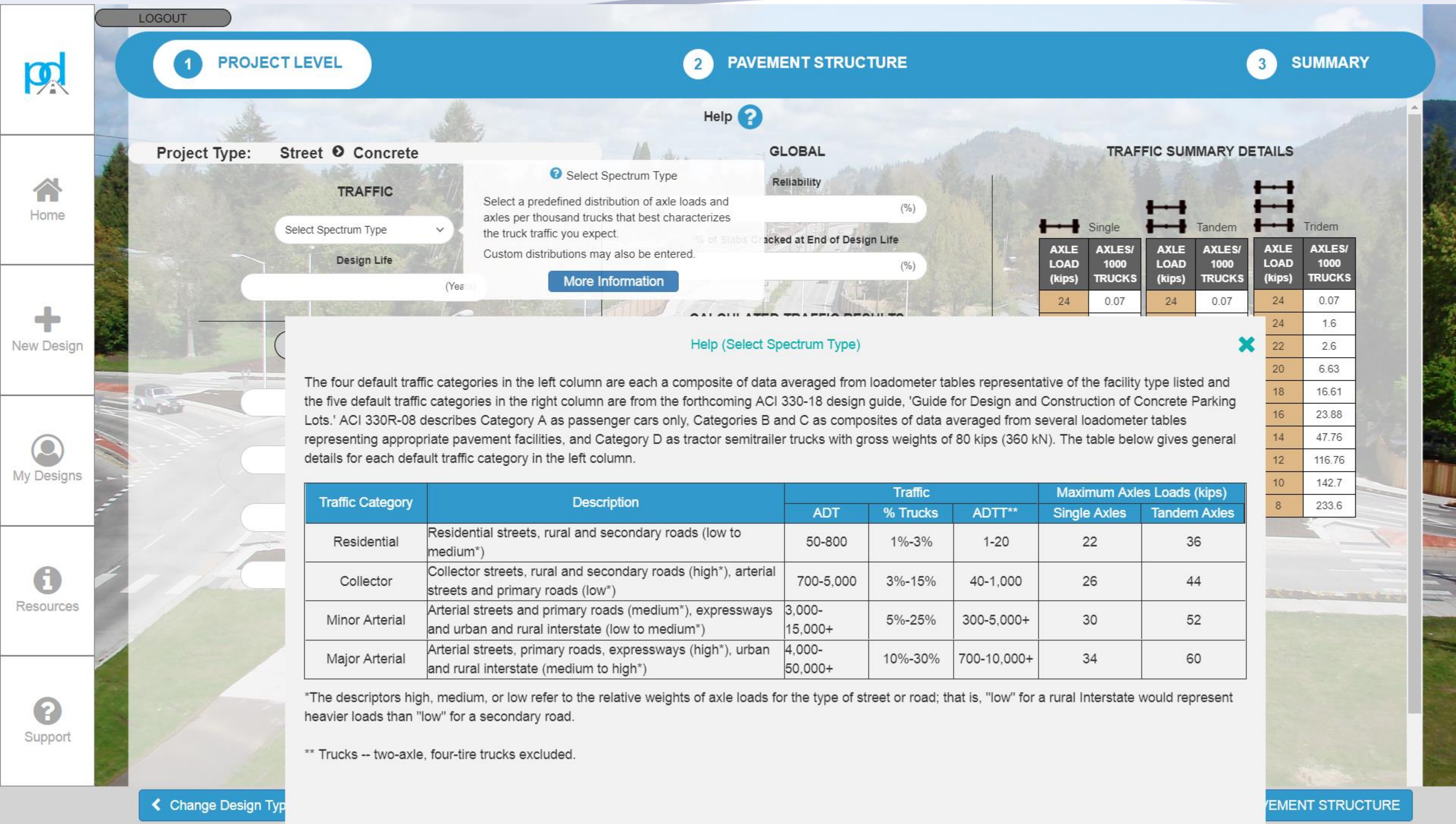
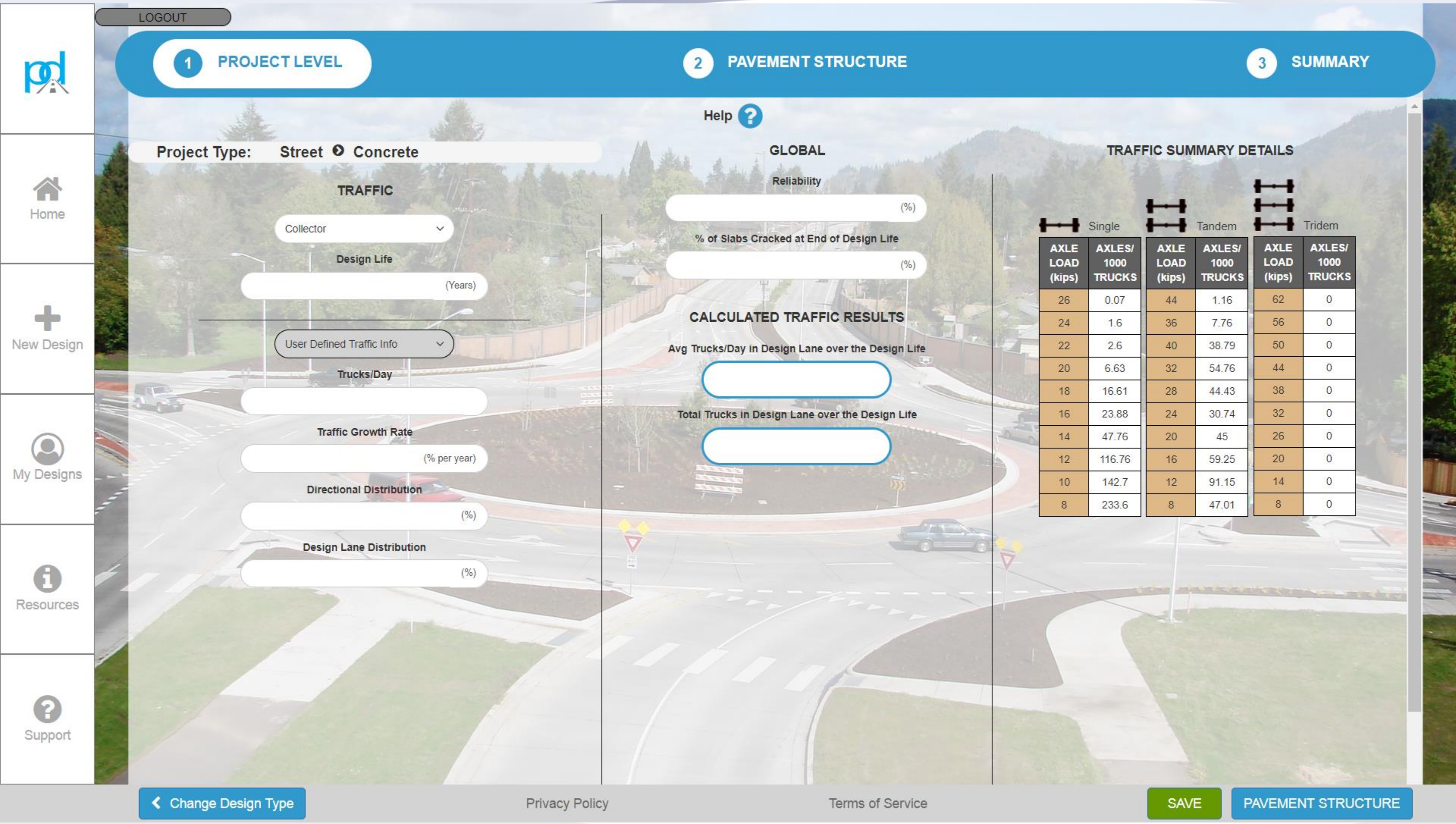


The four default traffic categories in the left column are each a composite of data averaged from loadometer tables representative of the facility type listed and the five default traffic categories in the right column are from the forthcoming ACI 330-18 design guide, 'Guide for Design and Construction of Concrete Parking Lots.' ACI 330R-08 describes Category A as passenger cars only, Categories B and C as composites of data averaged from several loadometer tables representing appropriate pavement facilities, and Category D as tractor semitrailer trucks with gross weights of 80 kips (360 kN). The table below gives general details for each default traffic category in the left column.

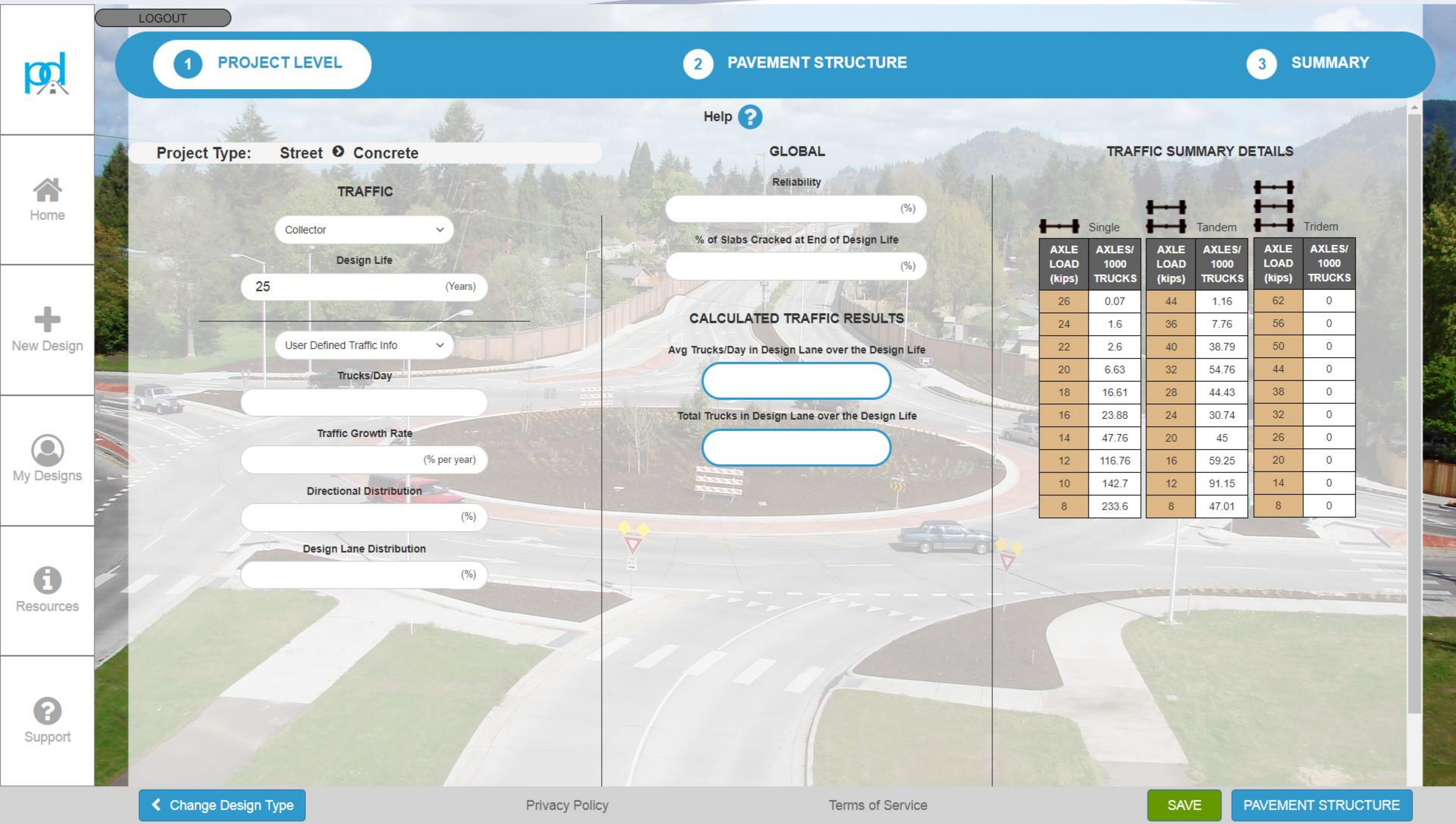
Traffic Category	Description	Traffic			Maximum Axles Loads (kips)	
		ADT	% Trucks	ADTT**	Single Axles	Tandem Axles
Residential	Residential streets, rural and secondary roads (low to medium*)	50-800	1%-3%	1-20	22	36
Collector	Collector streets, rural and secondary roads (high*), arterial streets and primary roads (low*)	700-5,000	3%-15%	40-1,000	26	44
Minor Arterial	Arterial streets and primary roads (medium*), expressways and urban and rural interstate (low to medium*)	3,000-15,000+	5%-25%	300-5,000+	30	52
Major Arterial	Arterial streets, primary roads, expressways (high*), urban and rural interstate (medium to high*)	4,000-50,000+	10%-30%	700-10,000+	34	60

*The descriptors high, medium, or low refer to the relative weights of axle loads for the type of street or road; that is, "low" for a rural Interstate would represent heavier loads than "low" for a secondary road.

