PAVEMENT DESIGN - 101

Why it is Necessary & Factors that Impact Design

Presented by Andrew LaCroix, PhD, PE

CROSSROAD
PAVEMENT CONSULTING

OUTLINE

- Purpose of Pavement Design
- Factors of Pavement Design
- Example of a Pavement Design

WHY DESIGN PAVEMENTS?

- Traffic
- Subgrade
- Available Materials

TRAFFIC

- Vehicles
  - Trucks
  - Busses
  - Cars
- Speed
  - Fast - highway
  - Slow - local
  - Standing - Intersections

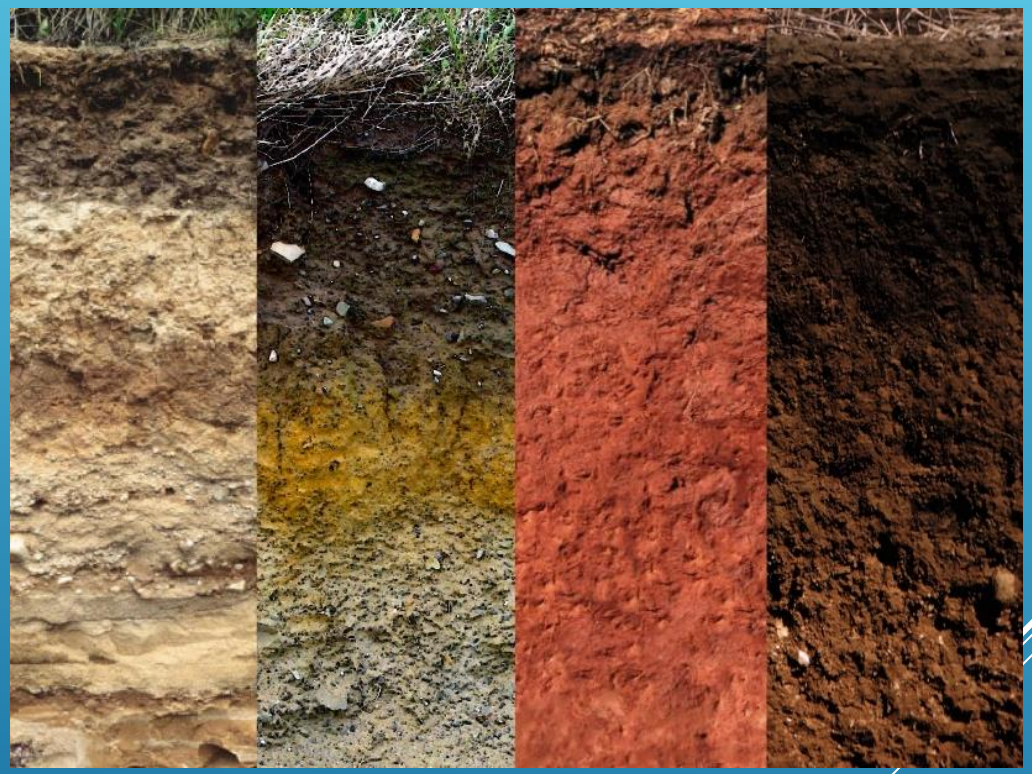
PAVEMENT CLASSIFICATIONS

- Roadways
  - Interstates
  - Arterial – multilane, limited access
  - Collectors – connect local and arterial roads
  - Local – access homes/businesses
- Parking Lots

SUBGRADE (SOILS)

- Load Bearing Capacity
- Volume Change

- Remediation
  - Stabilization
  - Remove and Replace
  - Drainage



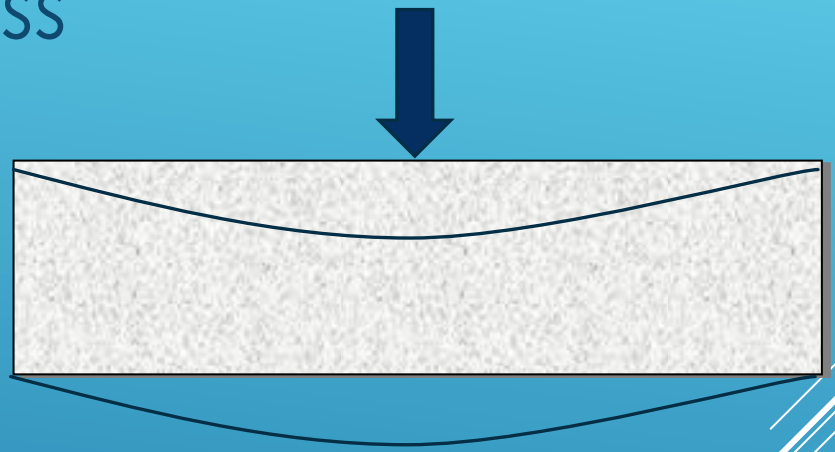
Source: petersoncompanies.net

- Pavement Design

  - determining pavement thickness

Base on:

