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August 12, 2019

Garrett Fountain, P.E. G.E.
West Area Engineer
Tensar Corporation
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San Diego, CA 92131
Cell: 858-287-3068
GFountain@tensarcorp.com

Re: In Situ Performance Verification of Geogrid-Stabilized Aggregate Base Layer and Control Test Sections Using Automated Plate Load Testing
I-5, North County Coastal, Encinitas, CA

Dear Garrett,

At the request of Tensar Corporation personnel, Ingios Geotechnics, Inc. conducted Automated Plate Load Tests (APLTs) on four test sections on Interstate Highway 5 (I-5) near Encinitas, CA. Testing was performed August 1, 2019. In situ testing included cyclic APLTs on the aggregate base course (ABC) layer to determine composite, base layer, and subgrade layer resilient modulus (M_r) values. Dynamic cone penetrometer tests were performed to determine penetration resistance profile with depth at each APLT location. The location and pavement foundation cross-section details of the four test sections are as follows:

- Section 1 located south of Sta. 2214+70. The section is comprised of nominal 0.35 ft thick TX5 geogrid-stabilized ABC over subgrade.
- Section 2 located between Sta. 2214+70 and Sta. 2216+20. The section is comprised of nominal 0.70 ft thick ABC over subgrade (control).
- Section 3 located between Sta. 2217+70 and Sta. 2219+20. The section is comprised of nominal 0.85 ft thick TX5 geogrid-stabilized ABC over subgrade.
- Section 4 located north of Sta. 2219+20. The section is comprised of nominal 2.25 ft thick ABC over subgrade (control).

The TX5 geogrid was a multi-axial geogrid with hexagonal structure and triangular apertures. The ABC layer material is CalTrans Class 6 aggregate base course material with recycled aggregate.

Five cyclic APLTs were conducted in each of sections with six different applied cyclic stresses for each test. Deflection basin measurements were obtained at three positions extending away from the plate (2r, 3r, and 4r).

Results from cyclic APLTs conducted at six different stress levels were used to determine the in situ "universal" model (AASHTO 2015), the k_1*, k_2*, and k_3* model parameters for the composite ($M_{r\text{-}comp}$) and stabilized aggregate base ($M_{r\text{-}Base}$) and subgrade layers ($M_{r\text{-}Subgrade}$). Summaries of each individual test result are attached. Results from extended cyclic APLTs were used to determine power model parameters and predict number of cycles to achieve a near-linear elastic condition.

The layered analysis performed in determining $M_{r\text{-}Base}$ and $M_{r\text{-}Sugrade}$ was based on Odemark's method of equivalent thickness and Boussinesq's elastic solution for linear-elastic materials. The applied cyclic stresses at the subgrade/base layer interface were calculated using the KENLAYER elastic layer analysis program. Layered analysis was not performed for test results obtained from section 4 (control) because of the thickness of the top layer (2.25 ft) is greater than the estimated measurement influence depth (1.5 to 2 x's plate diameter) of the 12 in. diameter loading plate. Therefore, $M_{r\text{-}comp}$ equals $M_{r\text{-}Base}$ for the section 4 test points.

The following assumptions were made in calculating the M_r values:

1. Shape factor, f = 8/3 for a rigid plate on granular material.
2. Poisson's ratio, v = 0.40 for aggregate base material and 0.40 for subgrade material.
3. Plate bending correction, $F_{Bending}$ = 1 (No correction). The 12 in. diameter plate used in this study is 1 in. thick and has a 6 in. diameter steel loading pedestal centered on the plate.
4. Future saturation correction, $F_{Saturation}$ = 1 (No correction). Laboratory testing is needed to determine this correction factor, else field saturation is required in situ.

The results presented herein represent a selected number of measurements per sample group that was requested by Tensar. Statistical determination of the minimum number of measurements requires knowledge of the coefficient of variation within a sample group and the difference between mean values of the selected sample groups. Determination of statistical input parameters needed for calculating statistical sample sizes was beyond the scope of this study. As a result, these test results are applicable to the specific testing point locations.

We appreciate the opportunity to provide Automated Plate Load Testing on your project. If you have any questions, please do not hesitate to contact us.

Sincerely,

Pavana Vennapusa, Ph.D., P.E.
Registered in AZ, IA, NM, NV, TX
Lead Engineer

David White, Ph.D., P.E.
Registered in CO, IA, KY, MN, TN
President and Chief Engineer

Attachments:

Aerial Image with In Situ Test Locations and Pictures
Composite Resilient Modulus Test Results
Layered Resilient Modulus Test Results
DCP Test Results

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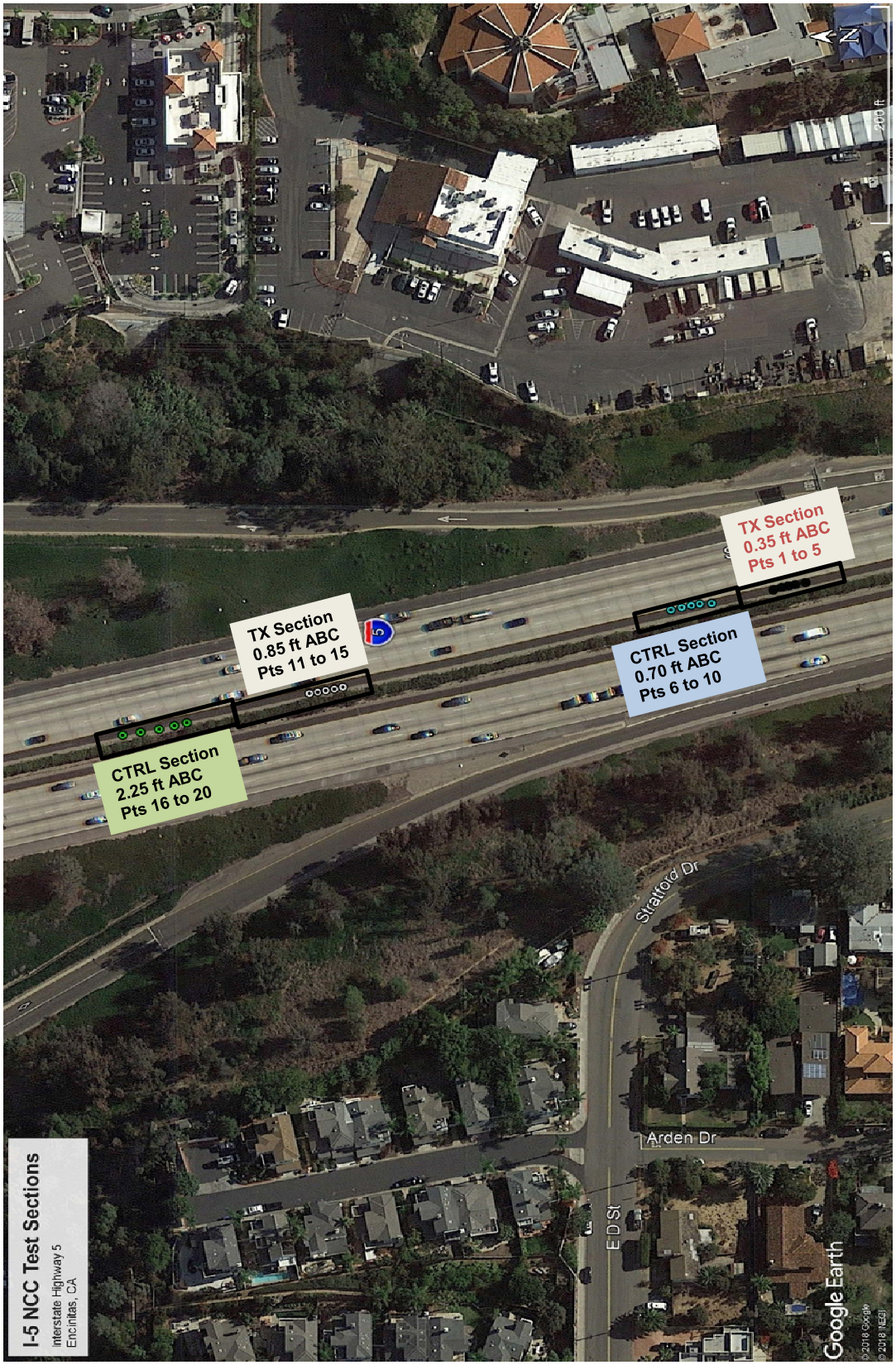
Project Location and Test Locations



Test Locations

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Site Conditions and Pictures

TX5 Geogrid at the base/subgrade interace
0.35 ft ABC - TX5 section

Pictures

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Site Conditions and Pictures

ABC surace
0.85 ft ABC - TX5 section

Test point locations on
ABC surace
0.85 ft ABC - TX5 section

TX5 Geogrid at
the base/subgrade
interace
0.85 ft ABC - TX5 section

Pictures

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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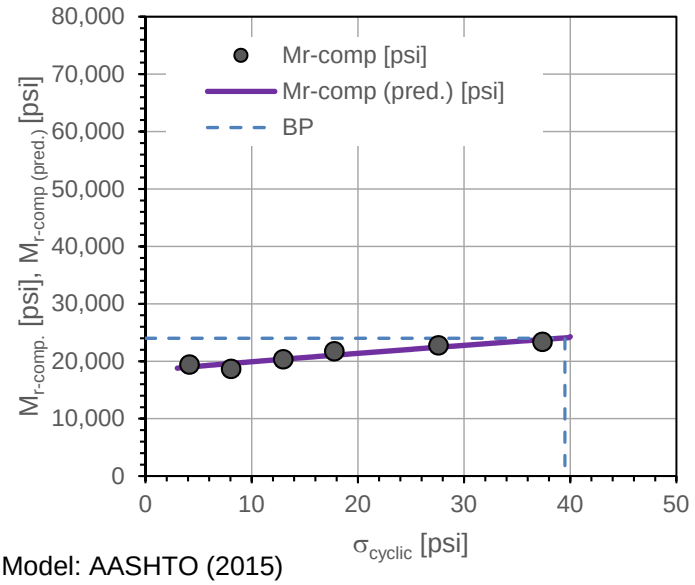
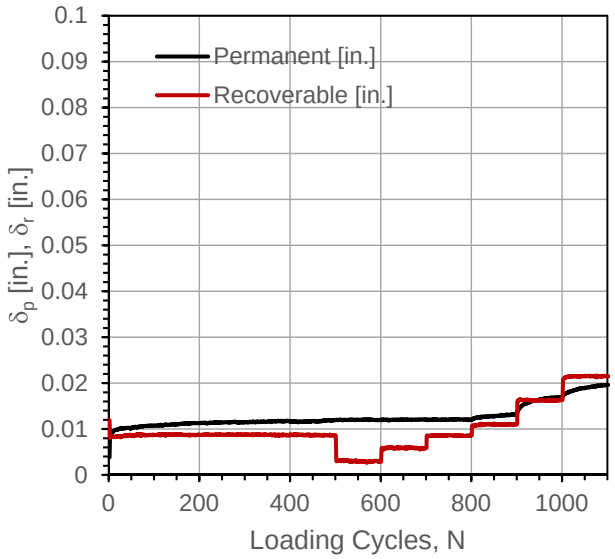
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	5:36:15 AM	Test ID	**I5_NCC_TX5_pt1**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.045910	Longitude,W:	117.286450	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface. Measured base layer thickness = 4 in.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.98	---	---	0.0119	---	0.067	---
1	100	4.14	19,427	18,993	0.0120	0.0001	0.043	Y
2	100	8.07	18,660	19,618	0.0121	0.0002	0.078	Y
3	100	12.98	20,345	20,355	0.0120	0.0001	0.070	Y
4	100	17.79	21,725	21,054	0.0131	0.0012	0.403	Y
5	100	27.60	22,757	22,441	0.0169	0.0050	0.423	Y
6	100	37.38	23,374	23,784	0.0196	0.0077	0.521	Y





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,254.9	5.39E-07
k^*_2	0.005	9.49E-01
k^*_3	0.727	3.03E-01
Adj. R^2	0.871	
Std. Error [psi]	647	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	24,002
$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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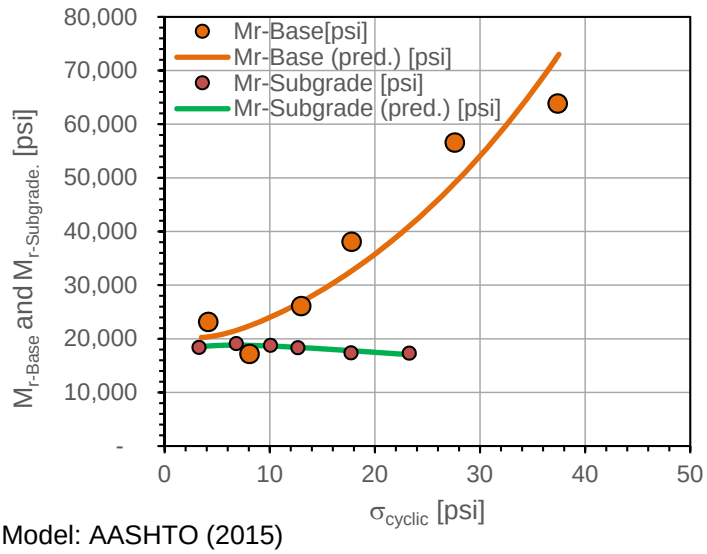
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	5:36:15 AM	Test ID	**I5_NCC_TX5_pt1**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.045910	Longitude, W:	117.286450	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface. Measured base layer thickness = 4 in.				