** Trucks -- two-axle, four-tire trucks excluded.



Single AXLE LOAD (kips)	Single AXLES/ 1000 TRUCKS	Tandem AXLE LOAD (kips)	Tandem AXLES/ 1000 TRUCKS	Tridem AXLE LOAD (kips)	Tridem AXLES/ 1000 TRUCKS
26	0.07	44	1.16	62	0
24	1.6	36	7.76	56	0
22	2.6	40	38.79	50	0
20	6.63	32	54.76	44	0
18	16.61	28	44.43	38	0
16	23.88	24	30.74	32	0
14	47.76	20	45	26	0
12	116.76	16	59.25	20	0
10	142.7	12	91.15	14	0
8	233.6	8	47.01	8	0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Project Type: Street Concrete
TRAFFIC
Collector
Design Life
25 (Years)
User Defined Traffic Info
Trucks/Day
Traffic Growth Rate
(% per year)
Directional Distribution
(%)
Design Lane Distribution
(%)
GLOBAL
Reliability
(%)
% of Slabs Cracked at End of Design Life
(%)
CALCULATED TRAFFIC RESULTS
Avg Trucks/Day in Design Lane over the Design Life
Total Trucks in Design Lane over the Design Life
TRAFFIC SUMMARY DETAILS
Single
Tandem
Tridem

Single: AXLE LOAD (kips)	Single: AXLES/ 1000 TRUCKS	Tandem: AXLE LOAD (kips)	Tandem: AXLES/ 1000 TRUCKS	Tridem: AXLE LOAD (kips)	Tridem: AXLES/ 1000 TRUCKS
26	0.07	44	1.16	62	0
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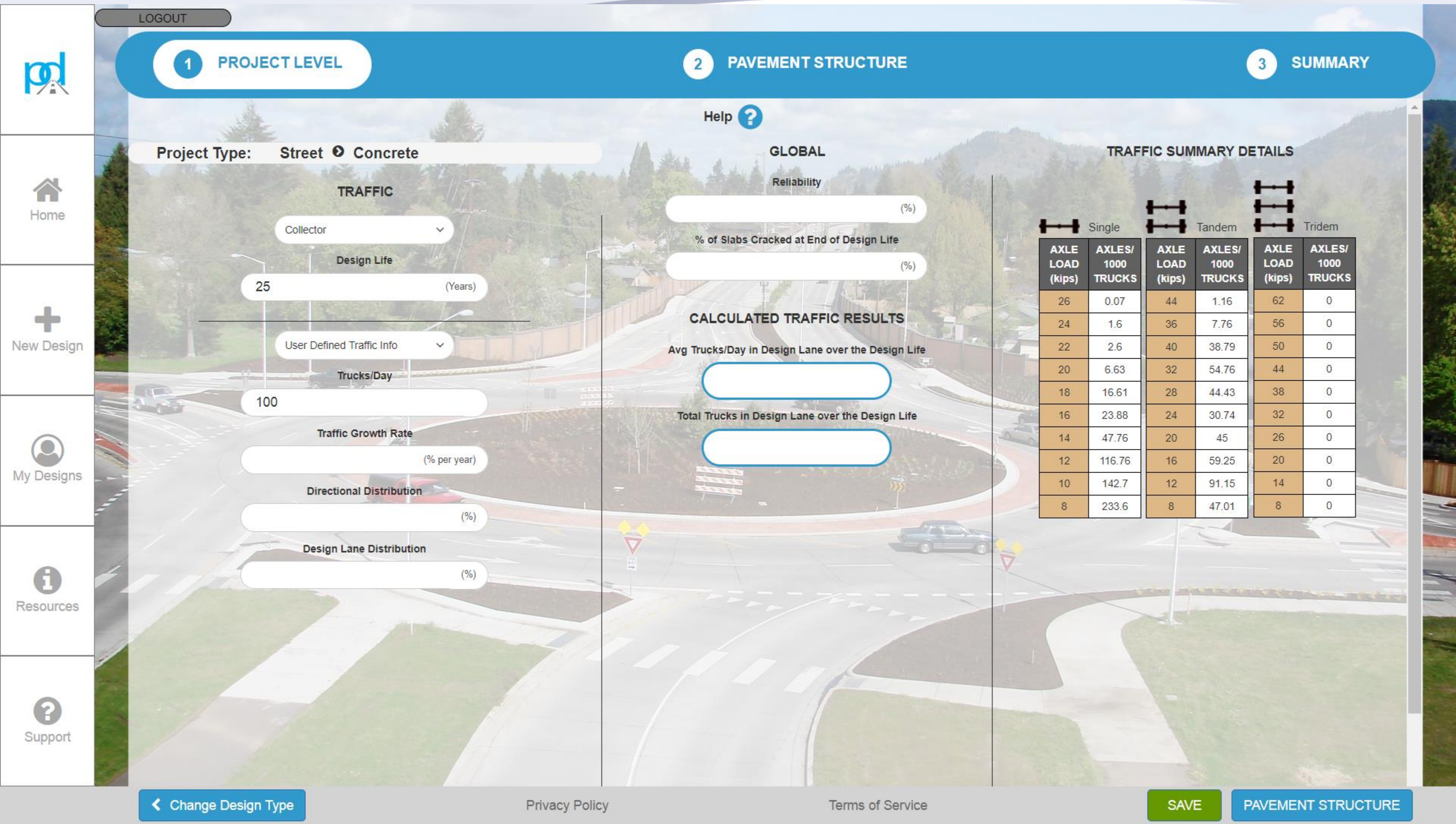
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Project Type: Street Concrete
TRAFFIC
Collector
Design Life
25 (Years)
User Defined Traffic Info
Trucks/Day
100
Traffic Growth Rate
(% per year)
Directional Distribution
(%)
Design Lane Distribution
(%)
GLOBAL
Reliability
(%)
% of Slabs Cracked at End of Design Life
(%)
CALCULATED TRAFFIC RESULTS
Avg Trucks/Day in Design Lane over the Design Life
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TRAFFIC SUMMARY DETAILS
Single
Tandem
Tridem

Single AXLE LOAD (kips)	Single AXLES/ 1000 TRUCKS	Tandem AXLE LOAD (kips)	Tandem AXLES/ 1000 TRUCKS	Tridem AXLE LOAD (kips)	Tridem AXLES/ 1000 TRUCKS
26	0.07	44	1.16	62	0
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Help ?

Project Type: Street ➔ Concrete

TRAFFIC

Collector

Design Life

25 (Years)

User Defined Traffic Info

Trucks/Day

100

Traffic Growth Rate

1 (% per year)

Directional Distribution

(%)

Design Lane Distribution

(%)

GLOBAL

Reliability

(%)

% of Slabs Cracked at End of Design Life

(%)

CALCULATED TRAFFIC RESULTS

Avg Trucks/Day in Design Lane over the Design Life

Total Trucks in Design Lane over the Design Life

TRAFFIC SUMMARY DETAILS

Single		Tandem		Tridem	
AXLE LOAD (kips)	AXLES/ 1000 TRUCKS	AXLE LOAD (kips)	AXLES/ 1000 TRUCKS	AXLE LOAD (kips)	AXLES/ 1000 TRUCKS
26	0.07	44	1.16	62	0
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Project Type: Street ➔ Concrete

TRAFFIC

Collector

Design Life

25 (Years)

User Defined Traffic Info

Trucks/Day

100

Traffic Growth Rate

1 (% per year)

Directional Distribution

50 (%)

Design Lane Distribution

(%)

GLOBAL

Reliability

(%)

% of Slabs Cracked at End of Design Life

(%)

CALCULATED TRAFFIC RESULTS

Avg Trucks/Day in Design Lane over the Design Life

Total Trucks in Design Lane over the Design Life

TRAFFIC SUMMARY DETAILS

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14	47.76
12	116.76
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8	233.6

Tandem

AXLE LOAD (kips)	AXLES/ 1000 TRUCKS
44	1.16
36	7.76
40	38.79
32	54.76
28	44.43
24	30.74
20	45
16	59.25
12	91.15
8	47.01

Tridem

AXLE LOAD (kips)	AXLES/ 1000 TRUCKS
62	0
56	0
50	0
44	0
38	0
32	0
26	0
20	0
14	0
8	0

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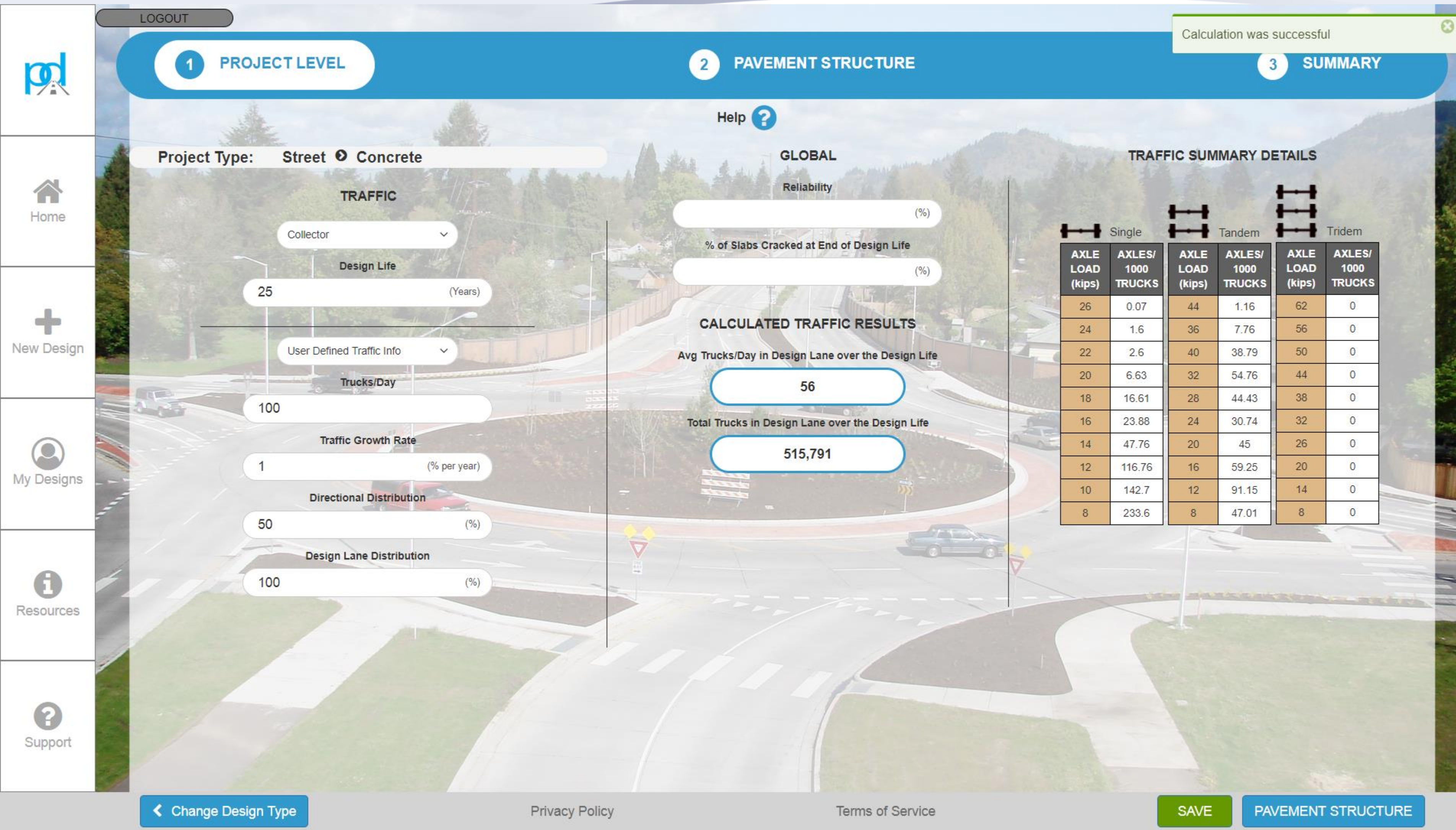

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10	142.7	12	91.15	14	0
8	233.6	8	47.01	8	0

LOGOUT

1 PROJECT LEVEL | 2 PAVEMENT STRUCTURE | 3 SUMMARY

Help ?