- Traffic / Loading
- Subgrade (soils present)
- Pavement materials available
- Desired life of pavement



LIFE CYCLE COST ANALYSIS

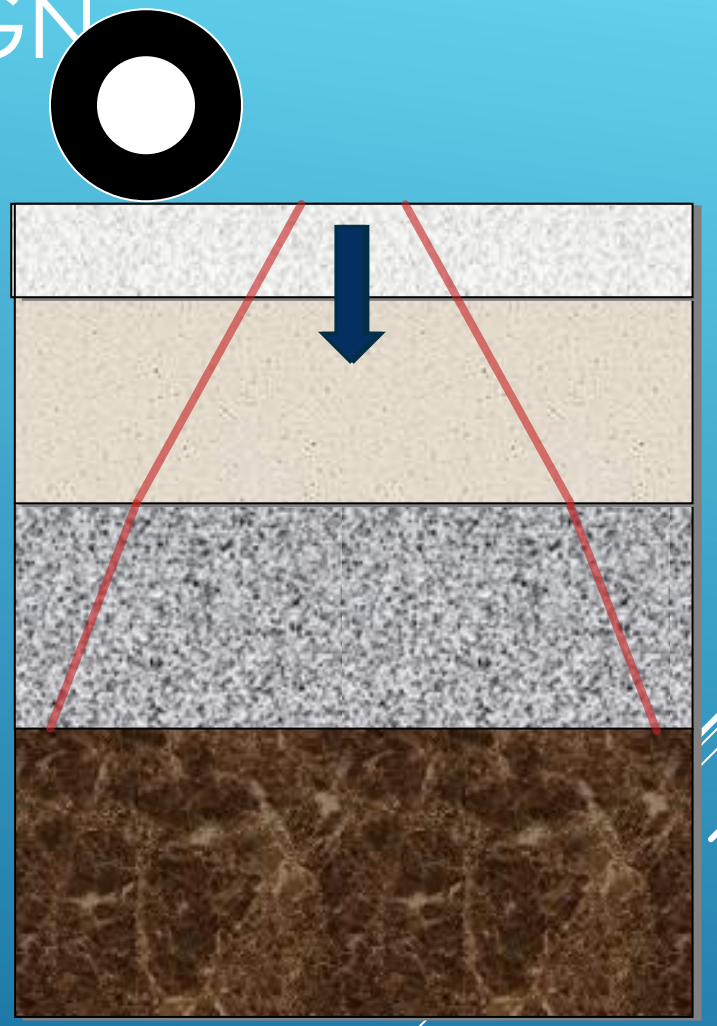
- Stages
  - Initial Construction
  - Expected Life of Pavement
  - Maintenance
  - Residual Value
- Perpetual Pavement