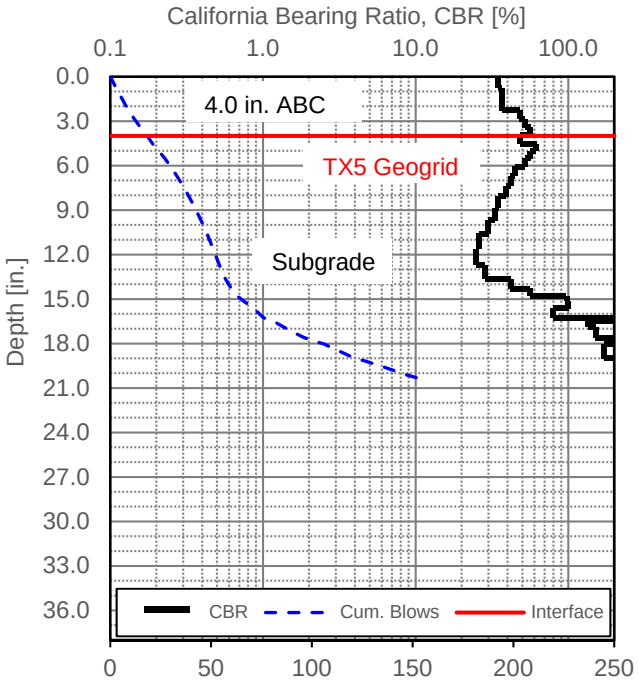
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.98	---	---	---	---	---	---
1	100	4.14	23,124	20,346	3.28	18,361	18,487	1.26
2	100	8.07	17,171	22,415	6.83	19,091	18,807	0.90
3	100	12.98	26,081	26,859	10.09	18,745	18,645	1.39
4	100	17.79	38,076	32,643	12.69	18,300	18,395	2.08
5	100	27.60	56,563	49,005	17.73	17,364	17,780	3.26
6	100	37.38	63,846	72,676	23.29	17,302	17,038	3.69

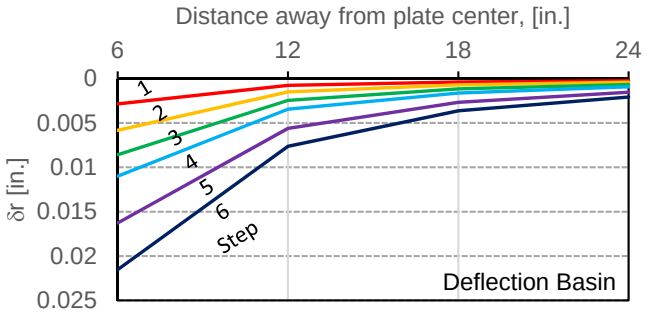


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	986.9	1.14E-04
$k^*_{2\ (Base)}$	-0.201	6.91E-01
$k^*_{3\ (Base)}$	5.859	1.81E-01
Adj. R^2	0.877	
Std. Error [psi]	7075	
$k^*_{1\ (Subgrade)}$	1431.4	5.56E-07
$k^*_{2\ (Subgrade)}$	0.105	1.38E-01
$k^*_{3\ (Subgrade)}$	-1.127	6.36E-02
Adj. R^2	0.830	
Std. Error [psi]	274	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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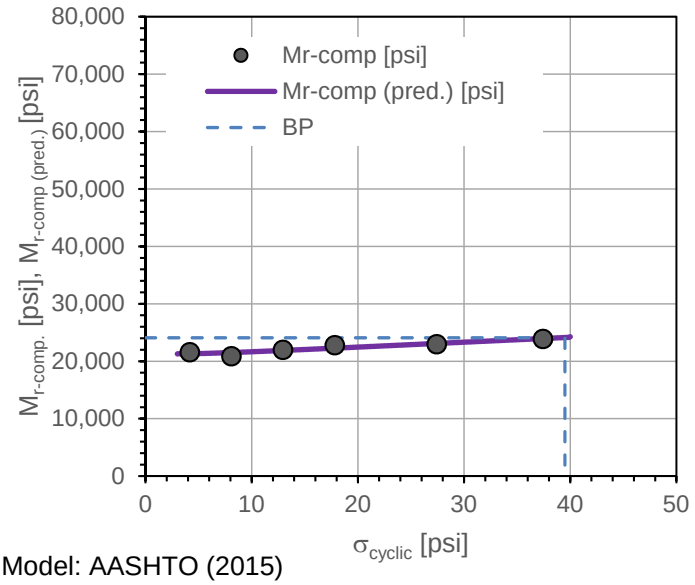
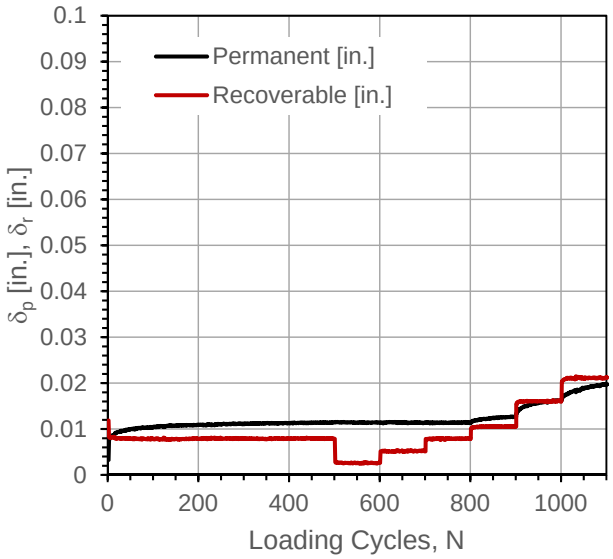
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	6:09:29 AM	Test ID	**I5_NCC_TX5_pt2**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.045921	Longitude,W:	117.286450	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface. Measured base layer thickness = 4.2 in.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.95	---	---	0.0114	---	0.078	---
1	100	4.18	21,572	21,307	0.0114	0.0000	-0.119	Y
2	100	8.10	20,866	21,518	0.0114	0.0000	-0.006	Y
3	100	12.95	21,992	21,881	0.0113	-0.0001	0.036	Y
4	100	17.83	22,788	22,282	0.0127	0.0013	0.441	Y
5	100	27.43	22,955	23,101	0.0163	0.0049	0.417	Y
6	100	37.43	23,889	23,955	0.0197	0.0083	0.517	Y





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,407.6	1.16E-07
k^*_2	-0.016	7.65E-01
k^*_3	0.520	2.44E-01
Adj. R^2	0.832	
Std. Error [psi]	416	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		24,089
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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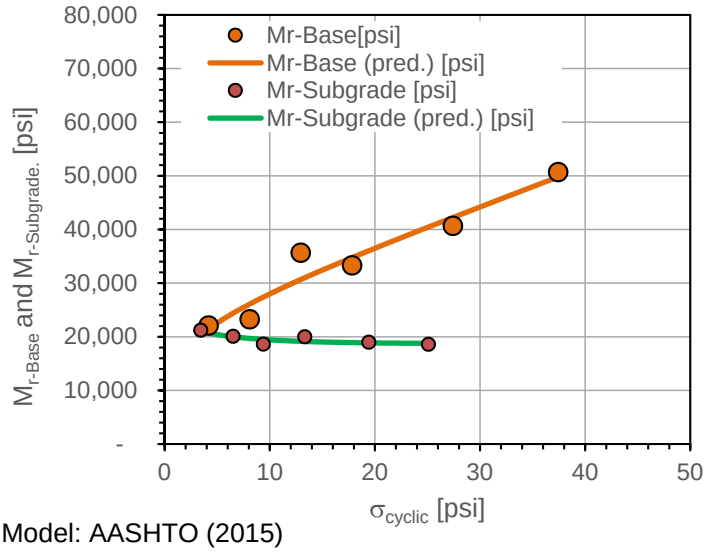
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	6:09:29 AM	Test ID	**I5_NCC_TX5_pt2**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.045921	Longitude, W:	117.286450	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface. Measured base layer thickness = 4.2 in.				

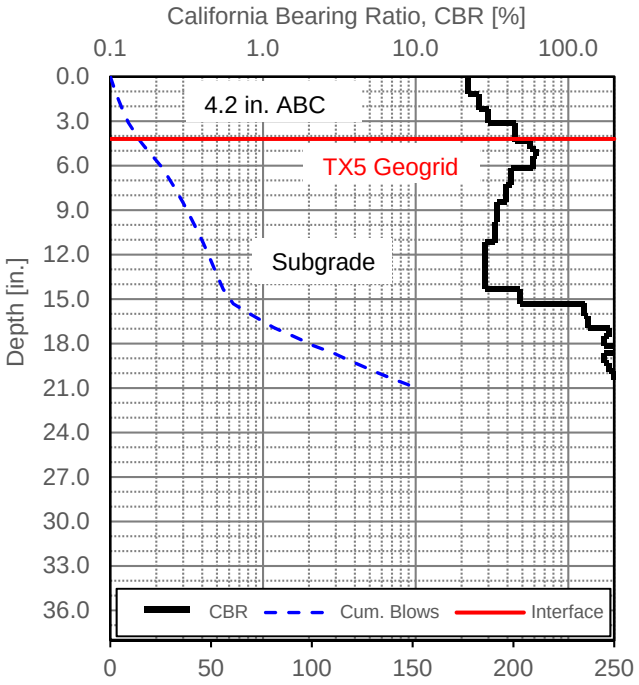
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.95	---	---	---	---	---	---
1	100	4.18	22,095	21,489	3.44	21,185	21,050	1.04
2	100	8.10	23,255	26,112	6.52	20,063	19,995	1.16
3	100	12.95	35,658	30,669	9.41	18,609	19,500	1.92
4	100	17.83	33,294	34,756	13.34	19,980	19,127	1.67
5	100	27.43	40,681	42,241	19.43	18,955	18,866	2.15
6	100	37.43	50,685	49,784	25.10	18,574	18,786	2.73

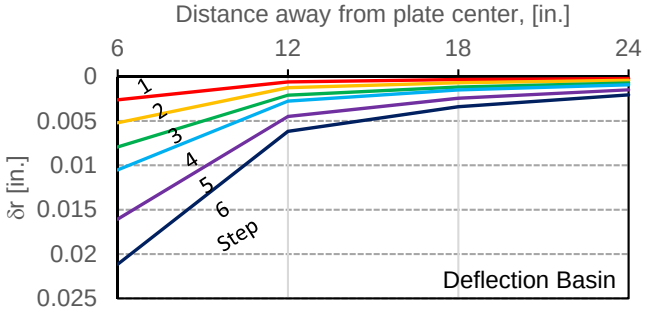


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	1521.2	1.34E-05
$k^*_{2\ (Base)}$	0.224	4.21E-01
$k^*_{3\ (Base)}$	1.189	5.49E-01
Adj. R^2	0.917	
Std. Error [psi]	3015	
$k^*_{1\ (Subgrade)}$	1305.4	3.65E-06
$k^*_{2\ (Subgrade)}$	-0.114	3.51E-01
$k^*_{3\ (Subgrade)}$	0.389	6.30E-01
Adj. R^2	0.624	
Std. Error [psi]	526	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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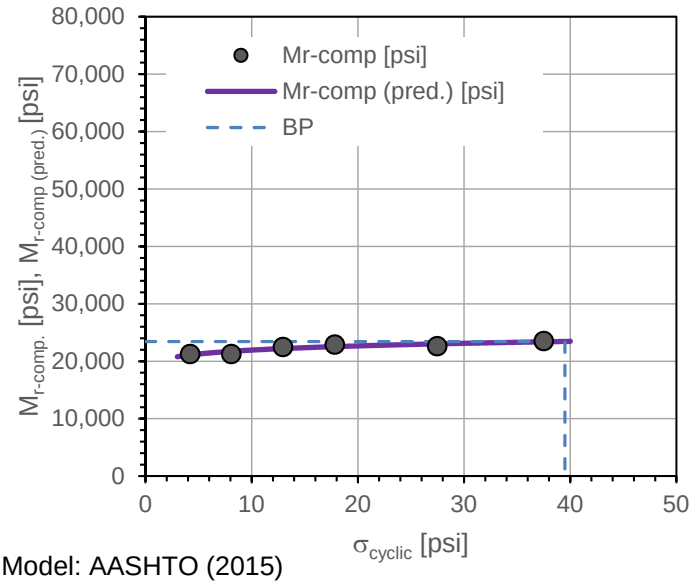
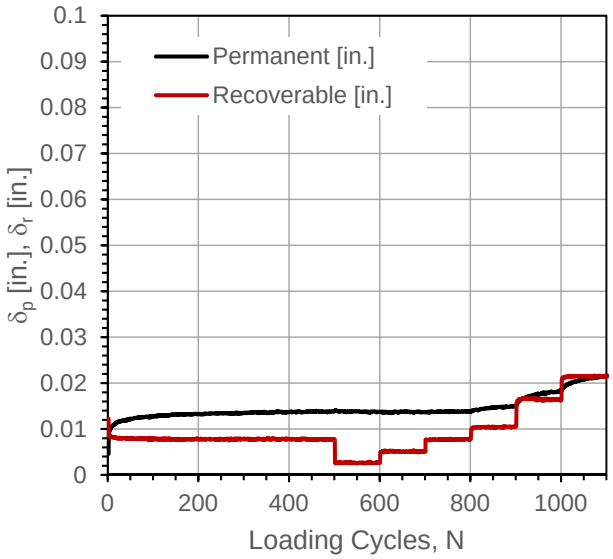
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	6:39:49 AM	Test ID	**I5_NCC_TX5_pt3**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.045933	Longitude,W:	117.286460	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.95	---	---	0.0138	---	0.071	---
1	100	4.20	21,245	21,098	0.0137	-0.0001	-0.159	Y
2	100	8.09	21,259	21,731	0.0137	-0.0001	0.052	Y
3	100	12.95	22,473	22,210	0.0138	0.0000	0.188	Y
4	100	17.83	22,901	22,547	0.0149	0.0011	0.445	Y
5	100	27.47	22,614	23,023	0.0183	0.0045	0.462	Y
6	100	37.52	23,514	23,384	0.0216	0.0078	0.517	Y





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,459.4	7.47E-08
k^*_2	0.044	3.81E-01
k^*_3	0.024	9.44E-01
Adj. R^2	0.812	
Std. Error [psi]	364	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		23,430
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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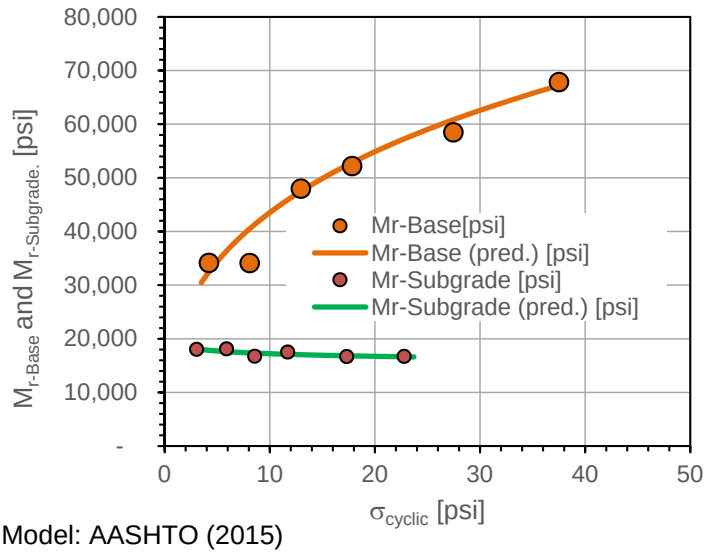
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	6:39:49 AM	Test ID	**I5_NCC_TX5_pt3**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.045933	Longitude, W:	117.286460	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.				