Project Type: Street ➔ Concrete

TRAFFIC

Collector

Design Life: 25 (Years)

User Defined Traffic Info

Trucks/Day: 100

Traffic Growth Rate: 1 (% per year)

Directional Distribution: 50 (%)

Design Lane Distribution: 100 (%)

GLOBAL

Reliability: 85 (%)

% of Slabs Cracked at End of Design Life: (%)

CALCULATED TRAFFIC RESULTS

Avg Trucks/Day in Design Lane over the Design Life: 56

Total Trucks in Design Lane over the Design Life: 515,791

TRAFFIC SUMMARY DETAILS

Single		Tandem		Tridem	
AXLE LOAD (kips)	AXLES/ 1000 TRUCKS	AXLE LOAD (kips)	AXLES/ 1000 TRUCKS	AXLE LOAD (kips)	AXLES/ 1000 TRUCKS
26	0.07	44	1.16	62	0
24	1.6	36	7.76	56	0
22	2.6	40	38.79	50	0
20	6.63	32	54.76	44	0
18	16.61	28	44.43	38	0
16	23.88	24	30.74	32	0
14	47.76	20	45	26	0
12	116.76	16	59.25	20	0
10	142.7	12	91.15	14	0
8	233.6	8	47.01	8	0

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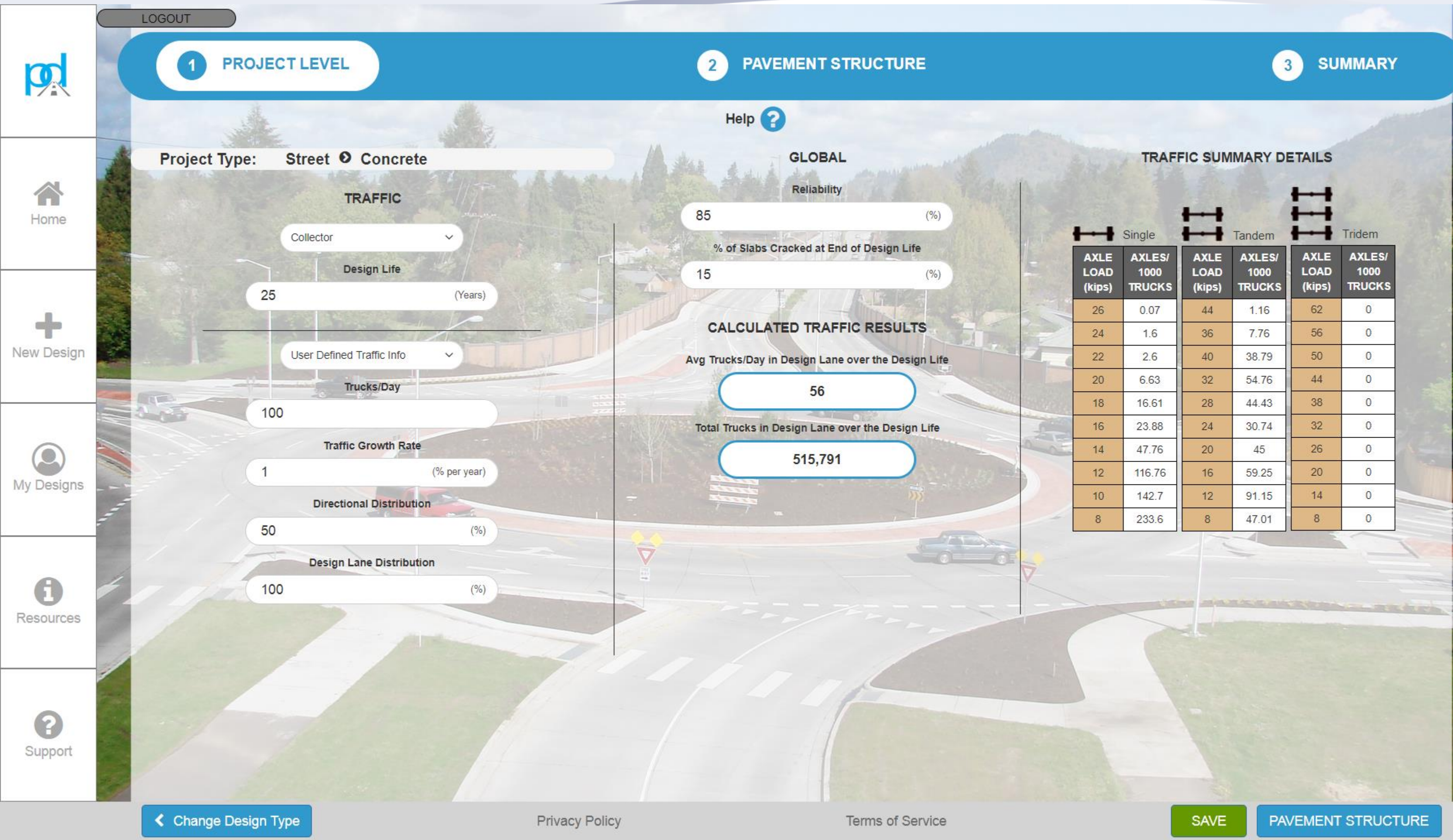
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Project Type: Street Concrete
TRAFFIC
Collector
Design Life
25 (Years)
User Defined Traffic Info
Trucks/Day
100
Traffic Growth Rate
1 (% per year)
Directional Distribution
50 (%)
Design Lane Distribution
100 (%)
GLOBAL
Reliability
85 (%)
% of Slabs Cracked at End of Design Life
15 (%)
CALCULATED TRAFFIC RESULTS
Avg Trucks/Day in Design Lane over the Design Life
56
Total Trucks in Design Lane over the Design Life
515,791
TRAFFIC SUMMARY DETAILS
Single
Tandem
Tridem

AXLE LOAD (kips)	AXLES/ 1000 TRUCKS	AXLE LOAD (kips)	AXLES/ 1000 TRUCKS	AXLE LOAD (kips)	AXLES/ 1000 TRUCKS
26	0.07	44	1.16	62	0
24	1.6	36	7.76	56	0
22	2.6	40	38.79	50	0
20	6.63	32	54.76	44	0
18	16.61	28	44.43	38	0
16	23.88	24	30.74	32	0
14	47.76	20	45	26	0
12	116.76	16	59.25	20	0
10	142.7	12	91.15	14	0
8	233.6	8	47.01	8	0

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Select Pavement Design Type

Jointed-Plain Concrete Pavement (JPCP)

Roller-Compacted Concrete (RCC)

Continuously Reinforced Concrete Pavement (CRCP)