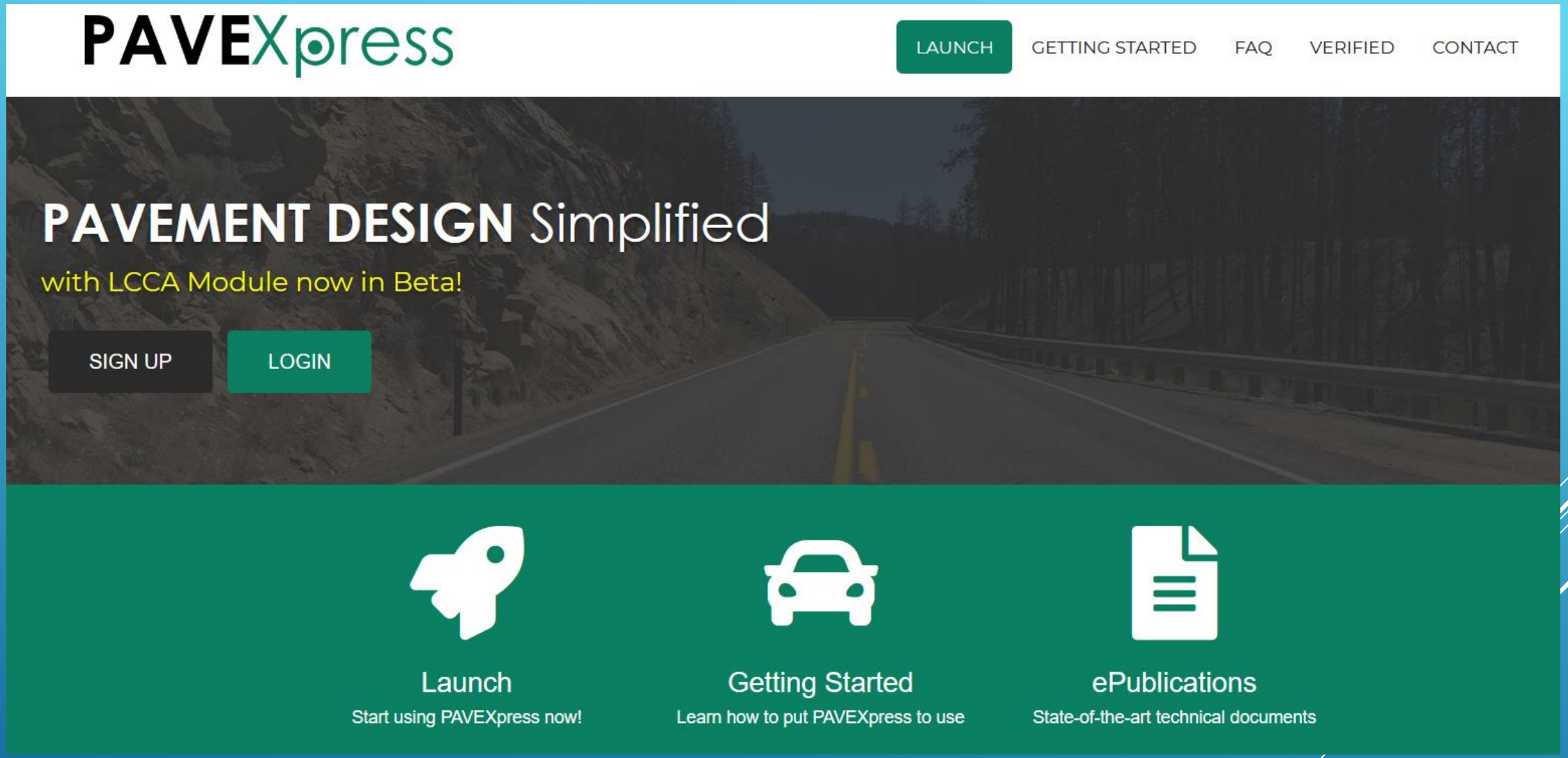
PREPARING FOR PAVEMENT DESIGN

- Intended Use
- Traffic
- Subgrade
- Target Lifespan

PERFORMING PAVEMENT DESIGN

- Determine Thickness of Layers of Pavement
  - Layered Elastic Calculations
    - Layer Structural Coefficients
  - Load Appropriate for Subgrade