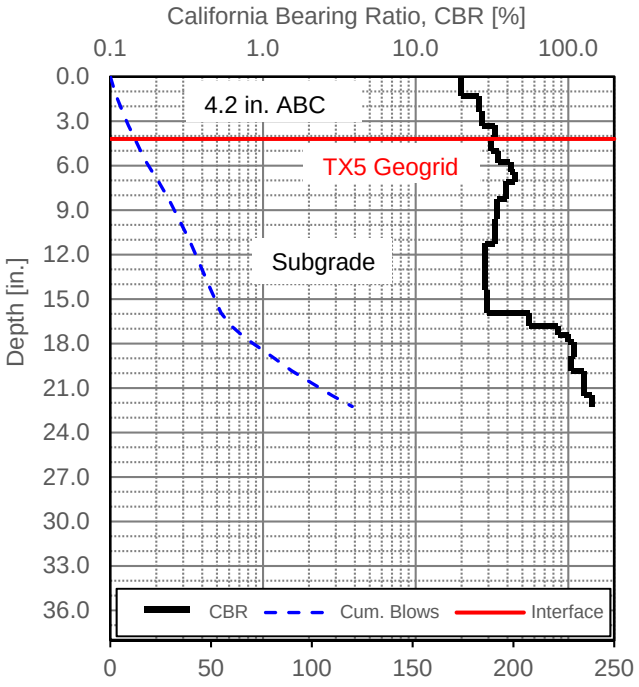
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.95	---	---	---	---	---	---
1	100	4.20	34,145	32,443	3.06	17,993	18,087	1.90
2	100	8.09	34,101	40,534	5.89	18,084	17,604	1.89
3	100	12.95	47,976	47,499	8.58	16,712	17,329	2.87
4	100	17.83	52,192	52,823	11.71	17,501	17,106	2.98
5	100	27.47	58,467	60,839	17.33	16,659	16,831	3.51
6	100	37.52	67,856	67,232	22.80	16,706	16,645	4.06

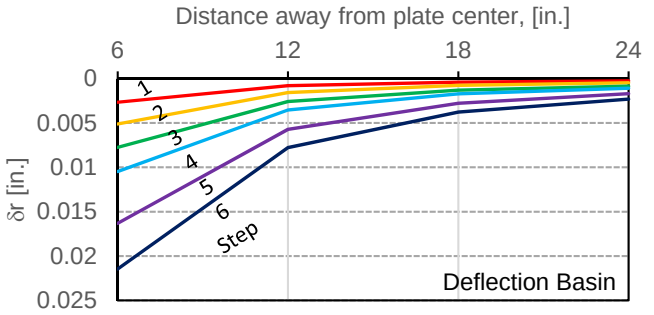


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2550.3	2.01E-05
$k^*_{2\ (Base)}$	0.346	3.29E-01
$k^*_{3\ (Base)}$	-0.101	9.66E-01
Adj. R^2	0.836	
Std. Error [psi]	5198	
$k^*_{1\ (Subgrade)}$	1188.4	2.50E-06
$k^*_{2\ (Subgrade)}$	-0.046	6.12E-01
$k^*_{3\ (Subgrade)}$	0.021	9.75E-01
Adj. R^2	0.529	
Std. Error [psi]	362	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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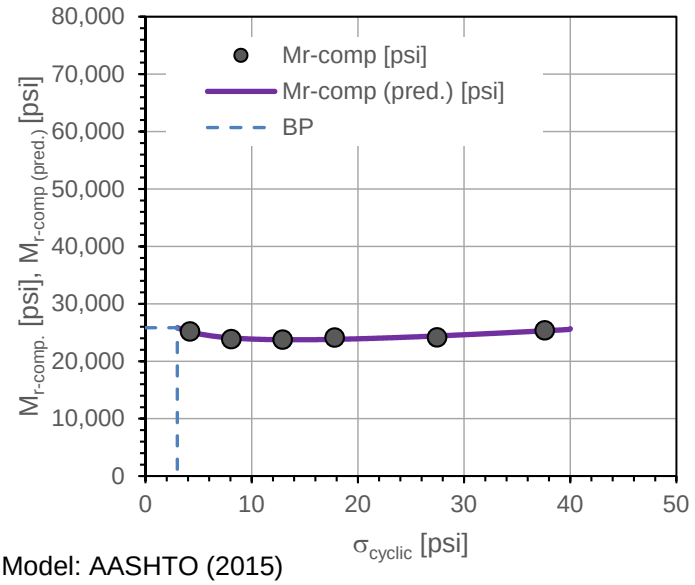
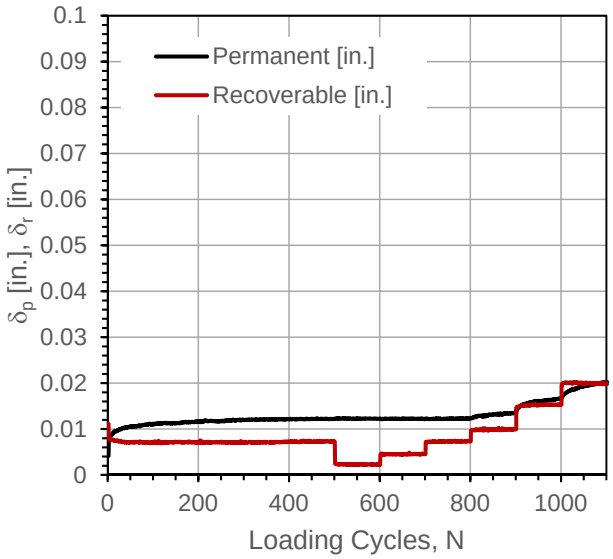
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	7:10:55 AM	Test ID	**I5_NCC_TX5_pt4**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.045959	Longitude,W:	117.286480	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface. Measured base layer thickness = 4.3 in.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.92	---	---	0.0122	---	0.084	---
1	100	4.20	25,180	25,105	0.0122	0.0001	-0.081	Y
2	100	8.08	23,859	24,064	0.0121	0.0000	0.030	Y
3	100	12.92	23,764	23,746	0.0123	0.0002	0.116	Y
4	100	17.81	24,113	23,815	0.0135	0.0013	0.520	Y
5	100	27.46	24,142	24,407	0.0166	0.0045	0.400	Y
6	100	37.60	25,392	25,308	0.0202	0.0080	0.512	Y





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,563.1	1.13E-08
k^*_2	-0.119	1.40E-02
k^*_3	0.916	1.21E-02
Adj. R^2	0.890	
Std. Error [psi]	220	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		25,836
	$\sigma_{cyclic\text{-}BP}$ [psi]	3.0

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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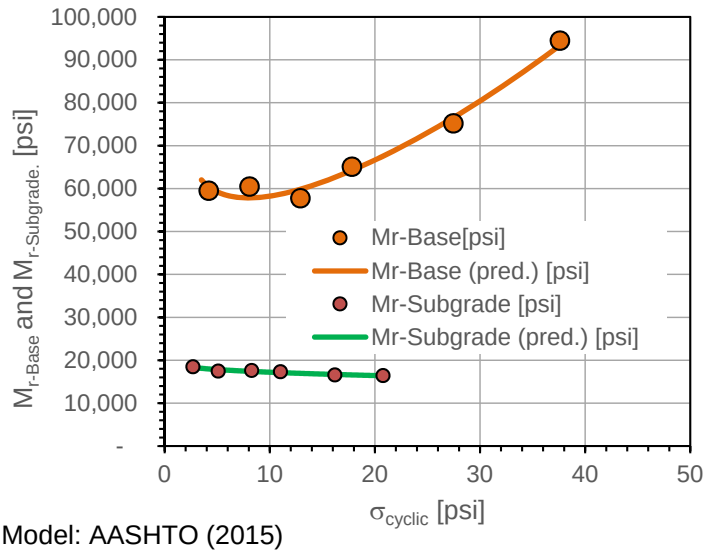
Automated Plate Load Test [APLT]

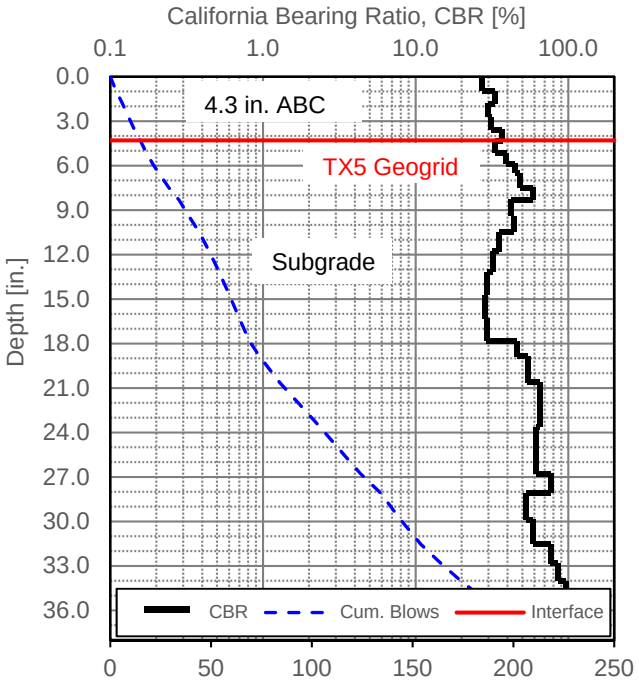
Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	7:10:55 AM	Test ID	**I5_NCC_TX5_pt4**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.045959	Longitude, W:	117.286480	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface. Measured base layer thickness = 4.3 in.				

Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.92	---	---	---	---	---	---
1	100	4.20	59,493	60,446	2.70	18,442	18,305	3.23
2	100	8.08	60,477	57,819	5.11	17,448	17,818	3.47
3	100	12.92	57,726	59,854	8.29	17,594	17,393	3.28
4	100	17.81	65,085	64,217	11.03	17,276	17,111	3.77
5	100	27.46	75,179	76,531	16.20	16,541	16,690	4.54
6	100	37.60	94,478	93,391	20.78	16,411	16,387	5.76

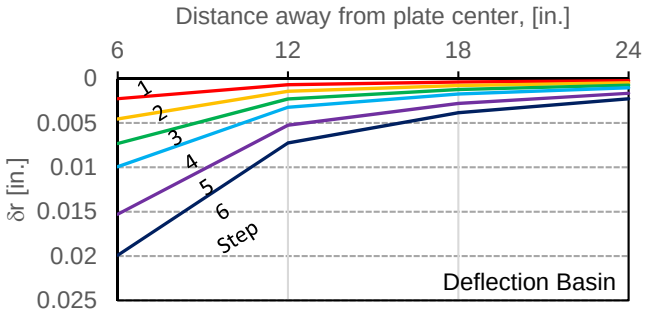


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$



Parameter	Value	P-Value
$k^*_{1\ (Base)}$	3137.8	3.33E-07
$k^*_{2\ (Base)}$	-0.280	3.68E-02
$k^*_{3\ (Base)}$	3.569	8.13E-03
Adj. R^2	0.980	
Std. Error [psi]	1972	
$k^*_{1\ (Subgrade)}$	1217.9	4.74E-07
$k^*_{2\ (Subgrade)}$	-0.036	4.59E-01
$k^*_{3\ (Subgrade)}$	-0.181	6.44E-01
Adj. R^2	0.889	
Std. Error [psi]	237	



In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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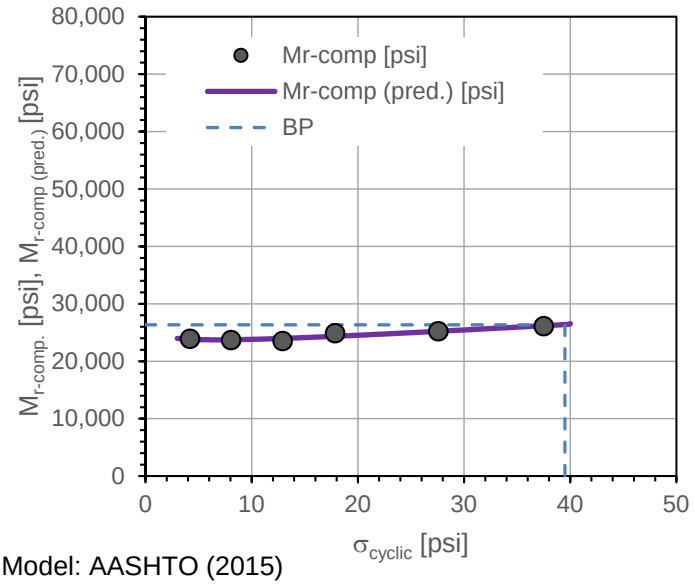
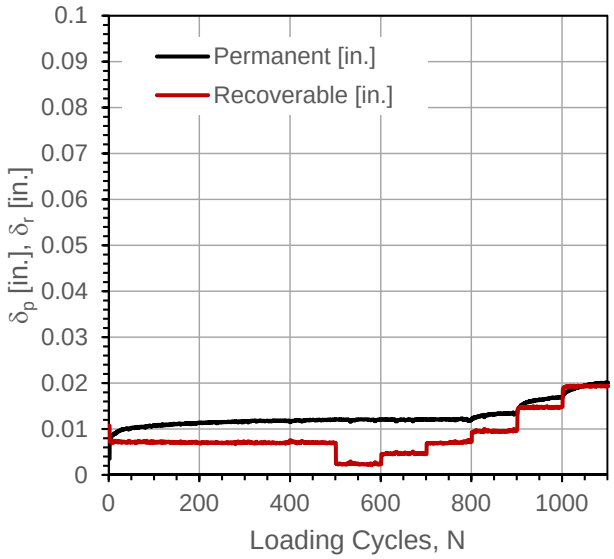
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	7:41:36 AM	Test ID	**I5_NCC_TX5_pt5**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.045979	Longitude,W:	117.286480	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.92	---	---	0.0120	---	0.085	---
1	100	4.20	23,913	23,826	0.0121	0.0000	-0.048	Y
2	100	8.06	23,688	23,746	0.0121	0.0001	-0.034	Y
3	100	12.92	23,526	23,978	0.0121	0.0000	-0.034	Y
4	100	17.85	24,885	24,346	0.0134	0.0014	0.411	Y
5	100	27.58	25,203	25,220	0.0169	0.0049	0.412	Y
6	100	37.52	26,100	26,189	0.0201	0.0081	0.507	Y