Project Level

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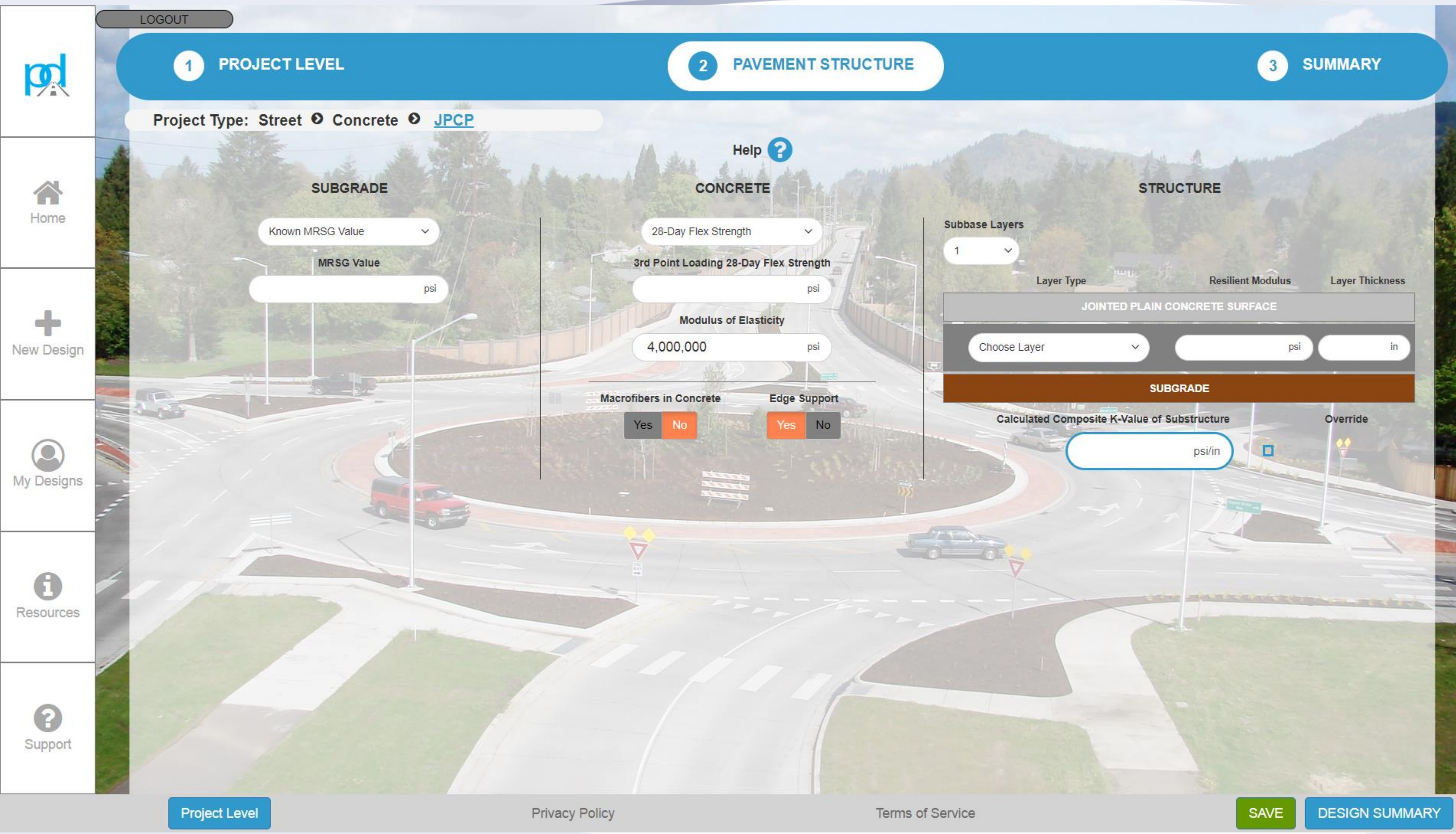
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Help
SUBGRADE
Known MRSG Value
MRSG Value
psi
CONCRETE
28-Day Flex Strength
3rd Point Loading 28-Day Flex Strength
psi
Modulus of Elasticity
4,000,000
psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Choose Layer
psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
Override
Project Level
Privacy Policy
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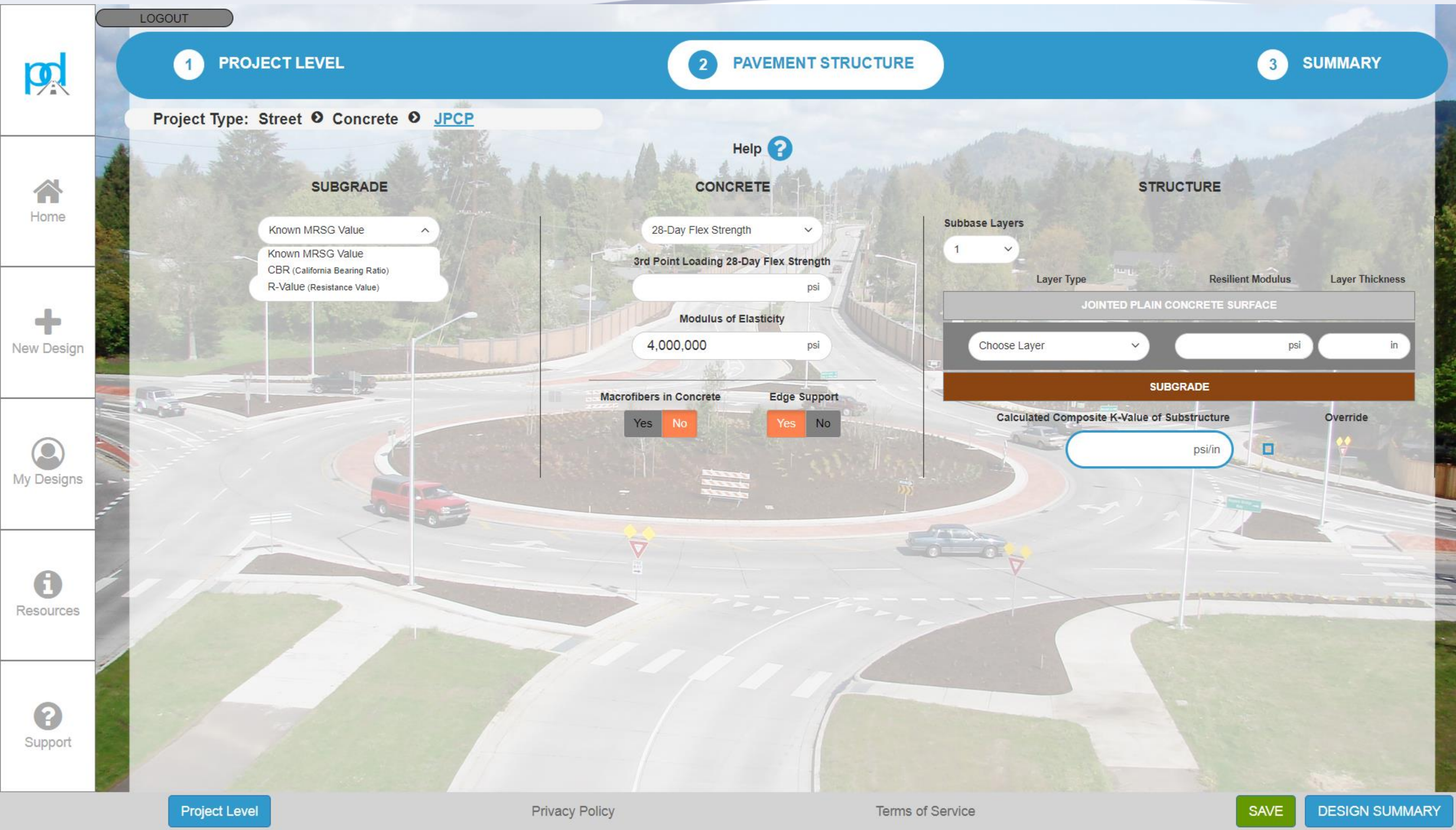
SAVE
DESIGN SUMMARY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Help
SUBGRADE
Known MRSG Value
Known MRSG Value
CBR (California Bearing Ratio)
R-Value (Resistance Value)
CONCRETE
28-Day Flex Strength
3rd Point Loading 28-Day Flex Strength
psi
Modulus of Elasticity
4,000,000 psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Choose Layer
psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
Override
Project Level
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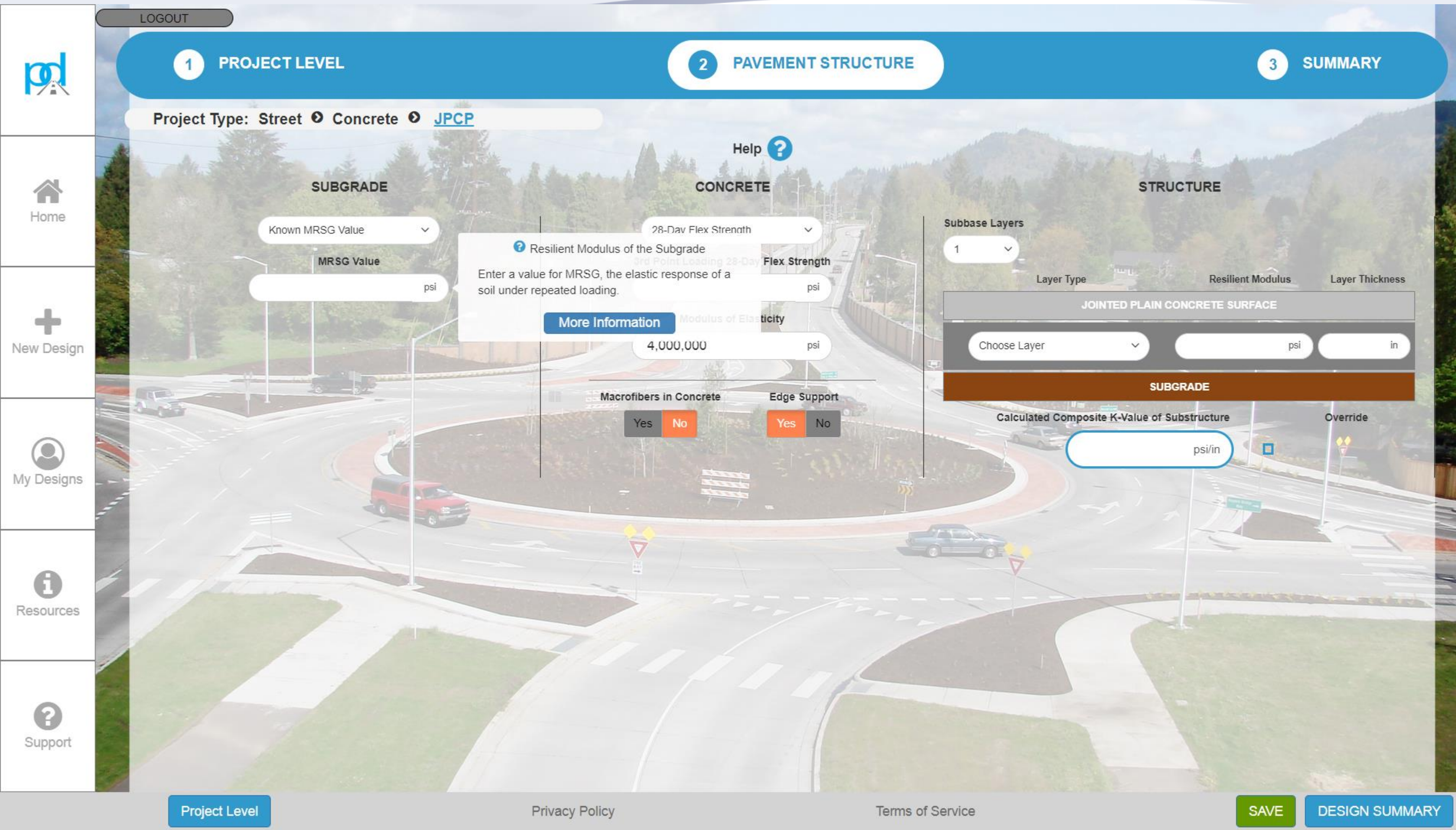
SAVE
DESIGN SUMMARY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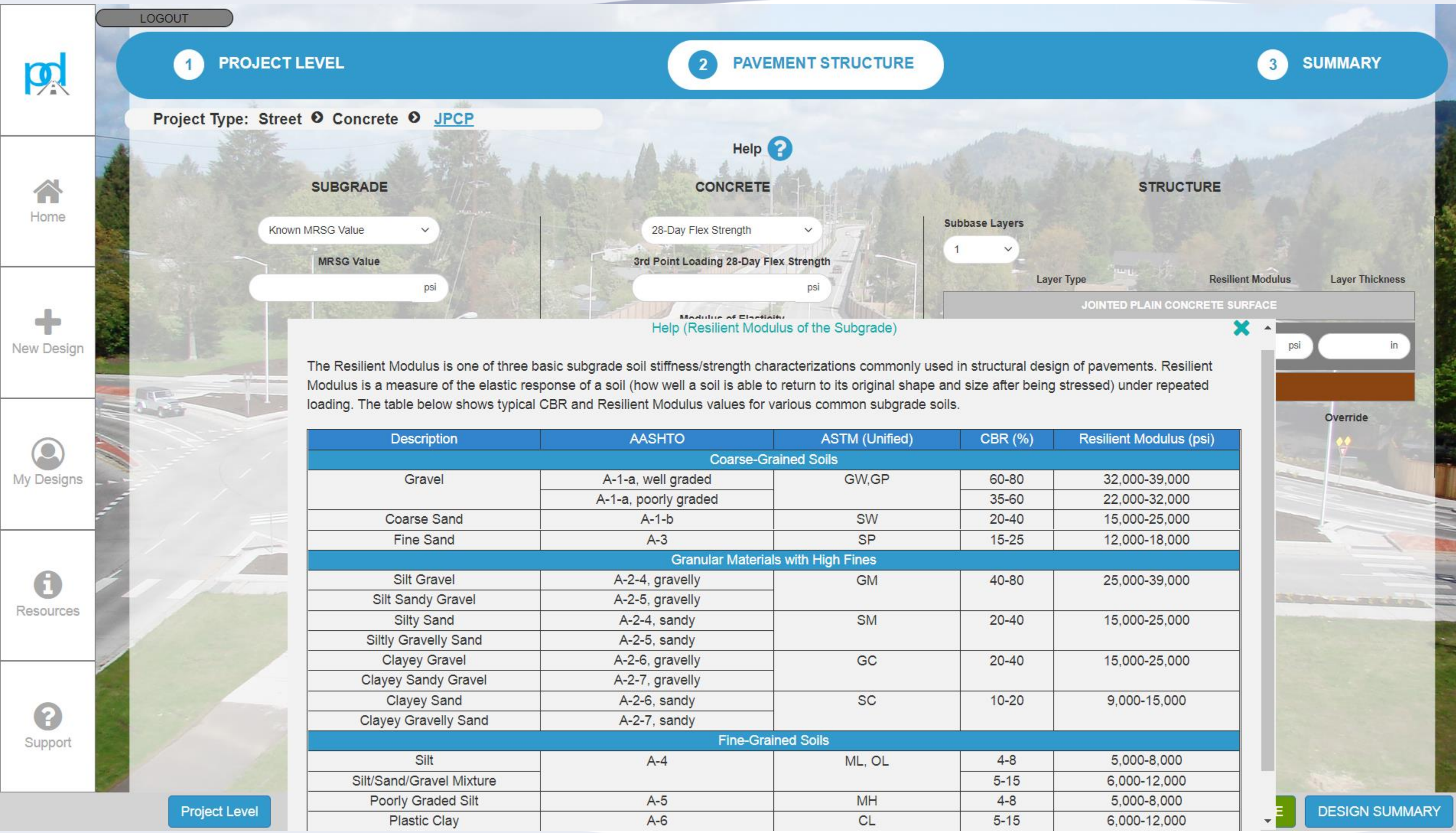
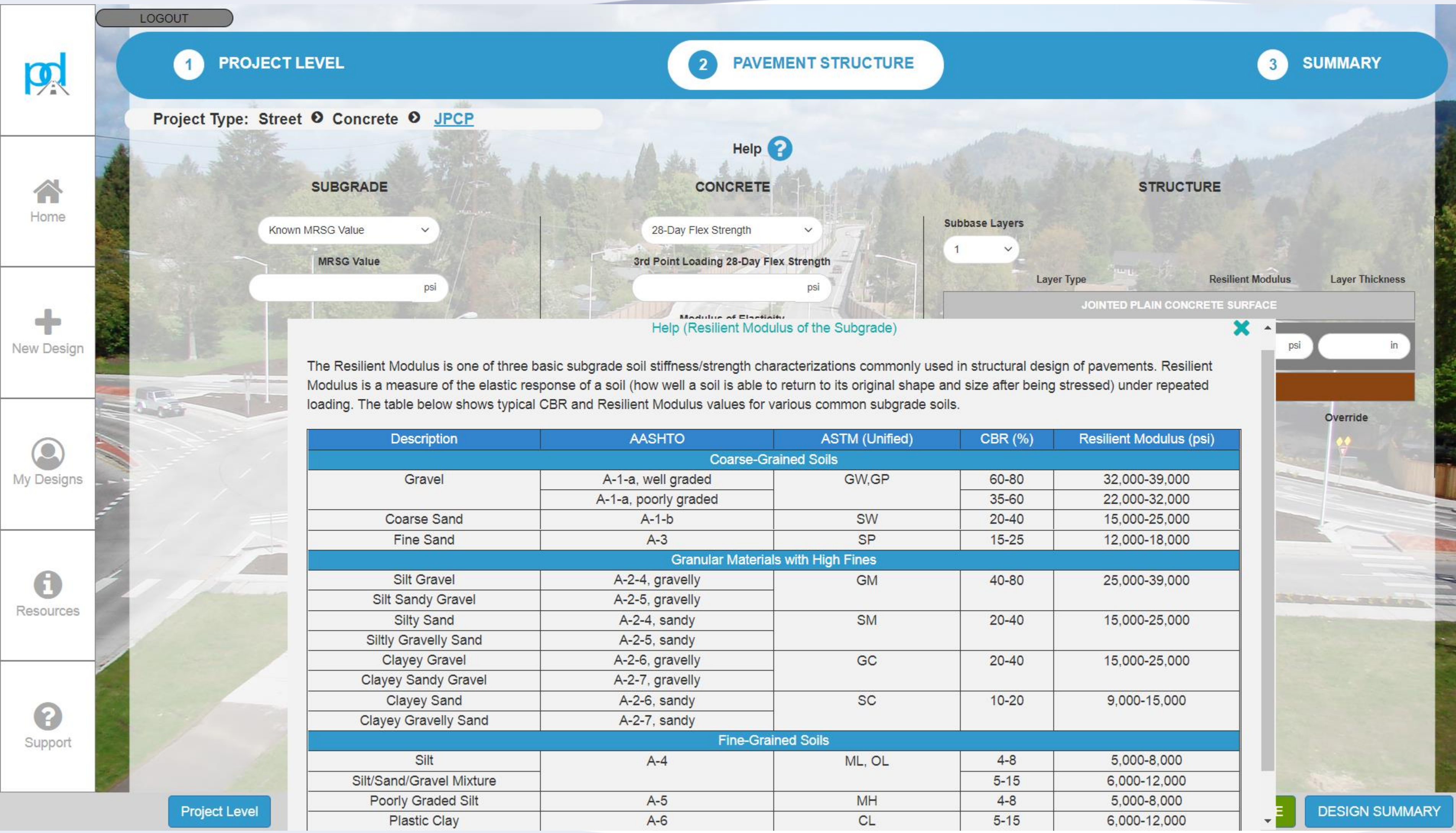
SUBGRADE
CONCRETE
STRUCTURE
Known MRSG Value
MRSG Value
psi
28-Day Flex Strength
Resilient Modulus of the Subgrade
Enter a value for MRSG, the elastic response of a soil under repeated loading.
More Information
Flex Strength
psi
ticity
4,000,000
psi
Macrofibers in Concrete
Yes
No
Edge Support
Yes
No
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Choose Layer
psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
Override
Project Level
Privacy Policy
Terms of Service
SAVE
DESIGN SUMMARY