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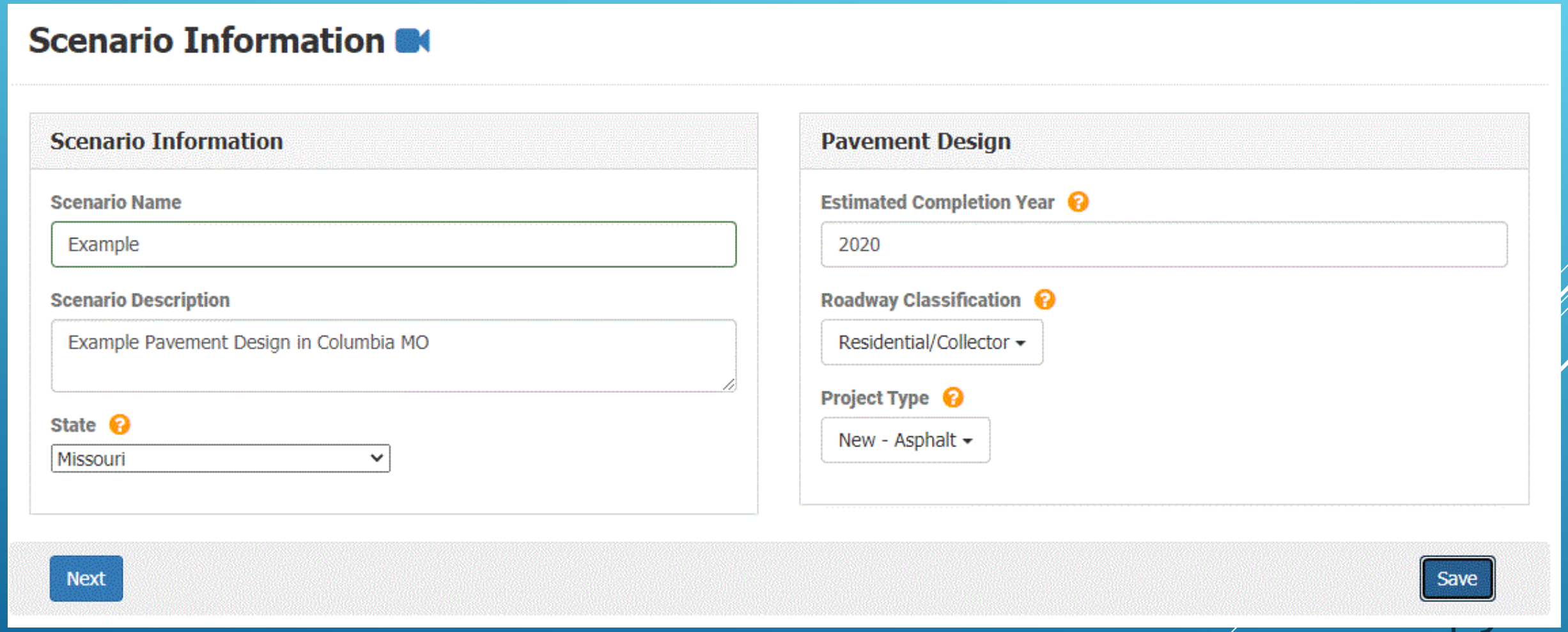
PAVEMENT DESIGN – CASE STUDY

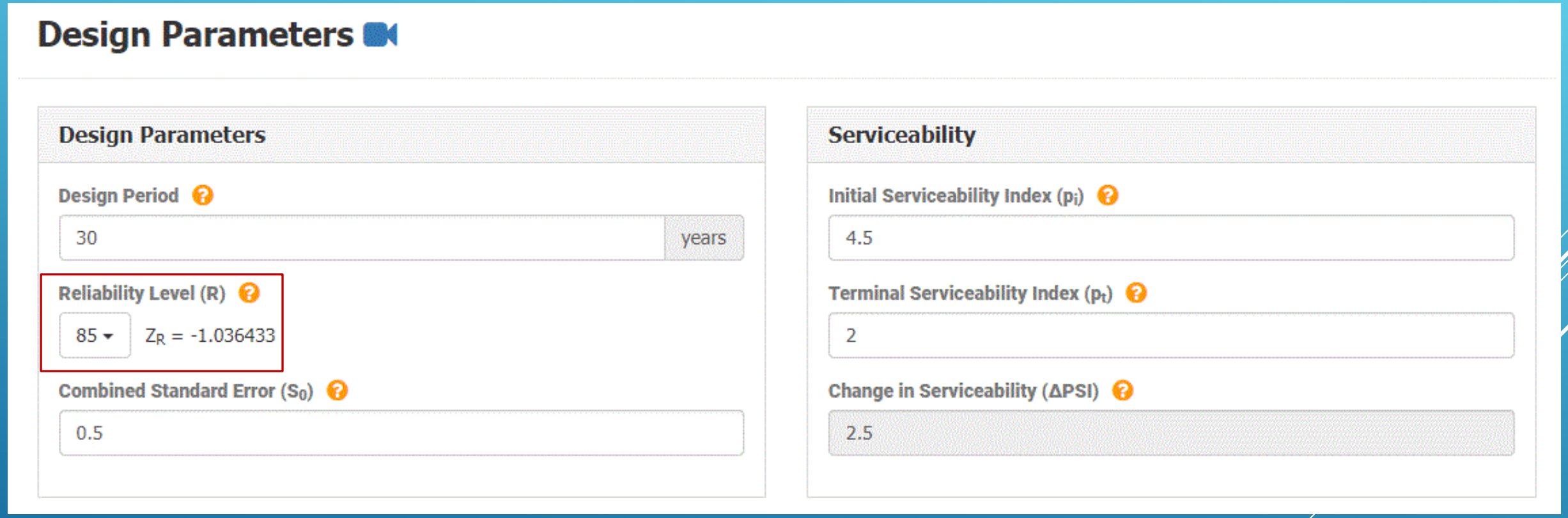
- Project
  - Collector Road in Columbia, MO near new school
  - Traffic – 1000 AADT (LEF – 97-2-1)