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,547.6	4.18E-08
k^*_2	-0.044	3.07E-01
k^*_3	0.648	8.77E-02
Adj. R^2	0.875	
Std. Error [psi]	342	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		26,336
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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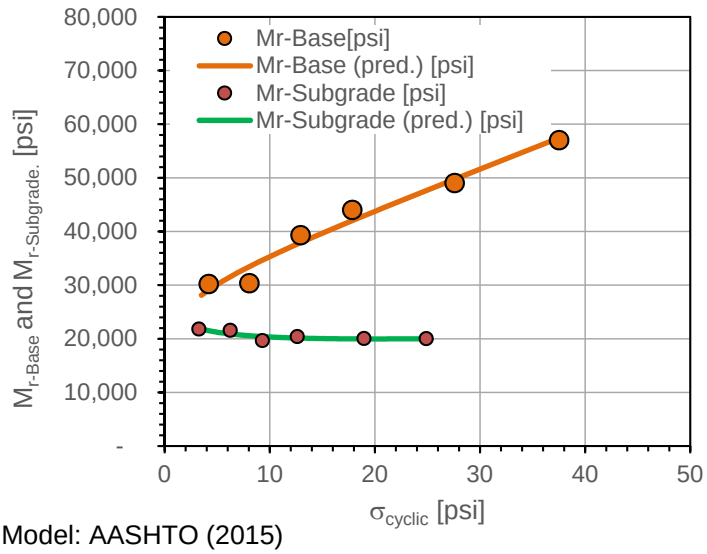
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	7:41:36 AM	Test ID	**I5_NCC_TX5_pt5**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.045979	Longitude, W:	117.286480	Elev. (ft):	NA
Comments:	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface.				

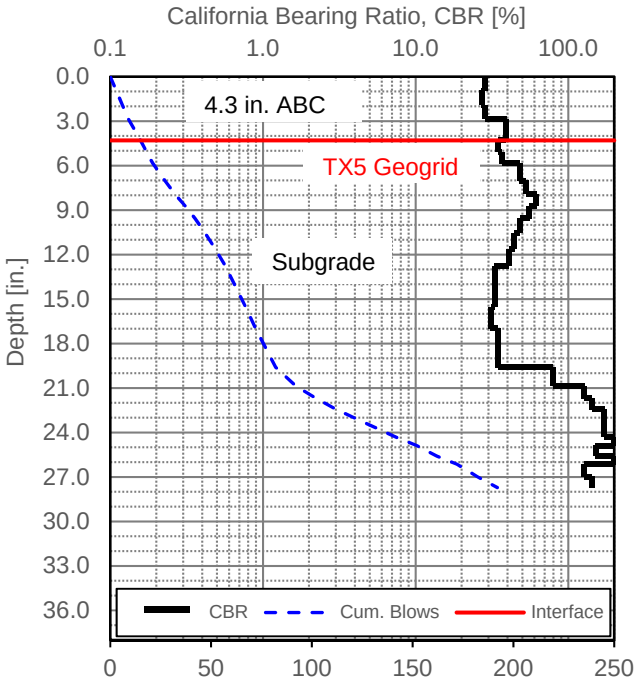
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.92	---	---	---	---	---	---
1	100	4.20	30,200	29,099	3.26	21,784	21,943	1.39
2	100	8.06	30,347	33,456	6.25	21,549	20,897	1.41
3	100	12.92	39,306	37,914	9.30	19,658	20,408	2.00
4	100	17.85	44,025	42,026	12.63	20,389	20,141	2.16
5	100	27.58	49,026	49,727	18.97	20,034	19,976	2.45
6	100	37.52	57,006	57,461	24.90	19,991	20,014	2.85

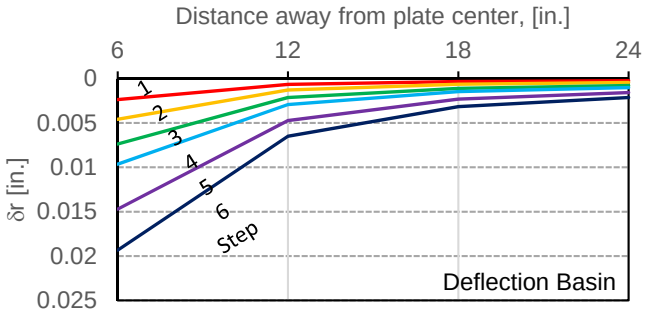


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	1976.1	2.60E-06
$k^*_{2\ (Base)}$	0.136	4.17E-01
$k^*_{3\ (Base)}$	1.302	3.07E-01
Adj. R^2	0.961	
Std. Error [psi]	2076	
$k^*_{1\ (Subgrade)}$	1346.8	1.57E-06
$k^*_{2\ (Subgrade)}$	-0.115	2.28E-01
$k^*_{3\ (Subgrade)}$	0.494	4.32E-01
Adj. R^2	0.656	
Std. Error [psi]	444	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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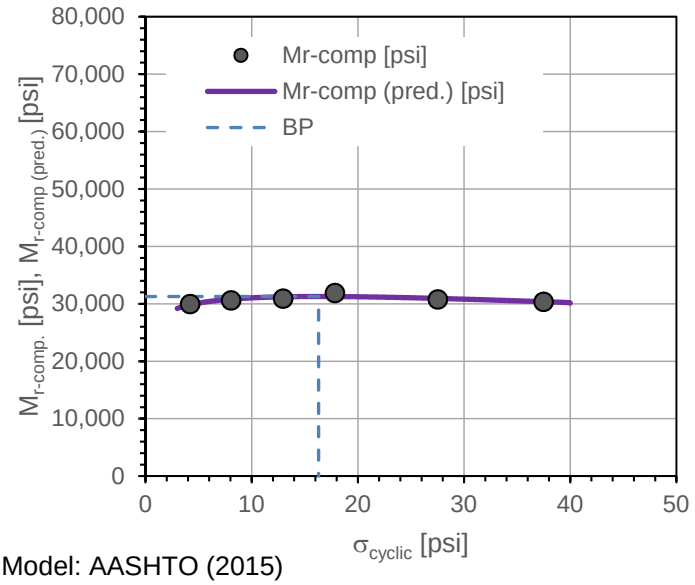
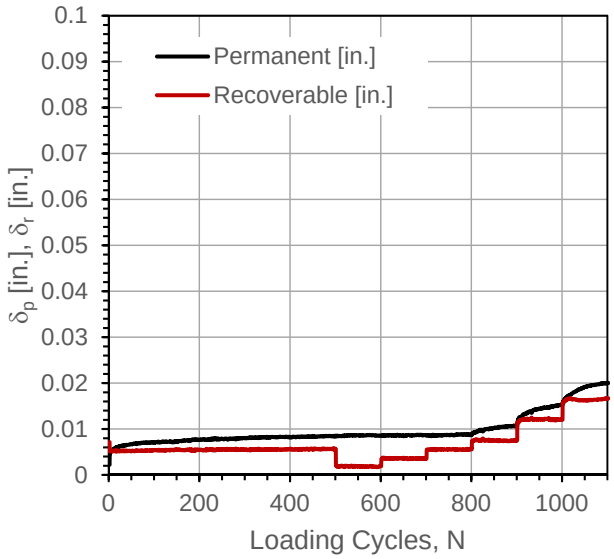
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	8:13:03 AM	Test ID	**I5_NCC_CTRL_pt6**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046124	Longitude,W:	117.286520	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				
Measured base layer thickness = 9.0 in.					

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.96	---	---	0.0084	---	0.113	---
1	100	4.21	29,949	29,824	0.0086	0.0002	0.177	Y
2	100	8.07	30,595	30,812	0.0087	0.0003	0.094	Y
3	100	12.96	30,899	31,220	0.0086	0.0003	0.194	Y
4	100	17.84	31,878	31,268	0.0107	0.0024	0.481	Y
5	100	27.54	30,771	30,937	0.0153	0.0069	0.419	Y
6	100	37.50	30,345	30,366	0.0201	0.0117	0.566	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,150.9	1.97E-08
k^*_2	0.083	6.33E-02
k^*_3	-0.562	7.65E-02
Adj. R^2	0.667	
Std. Error [psi]	319	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		31,277
	$\sigma_{cyclic\text{-}BP}$ [psi]	16.3

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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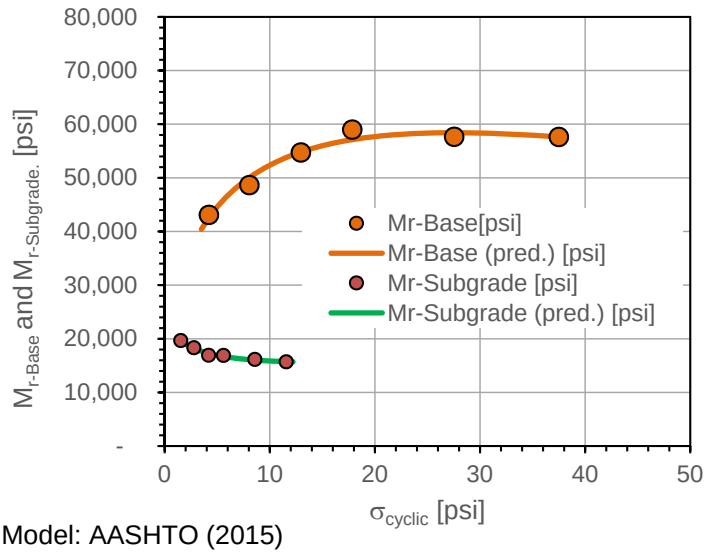
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	8:13:03 AM	Test ID	**I5_NCC_CTRL_pt6**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046124	Longitude, W:	117.286520	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				
Measured base layer thickness = 9.0 in.					

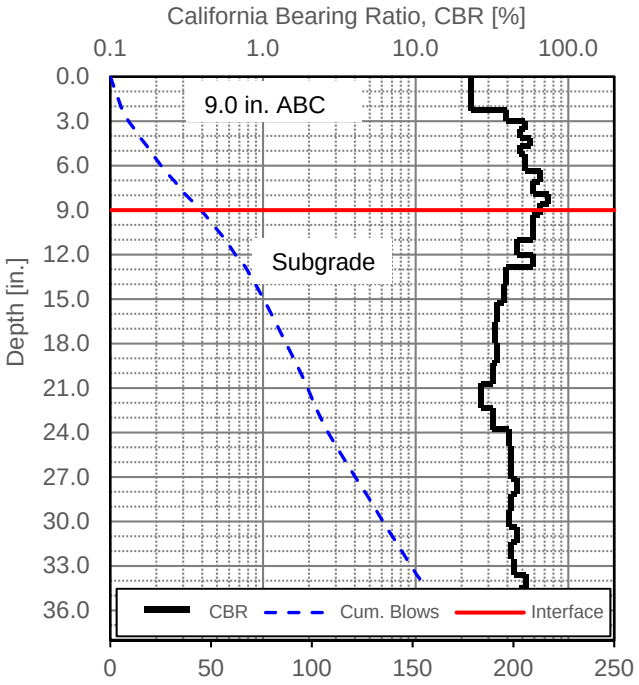
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.96	---	---	---	---	---	---
1	100	4.21	43,077	42,553	1.54	19,634	19,620	2.19
2	100	8.07	48,636	50,072	2.79	18,305	18,184	2.66
3	100	12.96	54,710	54,805	4.19	16,914	17,266	3.23
4	100	17.84	58,990	57,121	5.61	16,887	16,689	3.49
5	100	27.54	57,634	58,412	8.59	16,124	16,032	3.57
6	100	37.50	57,615	57,627	11.58	15,677	15,743	3.68