Help (Resilient Modulus of the Subgrade)

The Resilient Modulus is one of three basic subgrade soil stiffness/strength characterizations commonly used in structural design of pavements. Resilient Modulus is a measure of the elastic response of a soil (how well a soil is able to return to its original shape and size after being stressed) under repeated loading. The table below shows typical CBR and Resilient Modulus values for various common subgrade soils.

Description	AASHTO	ASTM (Unified)	CBR (%)	Resilient Modulus (psi)
Coarse-Grained Soils				
Gravel	A-1-a, well graded	GW,GP	60-80	32,000-39,000
	A-1-a, poorly graded		35-60	22,000-32,000
Coarse Sand	A-1-b	SW	20-40	15,000-25,000
Fine Sand	A-3	SP	15-25	12,000-18,000
Granular Materials with High Fines				
Silt Gravel	A-2-4, gravelly	GM	40-80	25,000-39,000
Silt Sandy Gravel	A-2-5, gravelly			
Silty Sand	A-2-4, sandy	SM	20-40	15,000-25,000
Siltly Gravelly Sand	A-2-5, sandy			
Clayey Gravel	A-2-6, gravelly	GC	20-40	15,000-25,000
Clayey Sandy Gravel	A-2-7, gravelly			
Clayey Sand	A-2-6, sandy	SC	10-20	9,000-15,000
Clayey Gravelly Sand	A-2-7, sandy			
Fine-Grained Soils				
Silt	A-4	ML, OL	4-8	5,000-8,000
Silt/Sand/Gravel Mixture			5-15	6,000-12,000
Poorly Graded Silt	A-5	MH	4-8	5,000-8,000
Plastic Clay	A-6	CL	5-15	6,000-12,000



Help (Resilient Modulus of the Subgrade)

The Resilient Modulus is one of three basic subgrade soil stiffness/strength characterizations commonly used in structural design of pavements. Resilient Modulus is a measure of the elastic response of a soil (how well a soil is able to return to its original shape and size after being stressed) under repeated loading. The table below shows typical CBR and Resilient Modulus values for various common subgrade soils.