    = 265,000 ESAL
  - Subgrade – Silty Loam (CBR – 6)
  - Drainage - Poor

Background Information



Design Parameters



Traffic

Traffic & Loading

Traffic Data

Method of Determining ESALs

Using AADT | Annual ESALs | Design ESALs

Completion Year Traffic (vehicles)

365000 — Calculate from AADT

Load Equivalency Factor

0.0181 — Calculate LEF

Completion Year ESALs

7,000

Traffic Growth

Design Period

30 Years

Future Traffic Growth Rate

1 %

ESAL Growth Rate

0.5 %

Total Design ESALs (W_{18})

263,000

Calculate Traffic from AADT

Use this page to calculate the completion year traffic level u
value. The Directional and Lane adjustment factors come fr
More

Average Annual Daily Traffic (AADT)

1000

Lanes Measured (AADT ✖ 1)

One-Way | 1

Directional Lanes (AADT ✖ 1)

1 | 1

Year of Traffic Count

2020

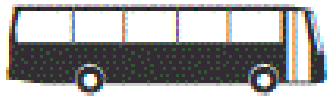
Historical Traffic Growth Rate

1 %

Completion Year Traffic

365000

Cancel | Set Completion Year Traffic

	% of Traffic	Weighted Load Equivalency Factor (LEF)
	97 %	✖ 0.0001
	2 %	✖ 0.4
	1 %	✖ 1

SUBGRADE (SOILS)

Material	Unified Soil Classification	CBR (%)	Resilient Modulus (ksi)
Crushed Stone	GW, GP, GM	20 - 100	20 - 40
Sandy Soil	SW, SP, SM, SC	5 - 40	7 - 30
Silty Soils	ML, MH	3 - 15	5 - 20
Clay Soils	CL, CH	3 - 10	5 - 15
Organic Soils	OH, OL, PT	1 - 5	< 5

Source: pavementinteractive.org

SUBGRADE

Relative Strength	CBR (%)
Weak	3 - 6
Moderate	6 - 9
Good	> 9

Layer Parameters

Pavement Structure (Flexible) (Asphalt)

Use Multiple Lifts

No

Layer Coefficient (a)

0.44

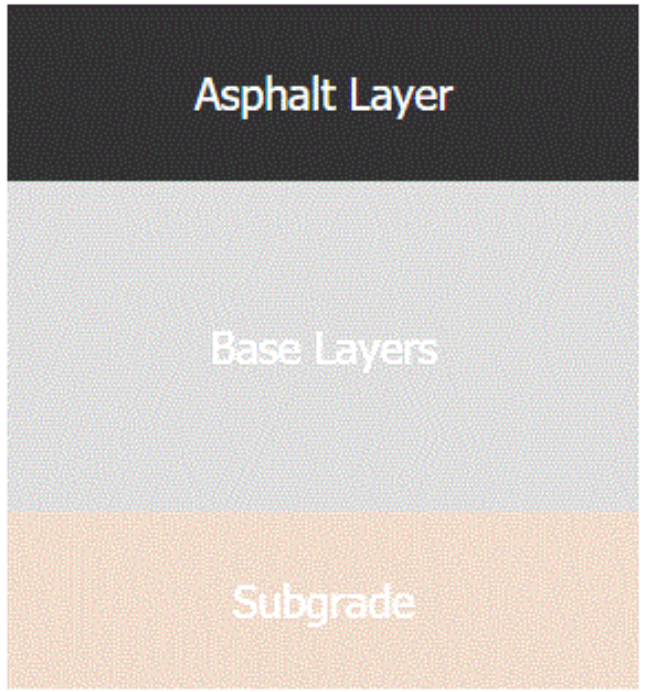
Drainage Coefficient (m)