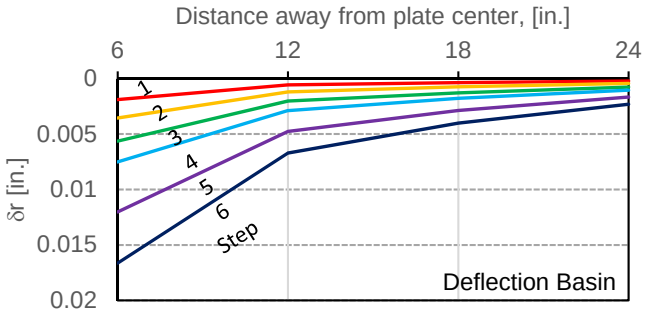


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	3544.7	1.23E-07
$k^*_{2\ (Base)}$	0.339	9.38E-03
$k^*_{3\ (Base)}$	-1.495	3.65E-02
Adj. R^2	0.959	
Std. Error [psi]	1234	
$k^*_{1\ (Subgrade)}$	1001.6	1.85E-06
$k^*_{2\ (Subgrade)}$	-0.220	1.94E-02
$k^*_{3\ (Subgrade)}$	1.127	1.53E-01
Adj. R^2	0.978	
Std. Error [psi]	216	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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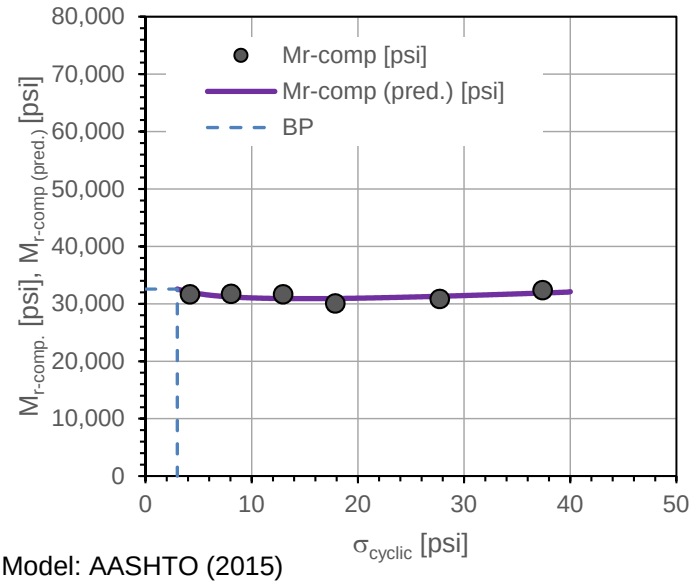
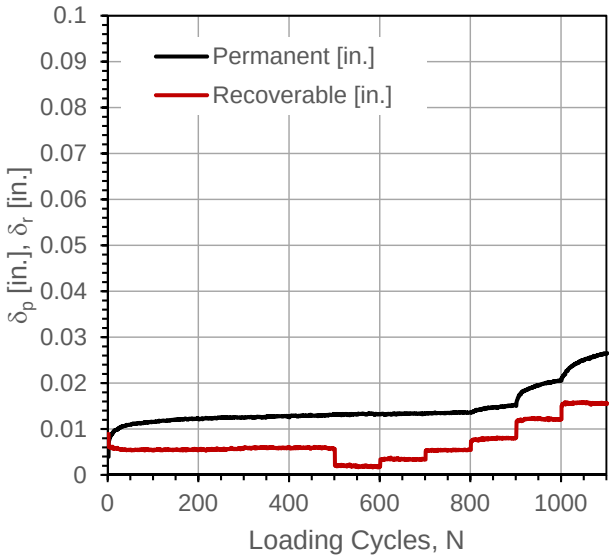
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	8:44:02 AM	Test ID	**I5_NCC_CTRL_pt7**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046158	Longitude,W:	117.286520	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.96	---	---	0.0131	---	0.094	---
1	100	4.20	31,644	32,016	0.0132	0.0001	0.140	Y
2	100	8.07	31,738	31,200	0.0134	0.0002	0.152	Y
3	100	12.96	31,659	30,917	0.0136	0.0004	0.272	Y
4	100	17.88	30,060	30,931	0.0153	0.0021	0.591	Y
5	100	27.71	30,828	31,315	0.0206	0.0074	0.477	Y
6	100	37.41	32,370	31,885	0.0264	0.0133	0.586	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,070.8	1.59E-07
k^*_2	-0.070	3.14E-01
k^*_3	0.506	3.16E-01
Adj. R^2	0.164	
Std. Error [psi]	431	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		32,568
	$\sigma_{cyclic\text{-}BP}$ [psi]	3.0

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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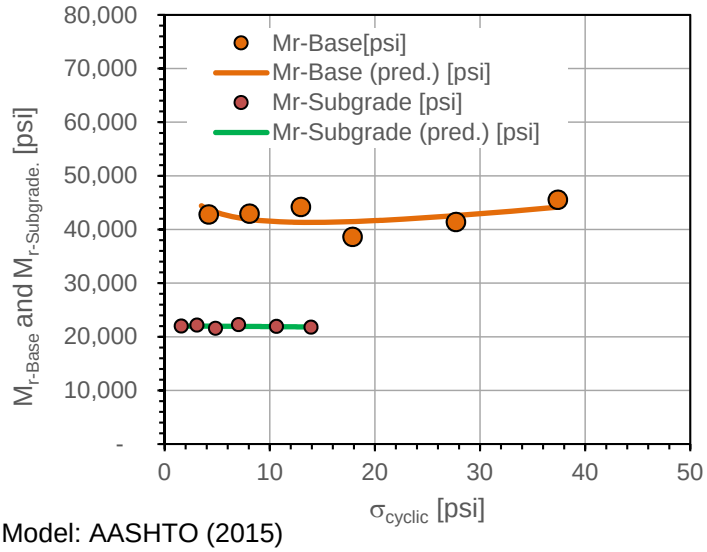
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	8:44:02 AM	Test ID	**I5_NCC_CTRL_pt7**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046158	Longitude, W:	117.286520	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				

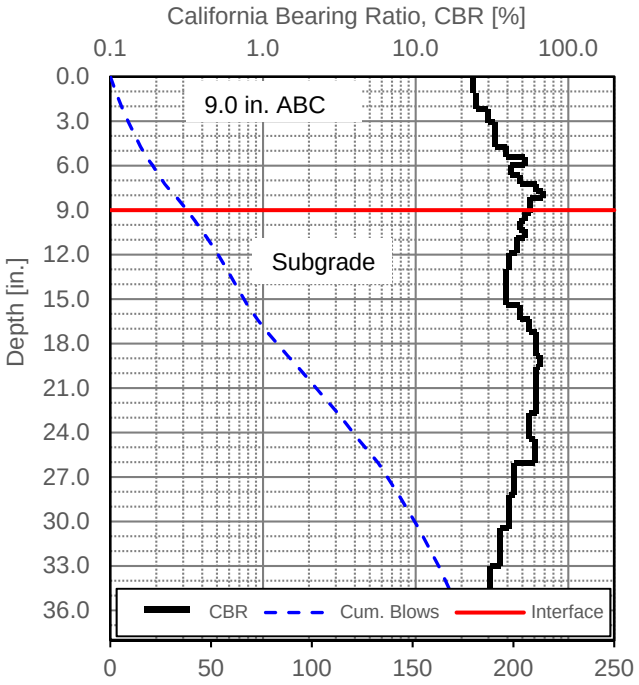
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.96	---	---	---	---	---	---
1	100	4.20	42,791	43,728	1.60	21,975	21,983	1.95
2	100	8.07	42,933	41,886	3.08	22,164	21,989	1.94
3	100	12.96	44,184	41,333	4.86	21,551	21,976	2.05
4	100	17.88	38,627	41,476	7.04	22,249	21,948	1.74
5	100	27.71	41,380	42,593	10.64	21,905	21,889	1.89
6	100	37.41	45,521	44,162	13.94	21,778	21,829	2.09

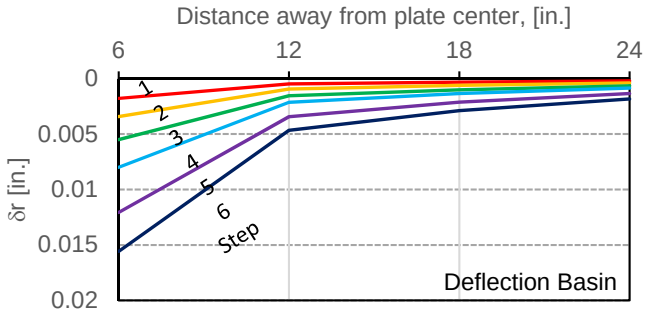


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2715.6	1.80E-06
$k^*_{2\ (Base)}$	-0.122	4.29E-01
$k^*_{3\ (Base)}$	0.947	4.05E-01
Adj. R^2	0.054	
Std. Error [psi]	1156	
$k^*_{1\ (Subgrade)}$	1508.0	8.00E-07
$k^*_{2\ (Subgrade)}$	0.005	9.17E-01
$k^*_{3\ (Subgrade)}$	-0.095	8.46E-01
Adj. R^2	-0.170	
Std. Error [psi]	69	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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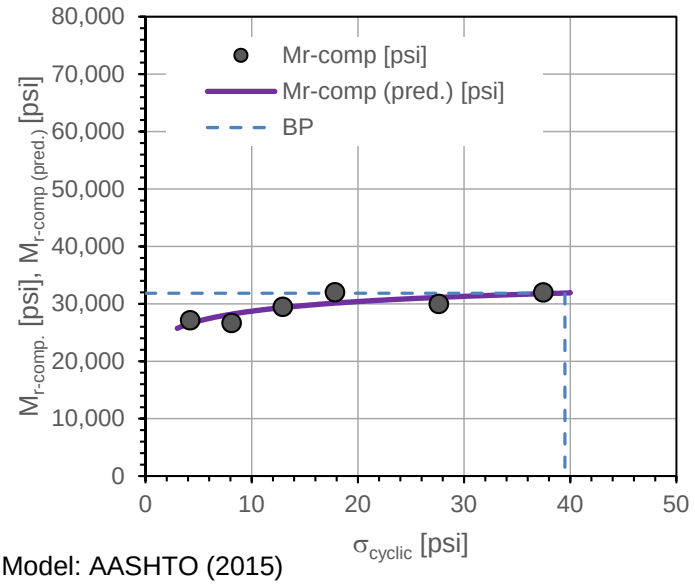
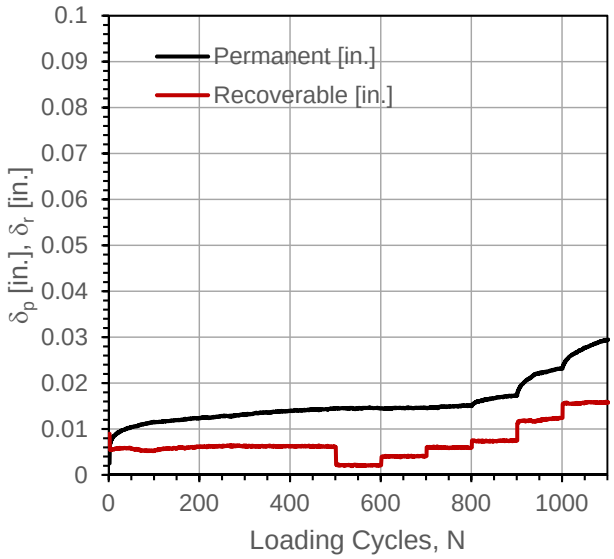
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	9:16:18 AM	Test ID	**I5_NCC_CTRL_pt8**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046181	Longitude,W:	117.286530	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				
Measured base layer thickness = 8.75 in.					

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.94	---	---	0.0146	---	0.151	---
1	100	4.21	27,148	26,570	0.0145	-0.0001	0.060	Y
2	100	8.11	26,664	28,198	0.0146	0.0001	0.232	Y
3	100	12.94	29,481	29,350	0.0151	0.0006	0.447	Y
4	100	17.84	32,016	30,124	0.0173	0.0027	0.492	Y
5	100	27.63	29,978	31,123	0.0232	0.0087	0.536	Y
6	100	37.46	31,970	31,763	0.0294	0.0149	0.601	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,890.2	1.23E-06
k^*_2	0.098	4.50E-01
k^*_3	-0.121	8.93E-01
Adj. R^2	0.636	
Std. Error [psi]	1,159	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		31,843
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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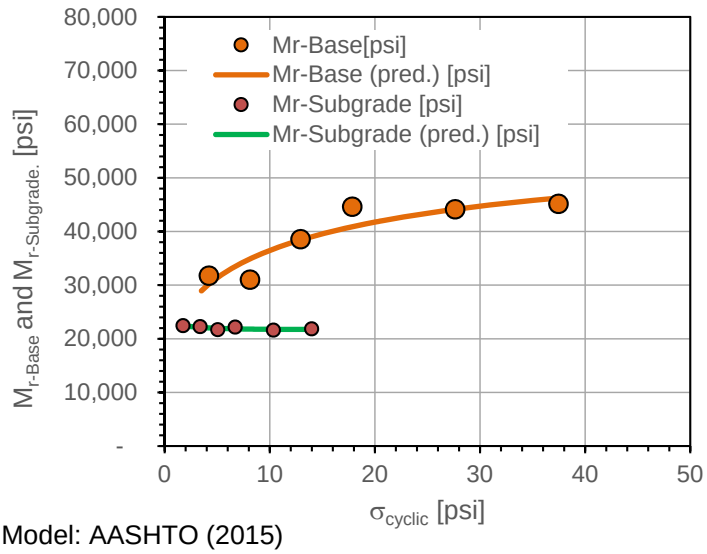
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	9:16:18 AM	Test ID	**I5_NCC_CTRL_pt8**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046181	Longitude, W:	117.286530	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				
Measured base layer thickness = 8.75 in.					