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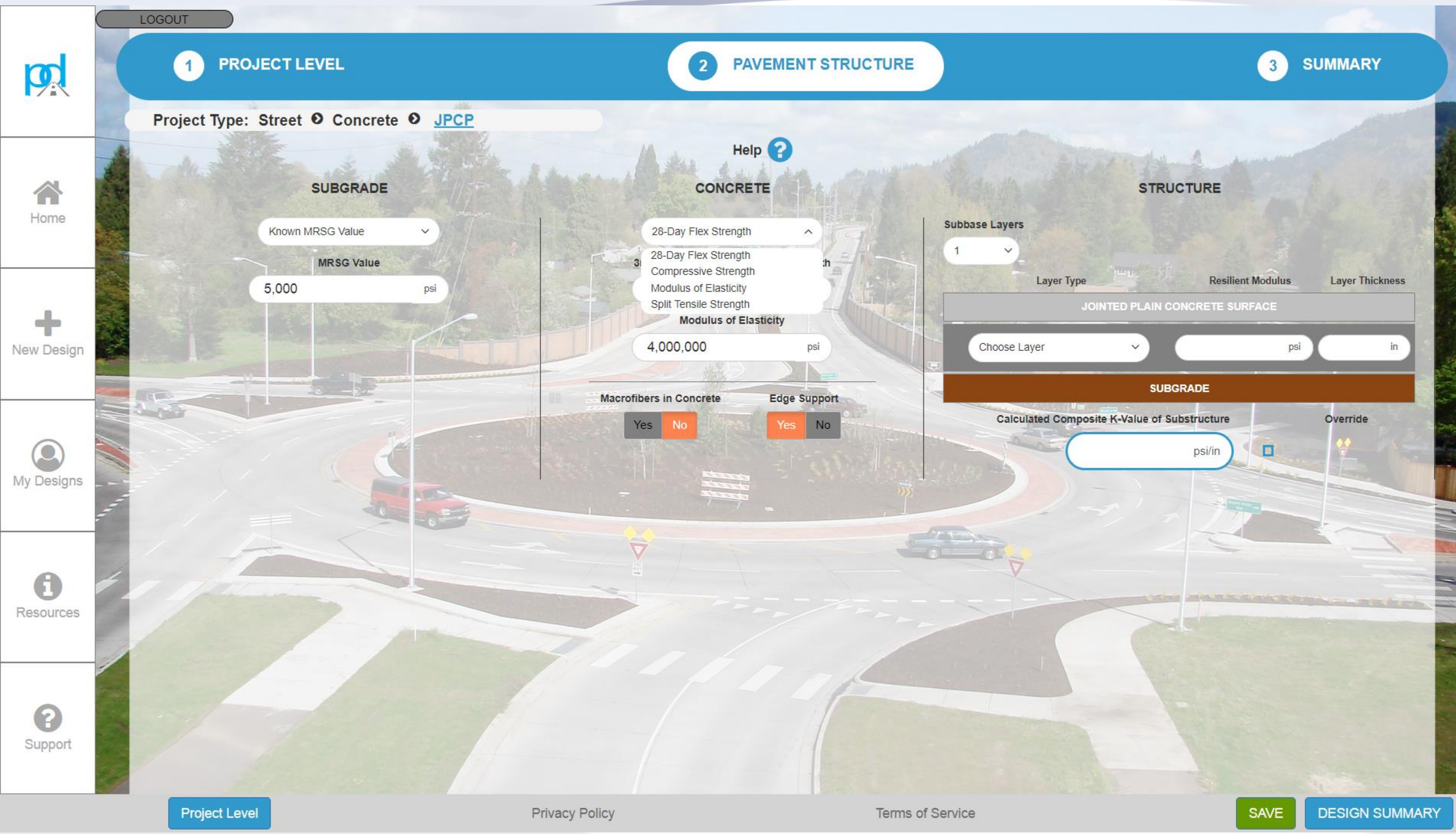
	A-1-a, poorly graded		35-60	22,000-32,000
Coarse Sand	A-1-b	SW	20-40	15,000-25,000
Fine Sand	A-3	SP	15-25	12,000-18,000
Granular Materials with High Fines				
Silt Gravel	A-2-4, gravelly	GM	40-80	25,000-39,000
Silt Sandy Gravel	A-2-5, gravelly			
Silty Sand	A-2-4, sandy	SM	20-40	15,000-25,000
Siltly Gravelly Sand	A-2-5, sandy			
Clayey Gravel	A-2-6, gravelly	GC	20-40	15,000-25,000
Clayey Sandy Gravel	A-2-7, gravelly			
Clayey Sand	A-2-6, sandy	SC	10-20	9,000-15,000
Clayey Gravelly Sand	A-2-7, sandy			
Fine-Grained Soils				
Silt	A-4	ML, OL	4-8	5,000-8,000
Silt/Sand/Gravel Mixture			5-15	6,000-12,000
Poorly Graded Silt	A-5	MH	4-8	5,000-8,000
Plastic Clay	A-6	CL	5-15	6,000-12,000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Project Type: Street Concrete JPCP
Help
SUBGRADE
Known MRSG Value
MRSG Value
5,000 psi
CONCRETE
28-Day Flex Strength
28-Day Flex Strength
Compressive Strength
Modulus of Elasticity
Split Tensile Strength
Modulus of Elasticity
4,000,000 psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Choose Layer
psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
Override
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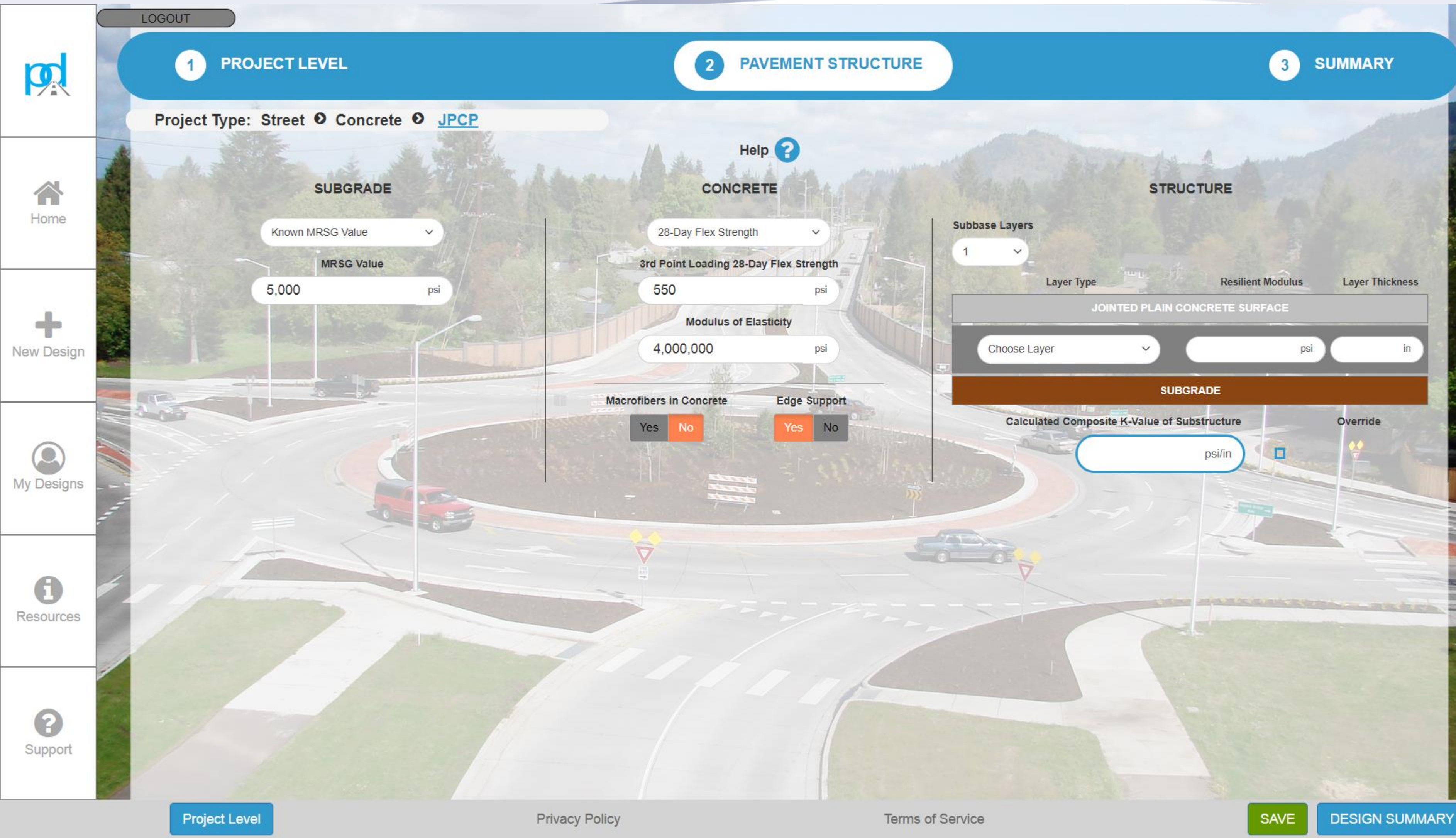
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Help
SUBGRADE
Known MRSG Value
MRSG Value
5,000 psi
CONCRETE
28-Day Flex Strength
3rd Point Loading 28-Day Flex Strength
550 psi
Modulus of Elasticity
4,000,000 psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Choose Layer
psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
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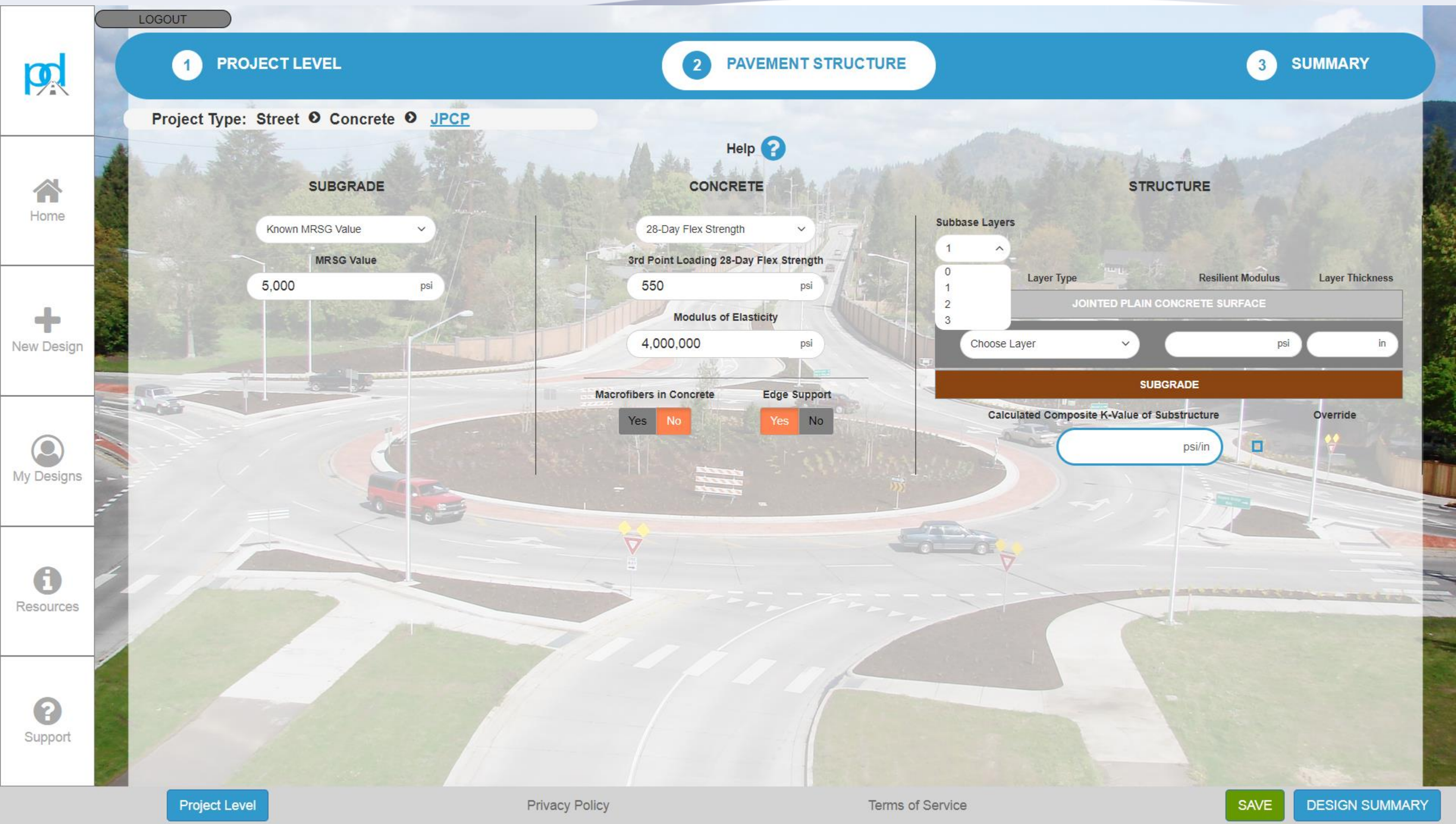
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SUBGRADE
Known MRSG Value
MRSG Value
5,000 psi
CONCRETE
28-Day Flex Strength
3rd Point Loading 28-Day Flex Strength
550 psi
Modulus of Elasticity
4,000,000 psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
0
1
2
3
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Choose Layer
psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
Override
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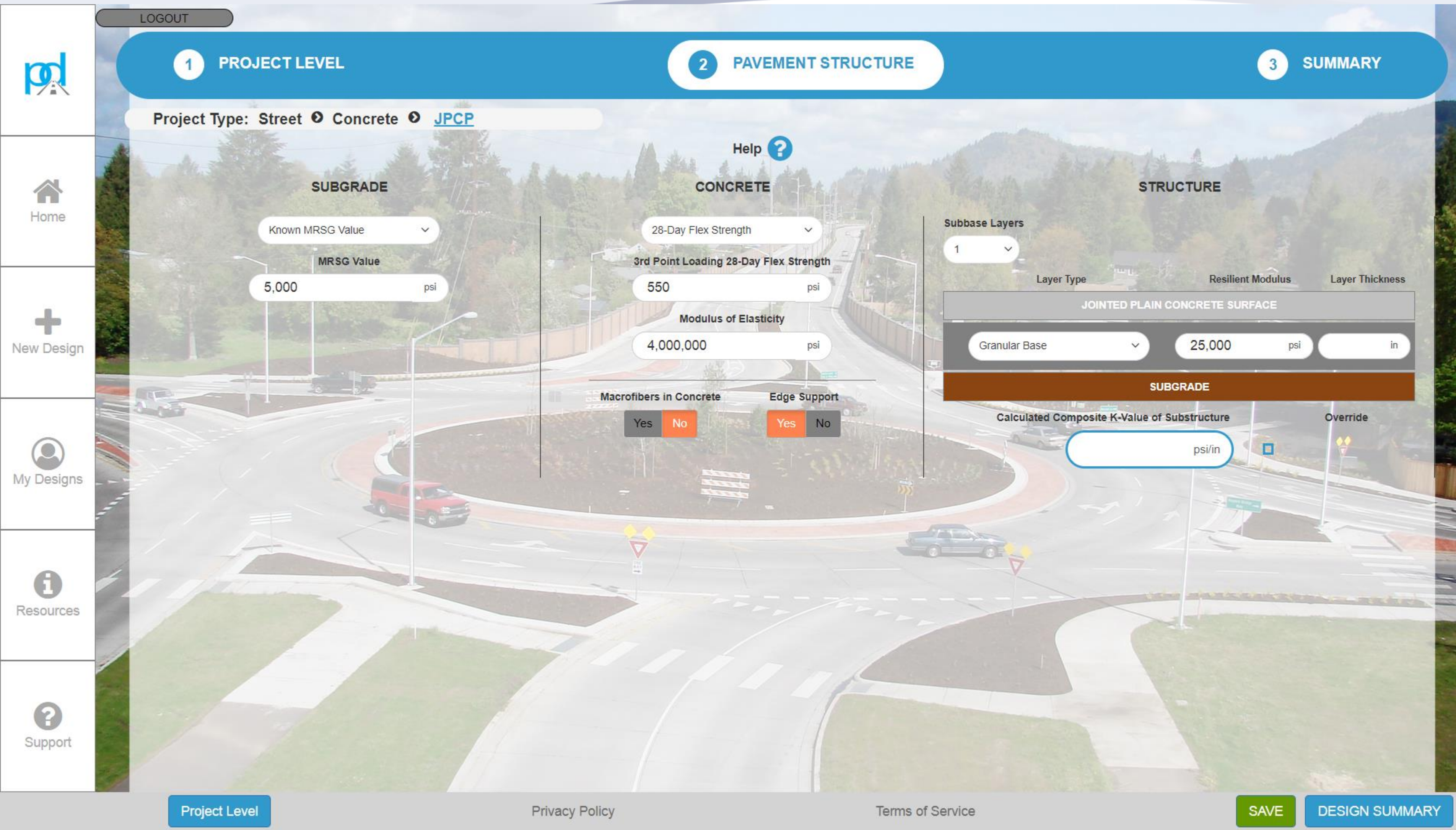
DESIGN SUMMARY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Help
SUBGRADE
Known MRSG Value
MRSG Value
5,000 psi
CONCRETE
28-Day Flex Strength
3rd Point Loading 28-Day Flex Strength
550 psi
Modulus of Elasticity
4,000,000 psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Granular Base
25,000 psi
in
SUBGRADE
Calculated Composite K-Value of Substructure
psi/in
Override
Project Level
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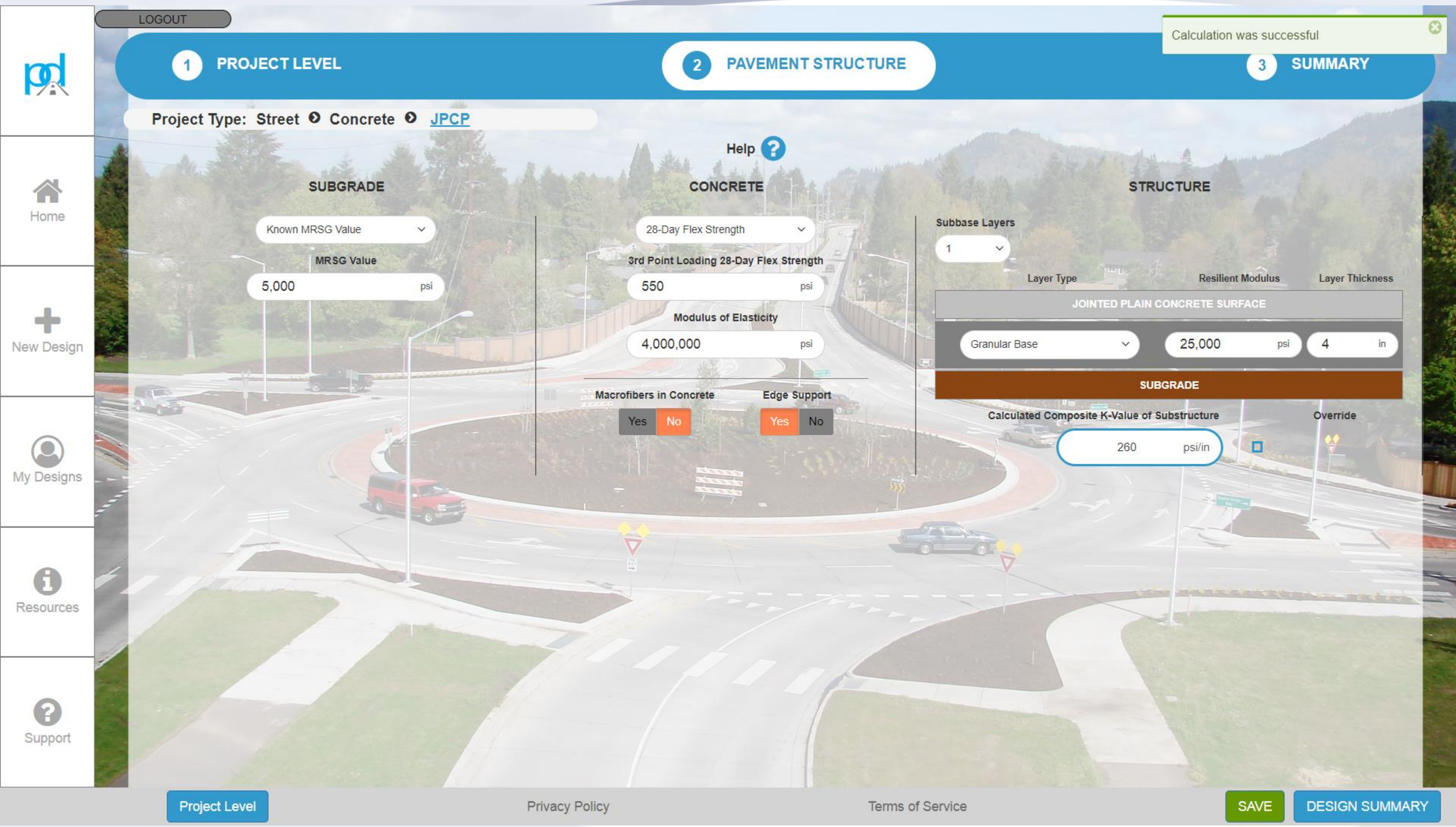
SAVE
DESIGN SUMMARY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Calculation was successful
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Project Type: Street Concrete JPCP
Help
SUBGRADE
Known MRSG Value
MRSG Value
5,000 psi
CONCRETE
28-Day Flex Strength
3rd Point Loading 28-Day Flex Strength
550 psi
Modulus of Elasticity
4,000,000 psi
Macrofibers in Concrete
Yes No
Edge Support
Yes No
STRUCTURE
Subbase Layers
1
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Granular Base
25,000 psi
4 in
SUBGRADE
Calculated Composite K-Value of Substructure
260 psi/in
Override
Project Level
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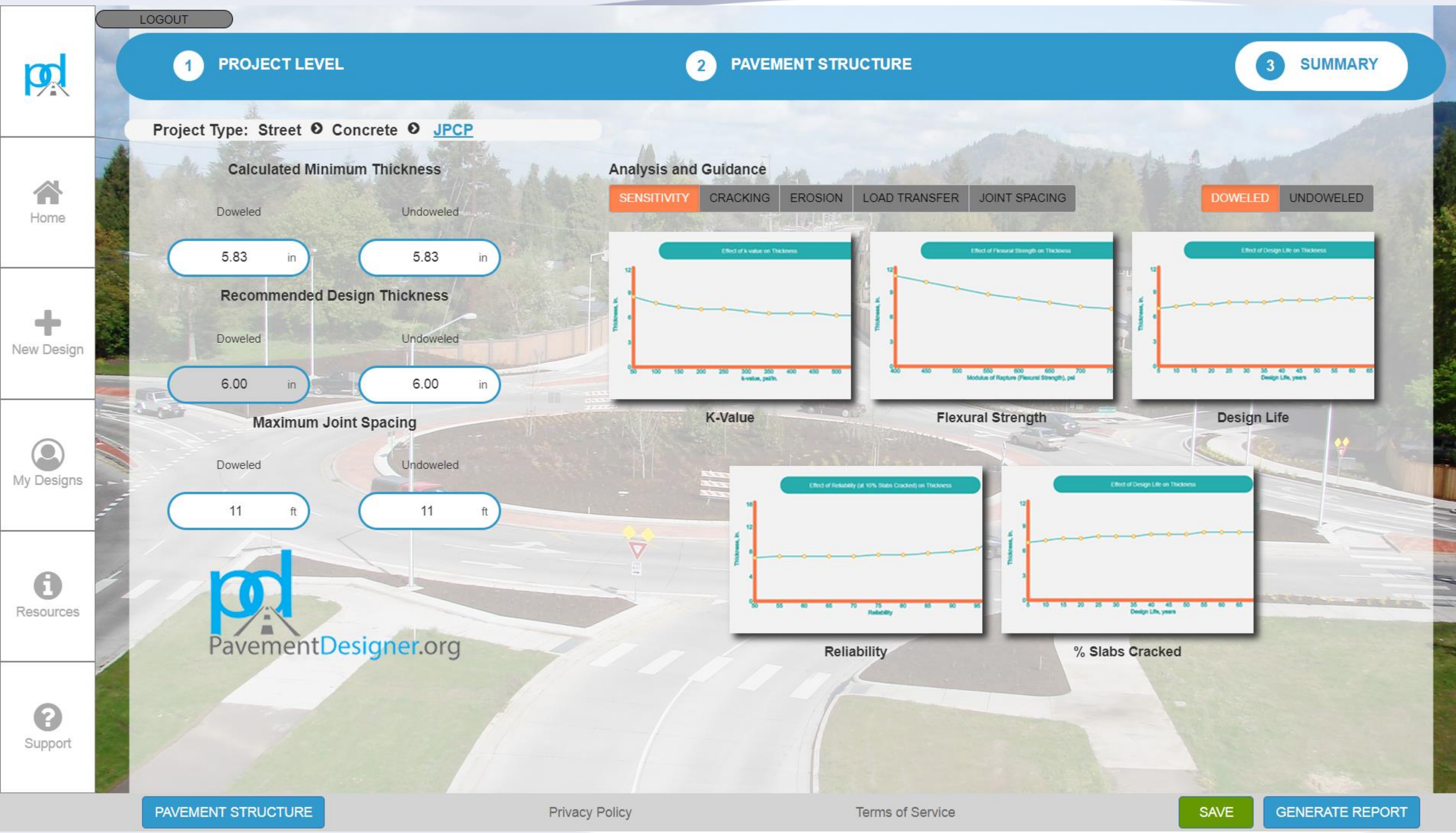
SAVE
DESIGN SUMMARY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Project Type: Street Concrete JPCP
Calculated Minimum Thickness
Doweled
Undoweled
5.83 in
5.83 in
Recommended Design Thickness
Doweled
Undoweled
6.00 in
6.00 in
Maximum Joint Spacing
Doweled
Undoweled
11 ft
11 ft
PavementDesigner.org
Analysis and Guidance
SENSITIVITY
CRACKING
EROSION
LOAD TRANSFER
JOINT SPACING
DOWELED
UNDOWELED
K-Value
Flexural Strength
Design Life
Reliability
% Slabs Cracked
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Project Type: Street ➜ Concrete ➜ JPCP