1.0

Minimum Thickness

3 in

Pavement Diagram



Layer Parameters

Base Layers

Layer Type	Layer Coef.	Drainage Coef.	Thickness	Resilient Mod	Action?
Aggregate Base	0.14	1.0	6 in.	30000	

Add Layer

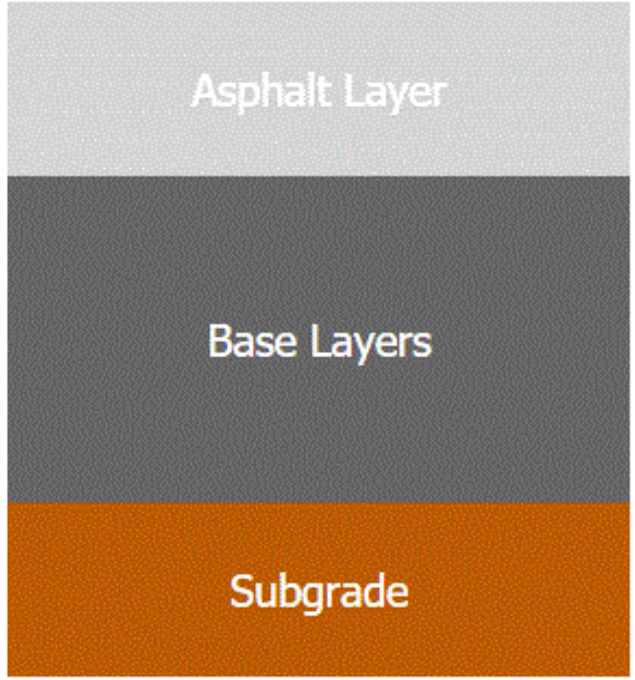
Subgrade

Resilient Modulus (M_R)