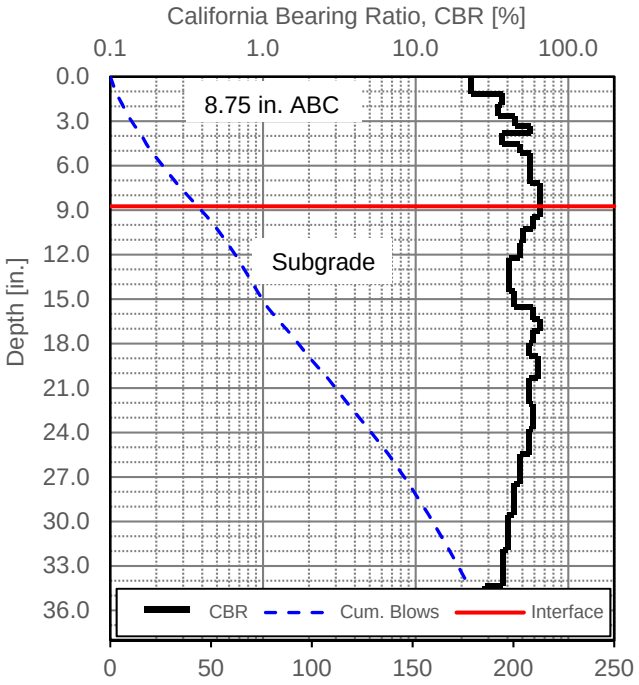
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.94	---	---	---	---	---	---
1	100	4.21	31,756	30,185	1.75	22,436	22,456	1.42
2	100	8.11	31,023	34,885	3.39	22,237	22,130	1.40
3	100	12.94	38,569	38,423	5.06	21,686	21,956	1.78
4	100	17.84	44,603	40,882	6.72	22,153	21,855	2.01
5	100	27.63	44,127	44,136	10.37	21,592	21,761	2.04
6	100	37.46	45,141	46,242	14.00	21,812	21,754	2.07

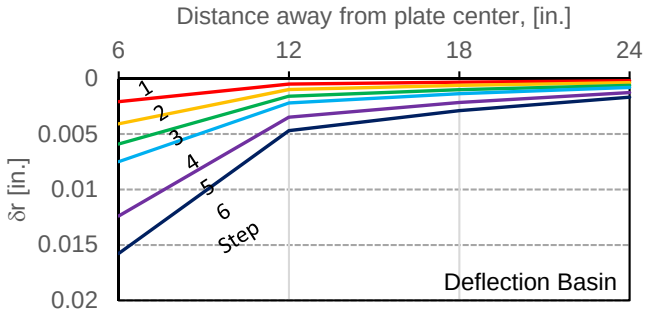


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2297.4	5.33E-06
$k^*_{2\ (Base)}$	0.241	2.92E-01
$k^*_{3\ (Base)}$	-0.343	8.19E-01
Adj. R^2	0.808	
Std. Error [psi]	2607	
$k^*_{1\ (Subgrade)}$	1452.4	4.61E-07
$k^*_{2\ (Subgrade)}$	-0.040	3.37E-01
$k^*_{3\ (Subgrade)}$	0.242	5.67E-01
Adj. R^2	0.548	
Std. Error [psi]	181	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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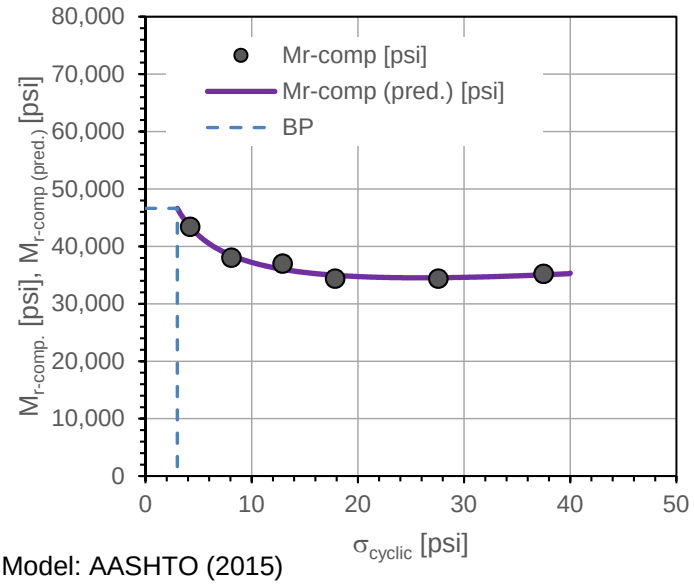
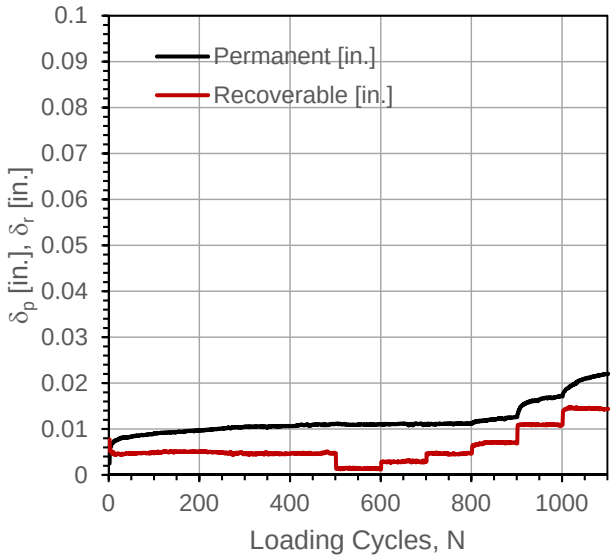
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	9:47:02 AM	Test ID	**I5_NCC_CTRL_pt9**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046204	Longitude,W:	117.286540	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.92	---	---	0.0111	---	0.127	---
1	100	4.20	43,414	43,389	0.0111	-0.0001	-0.160	Y
2	100	8.09	38,024	38,424	0.0110	-0.0001	0.031	Y
3	100	12.92	37,002	36,009	0.0112	0.0001	0.173	Y
4	100	17.86	34,374	34,972	0.0127	0.0016	0.479	Y
5	100	27.58	34,390	34,547	0.0172	0.0060	0.447	Y
6	100	37.49	35,211	35,053	0.0219	0.0108	0.574	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,526.0	5.48E-08
k^*_2	-0.256	8.58E-03
k^*_3	1.185	2.98E-02
Adj. R^2	0.967	
Std. Error [psi]	616	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		46,616
	$\sigma_{cyclic\text{-}BP}$ [psi]	3.0

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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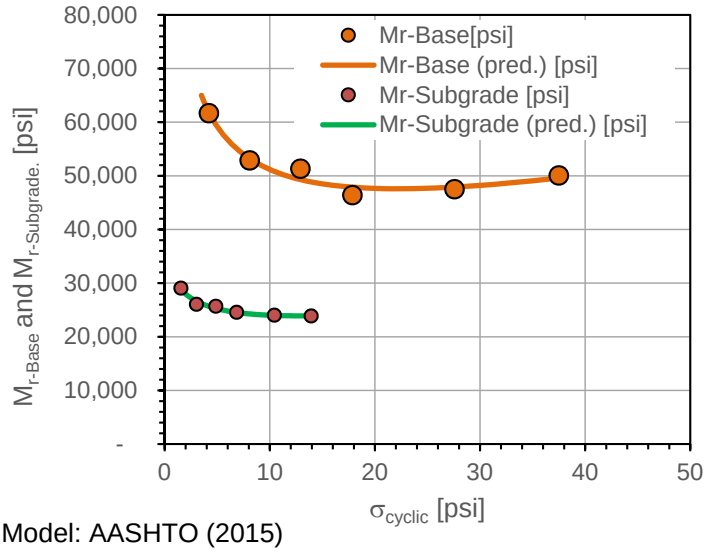
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	9:47:02 AM	Test ID	**I5_NCC_CTRL_pt9**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046204	Longitude, W:	117.286540	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				

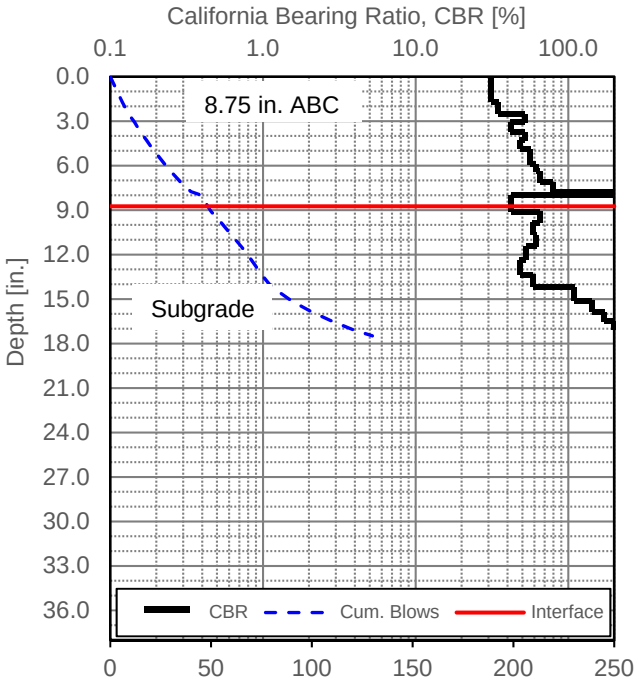
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.92	---	---	---	---	---	---
1	100	4.20	61,681	61,889	1.56	29,030	28,793	2.12
2	100	8.09	52,871	53,191	3.04	26,037	26,616	2.03
3	100	12.92	51,319	49,306	4.88	25,661	25,283	2.00
4	100	17.86	46,395	47,882	6.86	24,536	24,537	1.89
5	100	27.58	47,501	47,906	10.45	24,013	23,983	1.98
6	100	37.49	50,060	49,590	13.95	23,862	23,917	2.10

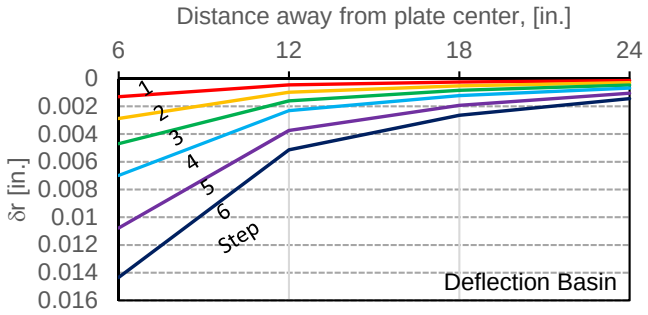


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	3403.9	1.78E-07
$k^*_{2\ (Base)}$	-0.335	1.34E-02
$k^*_{3\ (Base)}$	1.749	3.30E-02
Adj. R^2	0.943	
Std. Error [psi]	1283	
$k^*_{1\ (Subgrade)}$	1483.4	1.01E-06
$k^*_{2\ (Subgrade)}$	-0.208	1.73E-02
$k^*_{3\ (Subgrade)}$	1.242	8.43E-02
Adj. R^2	0.964	
Std. Error [psi]	359	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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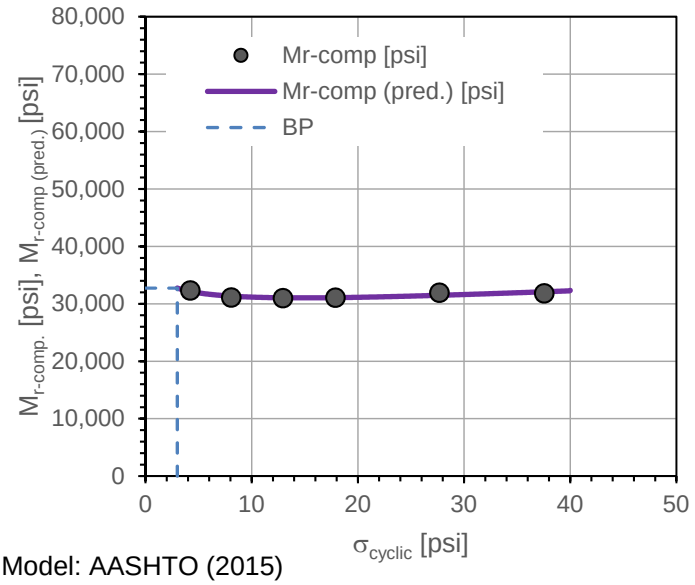
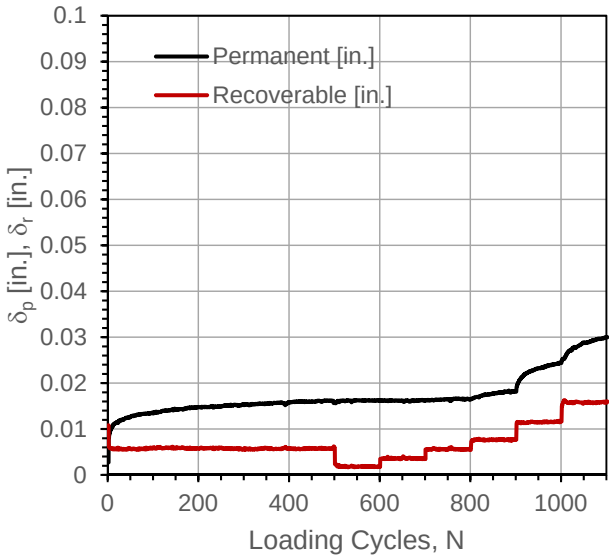
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	10:17:08 AM	Test ID	**I5_NCC_CTRL_pt10**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046219	Longitude,W:	117.286540	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.95	---	---	0.0158	---	0.123	---
1	100	4.22	32,306	32,161	0.0162	0.0004	0.244	Y
2	100	8.08	31,103	31,338	0.0162	0.0004	-0.014	Y
3	100	12.95	30,984	31,056	0.0164	0.0005	0.223	Y
4	100	17.89	31,076	31,079	0.0182	0.0023	0.563	Y
5	100	27.69	31,928	31,487	0.0244	0.0085	0.490	Y
6	100	37.56	31,827	32,099	0.0300	0.0141	0.627	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,077.9	9.32E-09
k^*_2	-0.071	5.10E-02
k^*_3	0.523	4.98E-02
Adj. R^2	0.715	
Std. Error [psi]	260	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	32,733
$\sigma_{cyclic\text{-}BP}$ [psi]	3.0

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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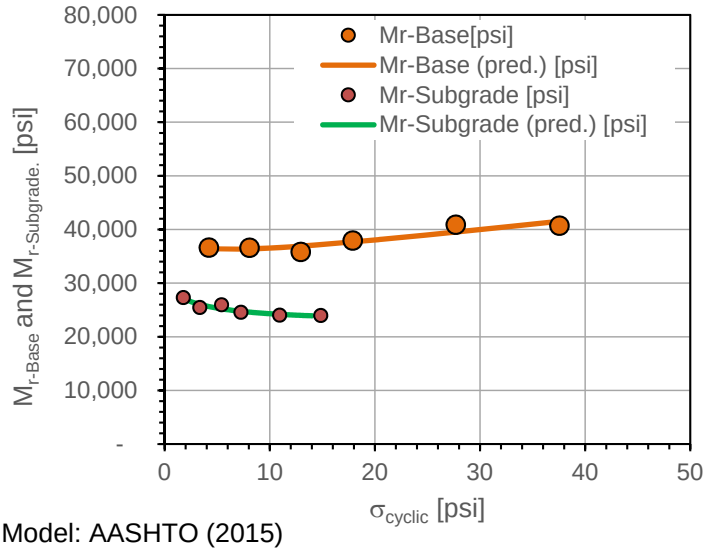
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	10:17:08 AM	Test ID	**I5_NCC_CTRL_pt10**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046219	Longitude, W:	117.286540	Elev. (ft):	NA
Comments:	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).				