Calculated Minimum Thickness

Doweled	Undoweled
5.83 in	5.83 in

Recommended Design Thickness

Doweled	Undoweled
6.00 in	6.00 in

Maximum Joint Spacing

Doweled	Undoweled
11 ft	11 ft

PavementDesigner.org

Analysis and Guidance

SENSITIVITY | CRACKING | EROSION | LOAD TRANSFER | JOINT SPACING | DOWELED | UNDOWELED

The key to excellent long-term performance of doweled joints is adequate load transfer over the life of the pavement. Load transfer devices generally are recommended for jointed plain concrete pavements that have an initial design thickness greater than about 8 inches (200 mm) because traffic levels that require such thicknesses for fatigue resistance also are of a level that might result in pumping and faulting of the joints if load transfer devices are not included in the joints. When the initial design thickness is less than 8 inches (200 mm), load transfer devices are recommended only if faulting is the predicted cause of failure.

Although other geometries (e.g., elliptical, plate, square, etc.) and materials (e.g., stainless or microcomposite steel, zinc alloy-sleeved, etc.) can be used to transfer load across transverse joints in jointed plain concrete pavements, round and smooth steel dowel bars are the most commonly used load transfer device. Typical size recommendations for round steel dowel bars placed at 12 in. (300 mm) on-center are:

Recommended Dowel Bar Size

Concrete Design Thickness, in.	Dowel Bar Size, in.
less than 8 in. and cracking is predicated cause of failure	Dowel not recommended
less than 8 in. and faulting is predicted cause of failure	1.00 in.
between 8 in. and 10 in.	1.25 in.
greater than 10 in.	1.50 in.

Required load transfer device size and spacing can, however, vary based on load transfer technology geometry and material (see manufacturer's recommendations), and some non-uniform spacings offer opportunities to optimize/minimize steel content at the joints while causing minimal impacts on pavement responses (see ACPA's DowelCAD 2.0). Other exceptions also exist, like the lack of a need for load transfer devices in bonded concrete overlays on asphalt or composite pavements. The National Concrete Consortium (NCC) also has developed, "Recommendations for Standardized Dowel Load Transfer Systems for Jointed Concrete Pavements," which are available through the National Concrete Pavement Technology (CP Tech) Center