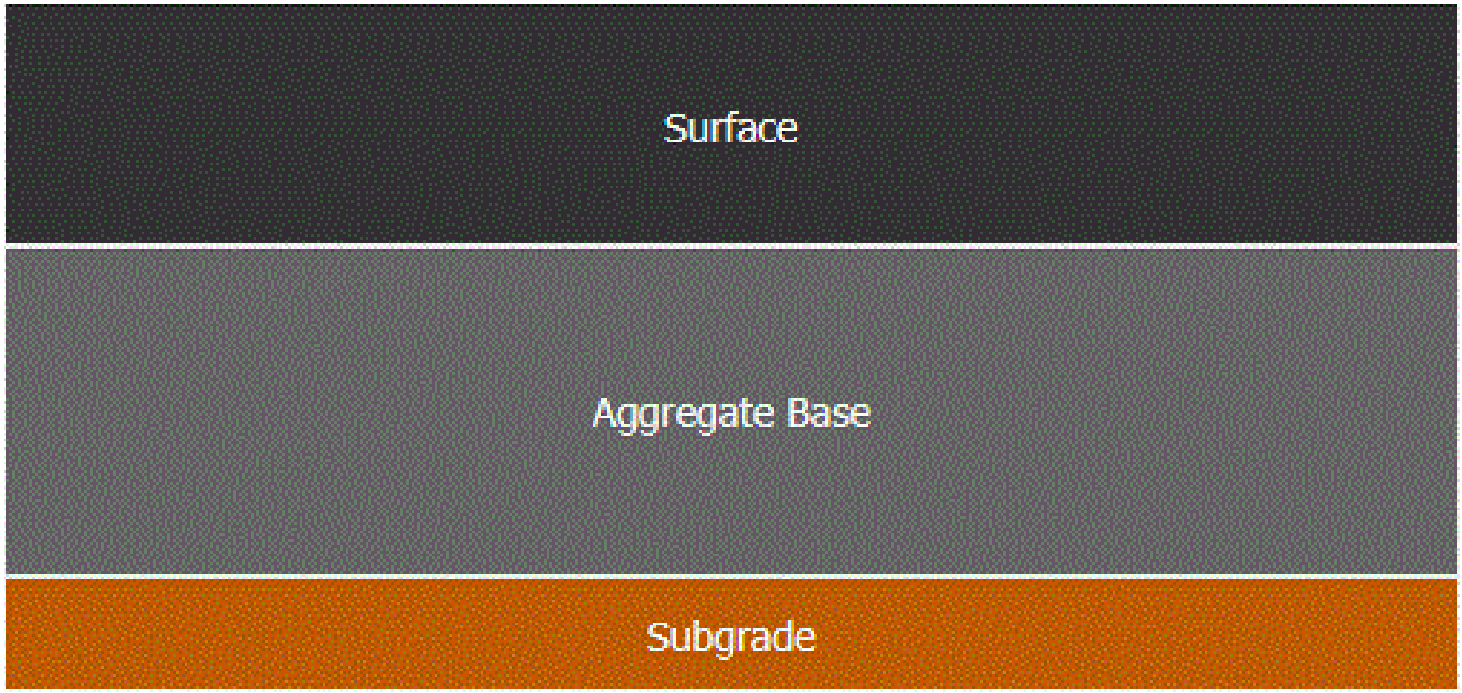
8000 psi

Calculate MR

Pavement Diagram



Result



Required minimum design SN: 2.65

Layer Thicknesses (in)