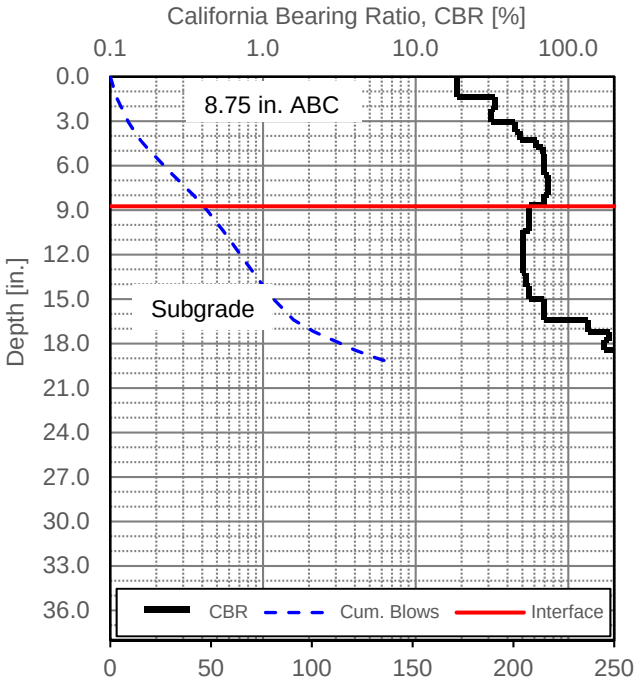
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.95	---	---	---	---	---	---
1	100	4.22	36,609	36,469	1.78	27,296	27,127	1.34
2	100	8.08	36,585	36,383	3.35	25,442	26,028	1.44
3	100	12.95	35,798	36,900	5.43	25,955	25,207	1.38
4	100	17.89	37,935	37,678	7.27	24,532	24,748	1.55
5	100	27.69	40,890	39,520	10.96	24,012	24,185	1.70
6	100	37.56	40,715	41,534	14.87	23,930	23,851	1.70

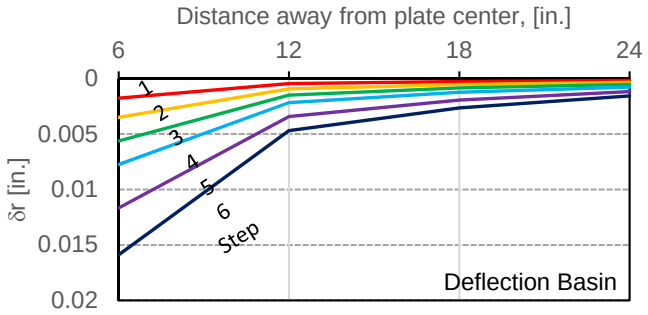


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2338.8	1.79E-07
$k^*_{2\ (Base)}$	-0.054	4.42E-01
$k^*_{3\ (Base)}$	0.846	1.54E-01
Adj. R^2	0.801	
Std. Error [psi]	914	
$k^*_{1\ (Subgrade)}$	1647.4	2.53E-06
$k^*_{2\ (Subgrade)}$	-0.098	2.19E-01
$k^*_{3\ (Subgrade)}$	0.300	6.84E-01
Adj. R^2	0.851	
Std. Error [psi]	472	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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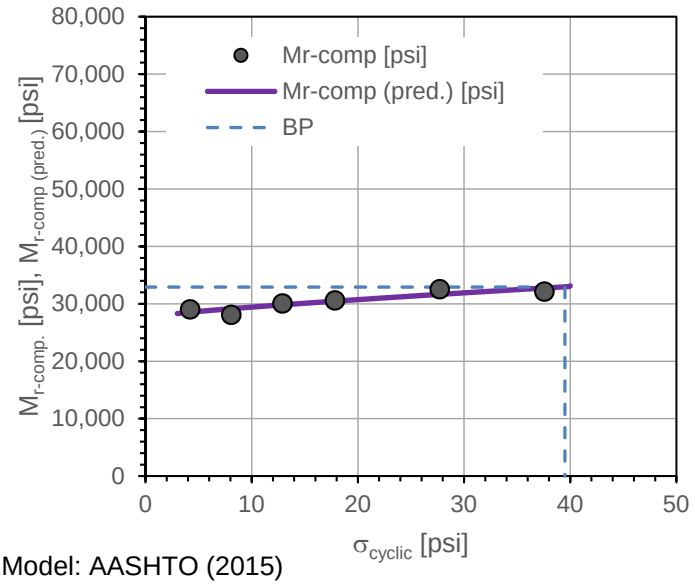
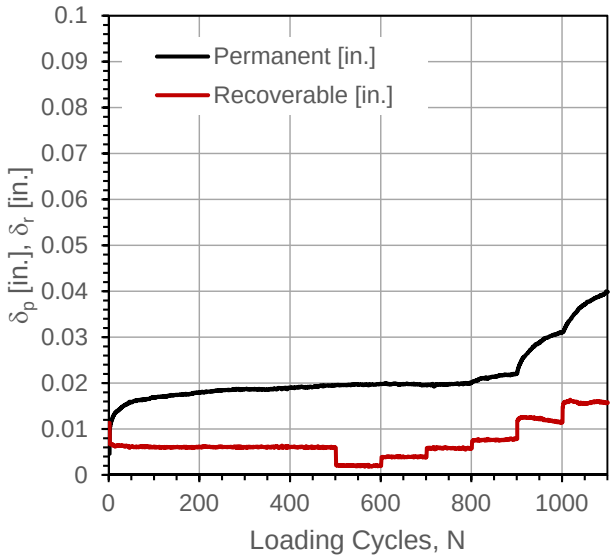
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	11:06:11 AM	Test ID	**I5_NCC_TX5_0.85_pt11**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046959	Longitude,W:	117.286770	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface. Measured base layer thickness = 9.75 in.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.90	---	---	0.0195	---	0.111	---
1	100	4.20	29,021	28,535	0.0198	0.0004	0.221	Y
2	100	8.08	28,095	29,152	0.0197	0.0002	-0.145	Y
3	100	12.90	30,052	29,823	0.0201	0.0006	0.192	Y
4	100	17.85	30,598	30,463	0.0221	0.0026	0.558	Y
5	100	27.72	32,530	31,650	0.0311	0.0117	0.657	N
6	100	37.57	32,124	32,754	0.0400	0.0205	0.835	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,913.5	2.26E-07
k^*_2	0.009	9.03E-01
k^*_3	0.406	4.50E-01
Adj. R^2	0.782	
Std. Error [psi]	737	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		32,909
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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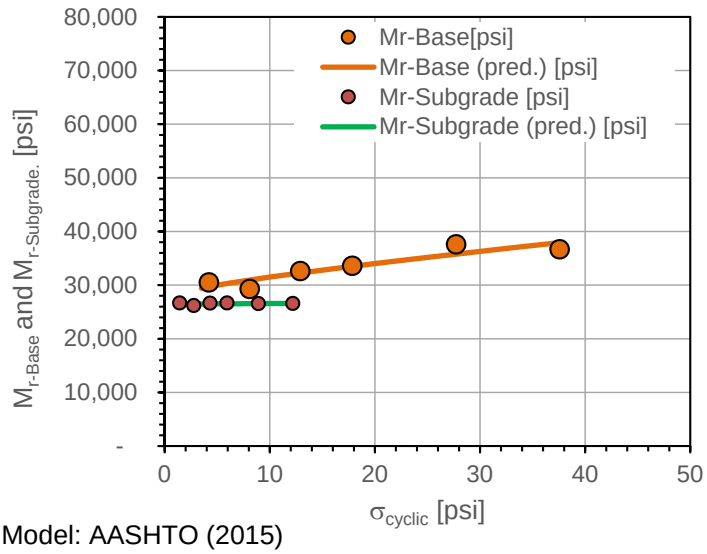
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	11:06:11 AM	Test ID	I5_NCC_TX5_0.85_pt11
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046959	Longitude, W:	117.286770	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface. Measured base layer thickness = 9.75 in.				

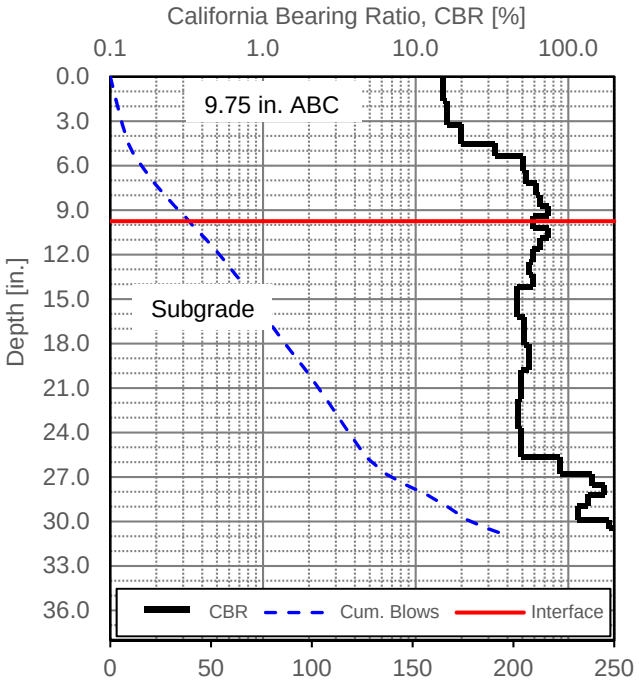
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.90	---	---	---	---	---	---
1	100	4.20	30,496	29,708	1.44	26,643	26,511	1.14
2	100	8.08	29,272	30,957	2.78	26,185	26,502	1.12
3	100	12.90	32,612	32,267	4.32	26,614	26,508	1.23
4	100	17.85	33,603	33,500	5.94	26,655	26,522	1.26
5	100	27.72	37,595	35,785	8.93	26,540	26,557	1.42
6	100	37.57	36,690	37,931	12.19	26,570	26,603	1.38

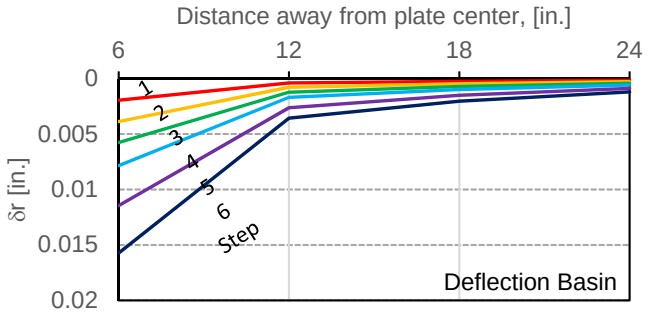


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	1983.2	9.44E-07
$k^*_{2\ (Base)}$	0.024	8.31E-01
$k^*_{3\ (Base)}$	0.651	4.54E-01
Adj. R^2	0.808	
Std. Error [psi]	1346	
$k^*_{1\ (Subgrade)}$	1793.0	2.03E-07
$k^*_{2\ (Subgrade)}$	-0.003	9.05E-01
$k^*_{3\ (Subgrade)}$	0.064	8.46E-01
Adj. R^2	-0.190	
Std. Error [psi]	43	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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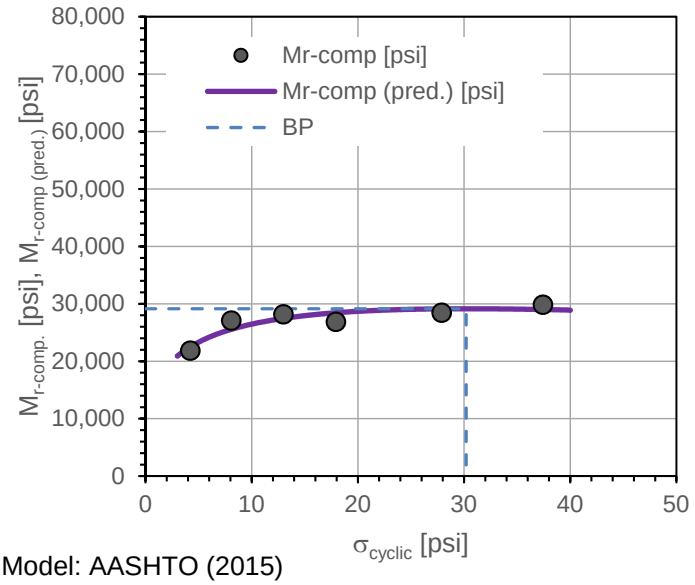
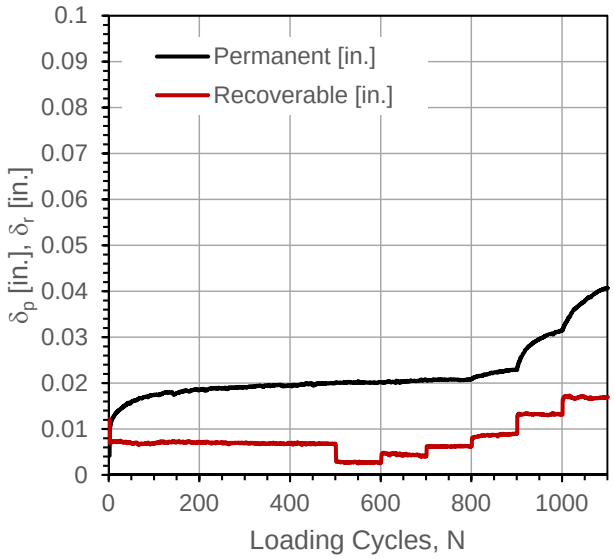
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	11:37:08 AM	Test ID	**I5_NCC_TX5_0.85_pt12**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046978	Longitude,W:	117.286780	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.99	---	---	0.0200	---	0.122	---
1	100	4.22	21,843	22,515	0.0201	0.0002	0.016	Y
2	100	8.09	27,067	25,550	0.0208	0.0008	0.389	Y
3	100	12.99	28,170	27,464	0.0209	0.0009	0.131	Y
4	100	17.94	26,861	28,445	0.0229	0.0030	0.556	Y
5	100	27.90	28,446	29,121	0.0315	0.0115	0.602	N
6	100	37.43	29,829	29,006	0.0407	0.0207	0.753	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,778.6	1.44E-06
k^*_2	0.257	1.18E-01
k^*_3	-1.051	3.09E-01
Adj. R^2	0.775	
Std. Error [psi]	1,220	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		29,139
	$\sigma_{cyclic\text{-}BP}$ [psi]	30.2