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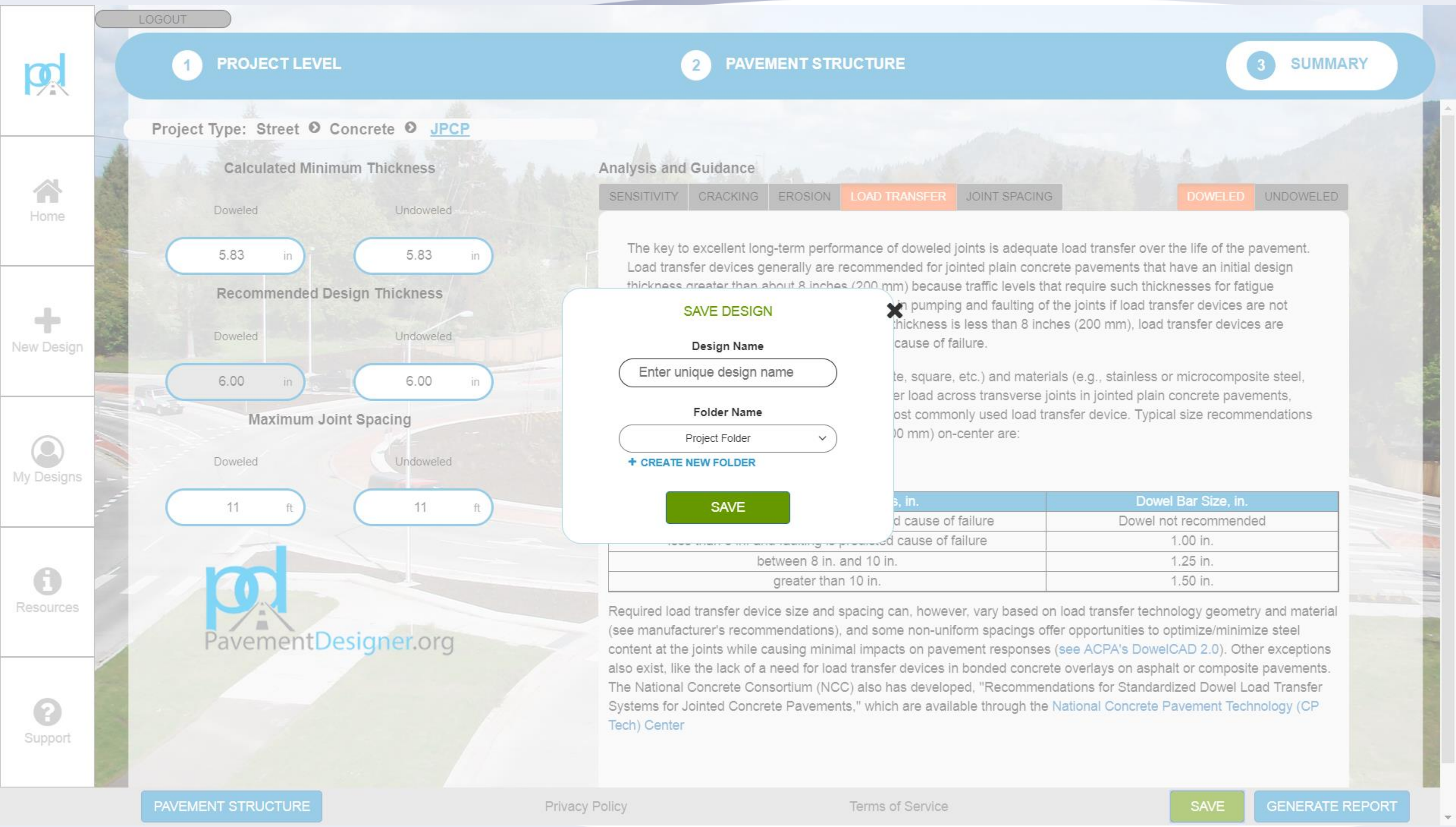
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Project Type: Street Concrete JPCP
Calculated Minimum Thickness
Doweled
Undoweled
5.83 in
5.83 in
Recommended Design Thickness
6.00 in
6.00 in
Maximum Joint Spacing
11 ft
11 ft
PavementDesigner.org
Analysis and Guidance
SENSITIVITY
CRACKING
EROSION
LOAD TRANSFER
JOINT SPACING
DOWELED
UNDOWELED
The key to excellent long-term performance of doweled joints is adequate load transfer over the life of the pavement.
SAVE DESIGN
Design Name
Enter unique design name
Folder Name
Project Folder
+ CREATE NEW FOLDER
SAVE
Dowel Bar Size, in.
Dowel not recommended
1.00 in.
between 8 in. and 10 in.
1.25 in.
greater than 10 in.
1.50 in.
Required load transfer device size and spacing can, however, vary based on load transfer technology geometry and material (see manufacturer's recommendations), and some non-uniform spacings offer opportunities to optimize/minimize steel content at the joints while causing minimal impacts on pavement responses (see ACPA's DowelCAD 2.0). Other exceptions also exist, like the lack of a need for load transfer devices in bonded concrete overlays on asphalt or composite pavements. The National Concrete Consortium (NCC) also has developed, "Recommendations for Standardized Dowel Load Transfer Systems for Jointed Concrete Pavements," which are available through the National Concrete Pavement Technology (CP Tech) Center
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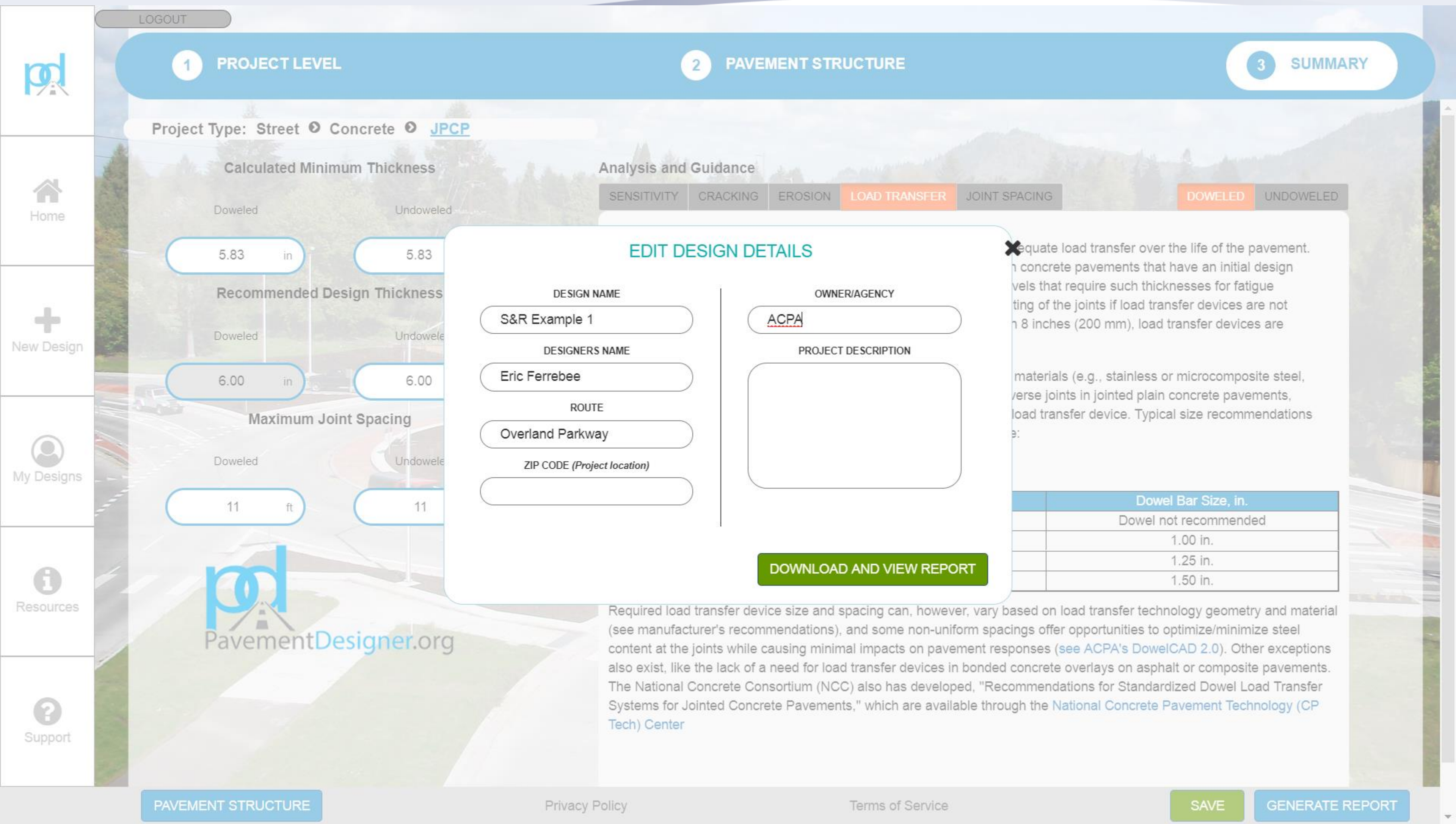
LOGOUT
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Support
Project Type: Street Concrete JPCP
Calculated Minimum Thickness
Doweled
Undoweled
5.83 in
5.83
Recommended Design Thickness
Doweled
6.00 in
6.00
Maximum Joint Spacing
Doweled
11 ft
11
PavementDesigner.org
Analysis and Guidance
SENSITIVITY
CRACKING
EROSION
LOAD TRANSFER
JOINT SPACING
DOWELED
UNDOWELED
EDIT DESIGN DETAILS
DESIGN NAME
S&R Example 1
DESIGNERS NAME
Eric Ferrebee
ROUTE
Overland Parkway
ZIP CODE (Project location)
OWNER/AGENCY
ACPA
PROJECT DESCRIPTION
DOWNLOAD AND VIEW REPORT
Dowel Bar Size, in.
Dowel not recommended
1.00 in.
1.25 in.
1.50 in.
Required load transfer device size and spacing can, however, vary based on load transfer technology geometry and material (see manufacturer's recommendations), and some non-uniform spacings offer opportunities to optimize/minimize steel content at the joints while causing minimal impacts on pavement responses (see ACPA's DowelCAD 2.0). Other exceptions also exist, like the lack of a need for load transfer devices in bonded concrete overlays on asphalt or composite pavements. The National Concrete Consortium (NCC) also has developed, "Recommendations for Standardized Dowel Load Transfer Systems for Jointed Concrete Pavements," which are available through the National Concrete Pavement Technology (CP Tech) Center
PAVEMENT STRUCTURE
Privacy Policy
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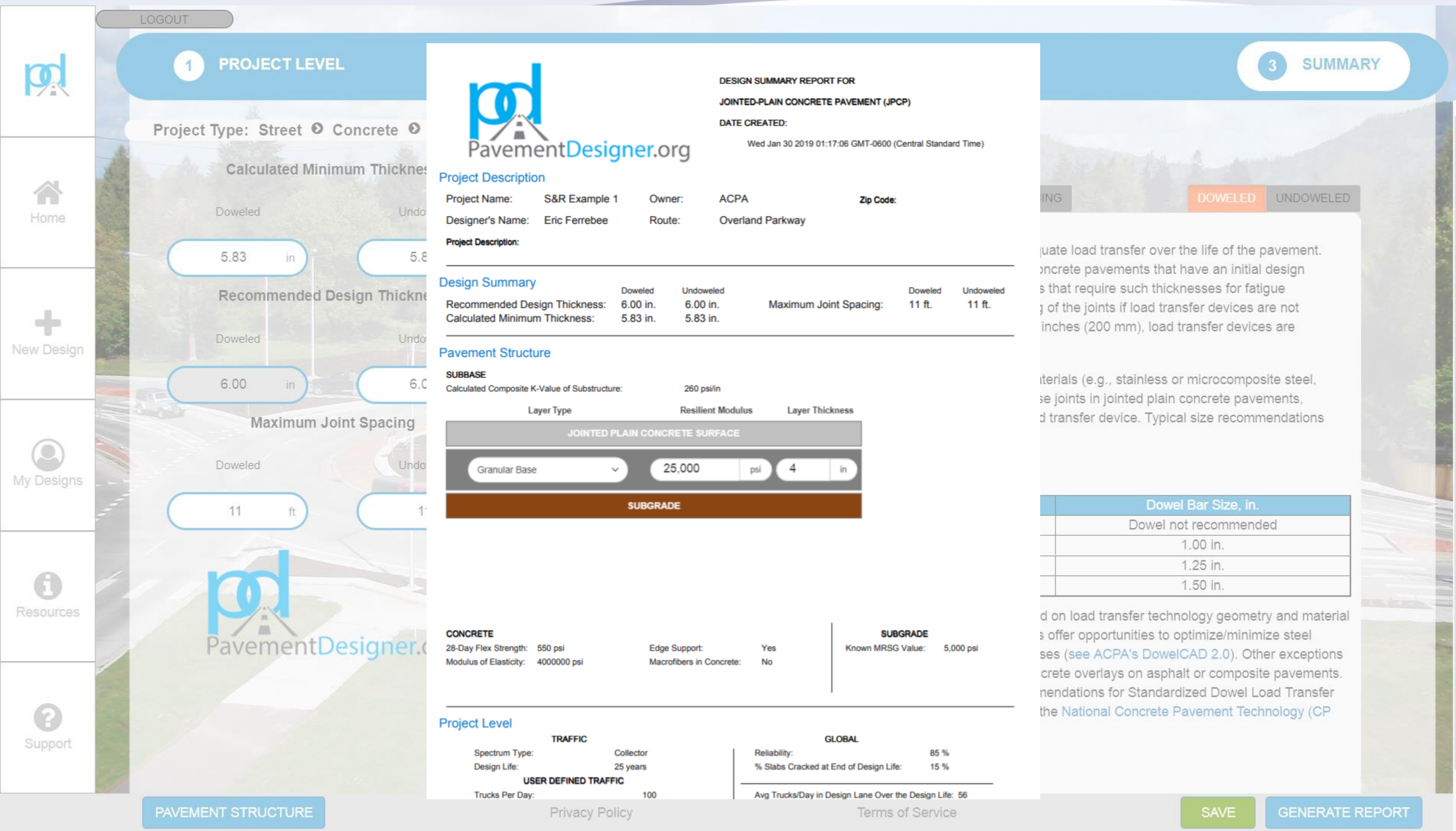
SAVE
GENERATE REPORT


LOGOUT
1 PROJECT LEVEL
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Home
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My Designs
Resources
Support
Project Type: Street Concrete
Calculated Minimum Thickne
Doweled
5.83 in
Recommended Design Thickne
6.00 in
Maximum Joint Spacing
11 ft
PavementDesigner.org
DESIGN SUMMARY REPORT FOR
JOINTED-PLAIN CONCRETE PAVEMENT (JPCP)
DATE CREATED:
Wed Jan 30 2019 01:17:06 GMT-0600 (Central Standard Time)
Project Description
Project Name: S&R Example 1
Owner: ACPA
Zip Code:
Designer's Name: Eric Ferrebee
Route: Overland Parkway
Project Description:
Design Summary
Doweled Undoweled
Recommended Design Thickness: 6.00 in. 6.00 in.
Calculated Minimum Thickness: 5.83 in. 5.83 in.
Maximum Joint Spacing: 11 ft. 11 ft.
Pavement Structure
SUBBASE
Calculated Composite K-Value of Substructure: 260 psi/in
Layer Type
Resilient Modulus
Layer Thickness
JOINTED PLAIN CONCRETE SURFACE
Granular Base
25,000 psi
4 in
SUBGRADE
CONCRETE
28-Day Flex Strength: 550 psi
Modulus of Elasticity: 4000000 psi
Edge Support: Yes
Macrofibers in Concrete: No
SUBGRADE
Known MRSG Value: 5,000 psi
Project Level
TRAFFIC
Spectrum Type: Collector
Design Life: 25 years
USER DEFINED TRAFFIC
Trucks Per Day: 100
GLOBAL
Reliability: 85 %
% Slabs Cracked at End of Design Life: 15 %
Avg Trucks/Day in Design Lane Over the Design Life: 56
DOWELED
UNDOWELED
Dowel Bar Size, in.
Dowel not recommended
1.00 in.
1.25 in.
1.50 in.
PAVEMENT STRUCTURE
Privacy Policy
Terms of Service
SAVE
GENERATE REPORT

THANK YOU!
Questions?

Main Website | **acpa.org**
Free Apps | **apps**.acpa.org
Resources | **resources**.acpa.org
Your Local Contact | **local**.acpa.org
Pavement Design | **PavementDesigner**.org

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