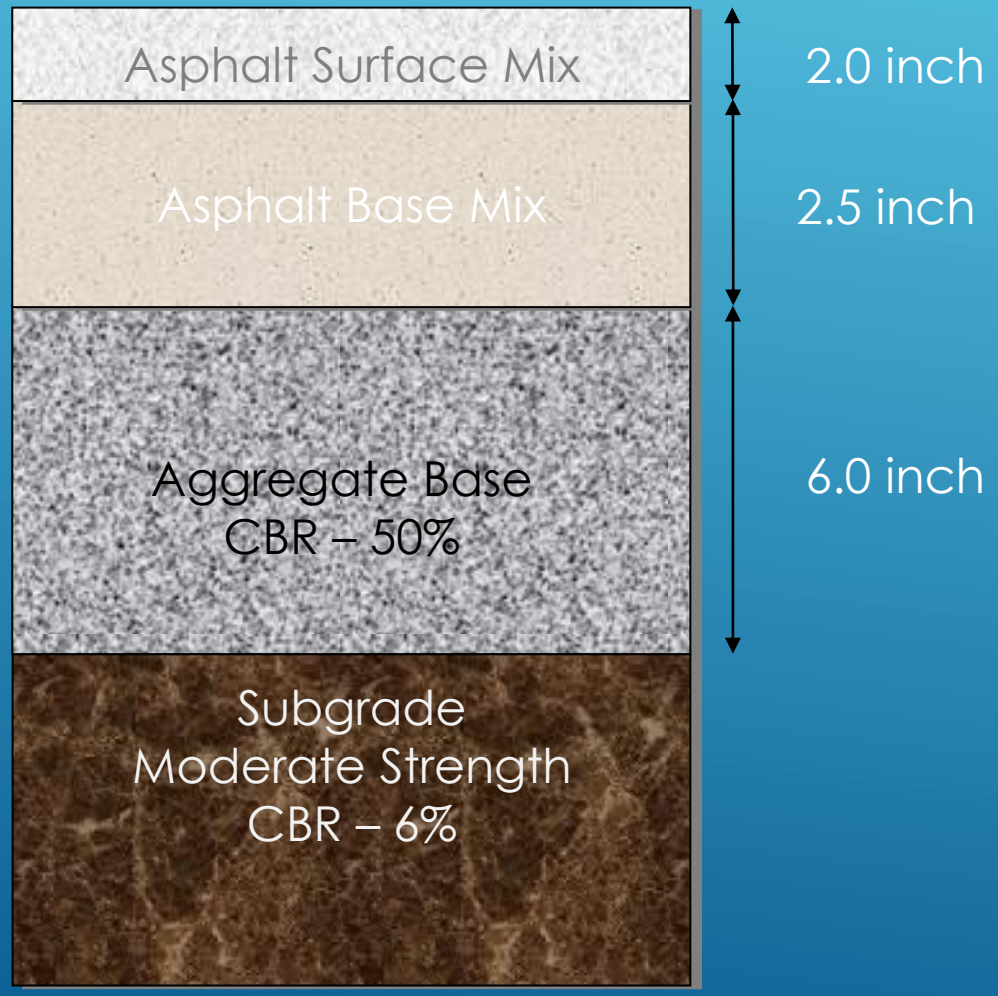
Surface: 4.50

Aggregate Base: 6.00

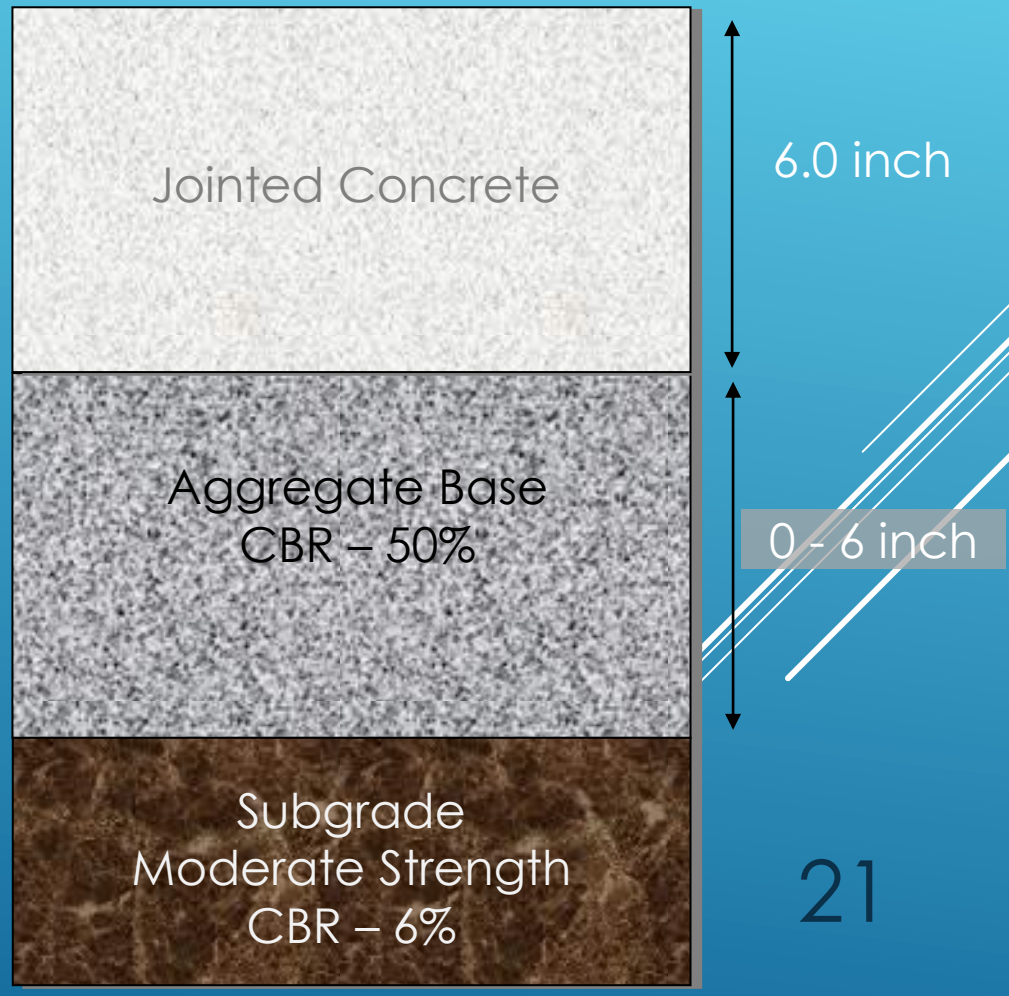
Total SN: 2.82

PAVEMENT DESIGN RESULTS

Flexible Pavement Design



Rigid Pavement Design



OTHER FACTORS IN PAVEMENT DESIGN

- Construction
  - Base Thickness
  - Asphalt Layer Thickness
  - Tack Coat
- Environment
  - Temperature
  - Moisture
- Technology Considerations
  - Recycled pavement materials (RAP, concrete)
  - Porous Pavements
  - Interlayers

PAVEMENT DESIGN CHECKLIST

- Project Specific Data
  - Location
  - Facility Type
  - Traffic
  - Subgrade
- Layers
  - Thickness
  - Materials w/ assumed strengths
  - Drainage
- Target Pavement Life

RESOURCES

- PAVExpress.com
- Missouri Asphalt Paving Association (MAPA)

  moasphalt.org
- Local Pavement Contractor

QUESTIONS?

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