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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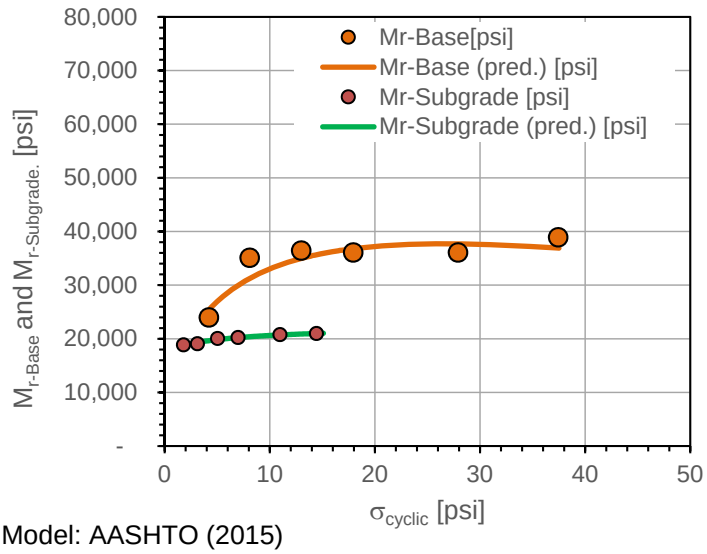
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	11:37:08 AM	Test ID	I5_NCC_TX5_0.85_pt12
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046978	Longitude, W:	117.286780	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

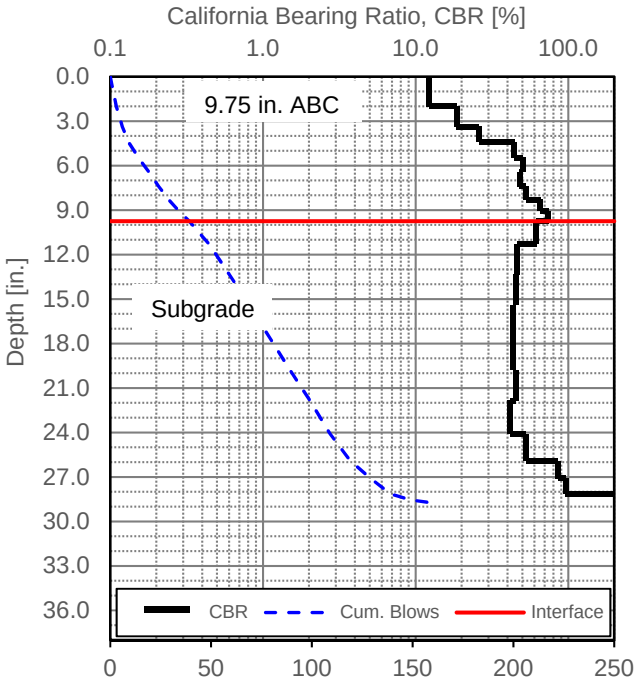
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.99	---	---	---	---	---	---
1	100	4.22	23,964	25,429	1.81	18,855	18,747	1.27
2	100	8.09	35,088	31,244	3.13	19,060	19,316	1.84
3	100	12.99	36,437	34,981	5.05	20,023	19,853	1.82
4	100	17.94	36,072	36,802	7.00	20,206	20,226	1.79
5	100	27.90	36,085	37,682	10.98	20,752	20,715	1.74
6	100	37.43	38,905	36,908	14.45	20,951	20,987	1.86

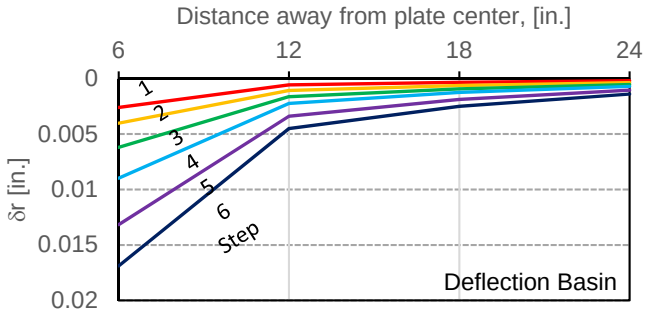


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2244.0	9.14E-06
$k^*_{2\ (Base)}$	0.433	1.51E-01
$k^*_{3\ (Base)}$	-1.958	3.20E-01
Adj. R^2	0.644	
Std. Error [psi]	2819	
$k^*_{1\ (Subgrade)}$	1393.1	2.79E-07
$k^*_{2\ (Subgrade)}$	0.081	7.31E-02
$k^*_{3\ (Subgrade)}$	-0.185	5.97E-01
Adj. R^2	0.963	
Std. Error [psi]	163	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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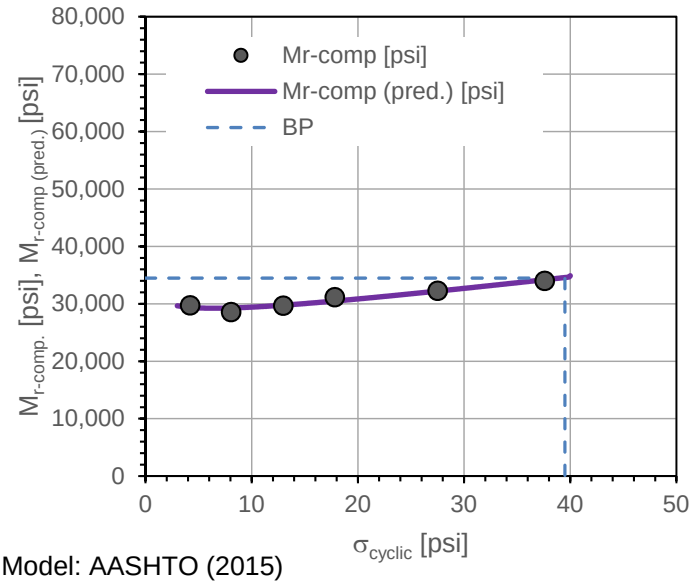
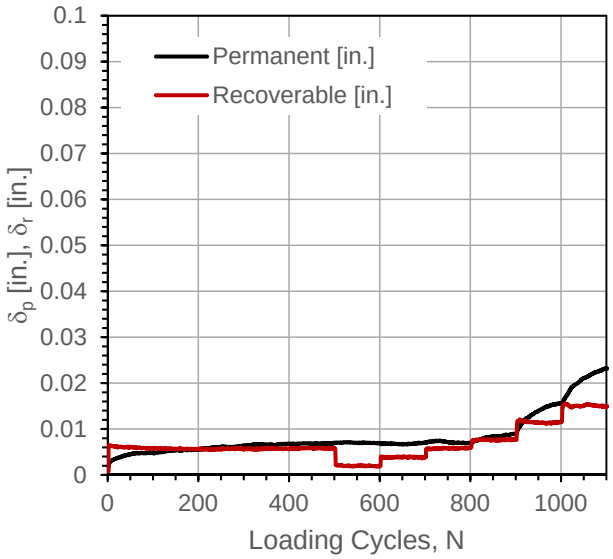
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	12:09:32 PM	Test ID	**I5_NCC_TX5_0.85_pt13**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.046993	Longitude,W:	117.286770	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface. Measured base layer thickness = 9.75 in.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.97	---	---	0.0069	---	0.204	---
1	100	4.20	29,714	29,378	0.0069	0.0000	-0.051	Y
2	100	8.06	28,566	29,279	0.0071	0.0001	-0.018	Y
3	100	12.97	29,668	29,763	0.0070	0.0000	-0.212	Y
4	100	17.84	31,143	30,486	0.0090	0.0020	0.601	Y
5	100	27.52	32,265	32,217	0.0155	0.0086	0.726	N
6	100	37.60	33,979	34,196	0.0232	0.0163	0.836	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,863.5	6.55E-08
k^*_2	-0.064	2.25E-01
k^*_3	0.998	4.83E-02
Adj. R^2	0.930	
Std. Error [psi]	516	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		34,479
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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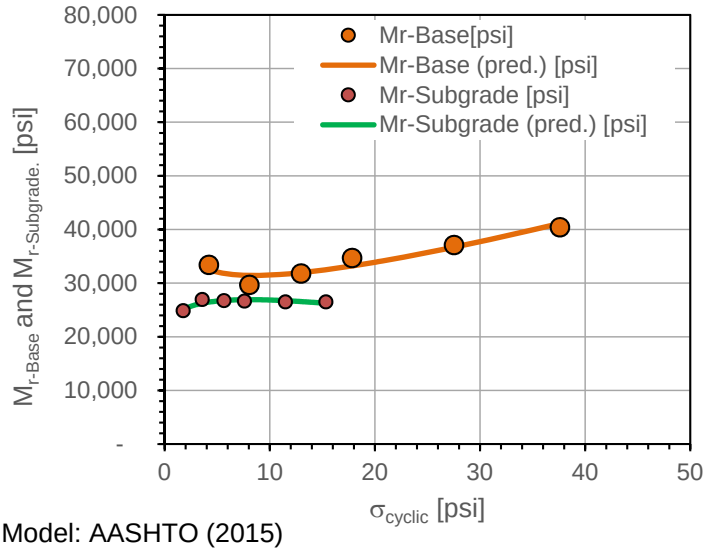
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	12:09:32 PM	Test ID	I5_NCC_TX5_0.85_pt13
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.046993	Longitude, W:	117.286770	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface. Measured base layer thickness = 9.75 in.				

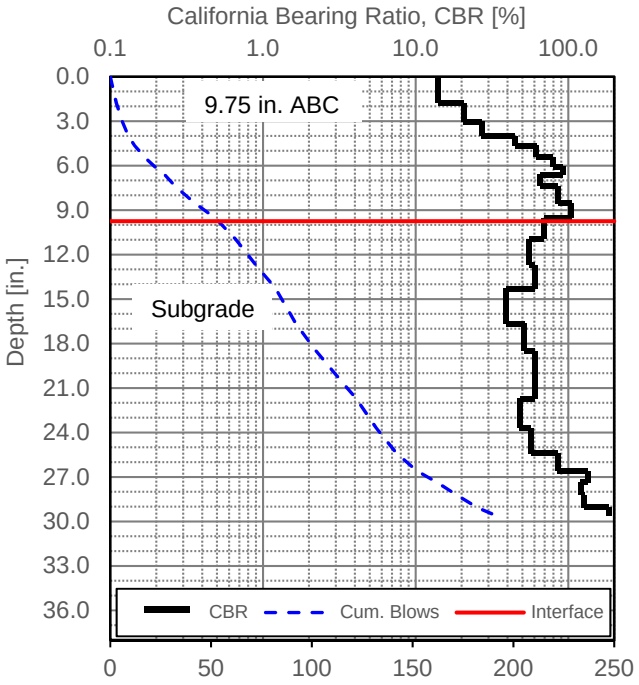
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.97	---	---	---	---	---	---
1	100	4.20	33,385	32,492	1.78	24,839	25,124	1.34
2	100	8.06	29,657	31,443	3.59	26,916	26,245	1.10
3	100	12.97	31,797	31,954	5.66	26,704	26,769	1.19
4	100	17.84	34,689	33,205	7.60	26,620	26,917	1.30
5	100	27.52	37,087	36,701	11.50	26,487	26,730	1.40
6	100	37.60	40,413	41,143	15.34	26,471	26,239	1.53

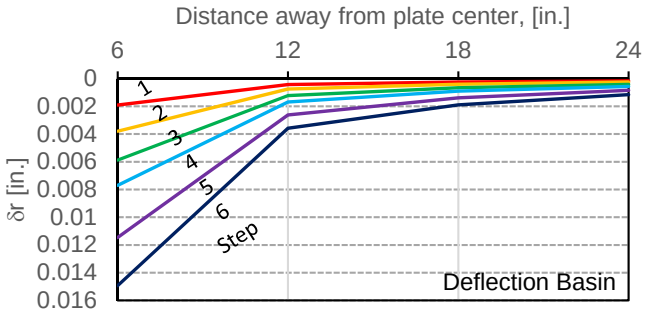


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	1875.4	7.85E-07
$k^*_{2\ (Base)}$	-0.176	1.67E-01
$k^*_{3\ (Base)}$	2.117	5.81E-02
Adj. R^2	0.884	
Std. Error [psi]	1280	
$k^*_{1\ (Subgrade)}$	2057.6	1.18E-06
$k^*_{2\ (Subgrade)}$	0.139	7.59E-02
$k^*_{3\ (Subgrade)}$	-1.198	1.10E-01
Adj. R^2	0.675	
Std. Error [psi]	375	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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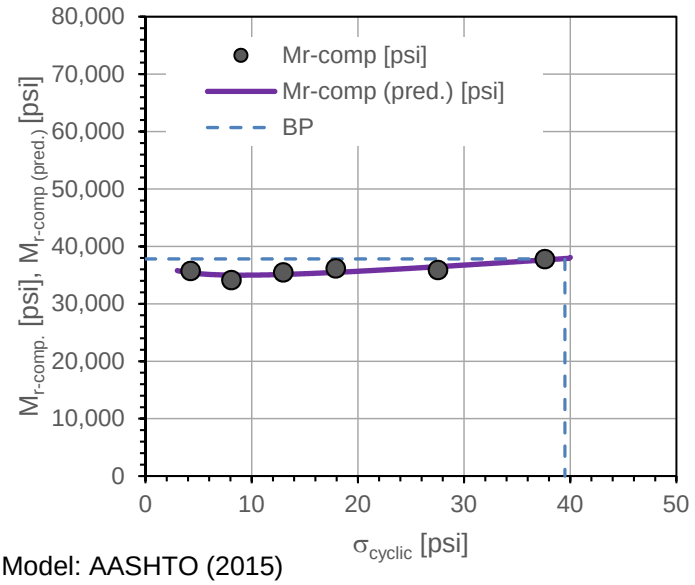
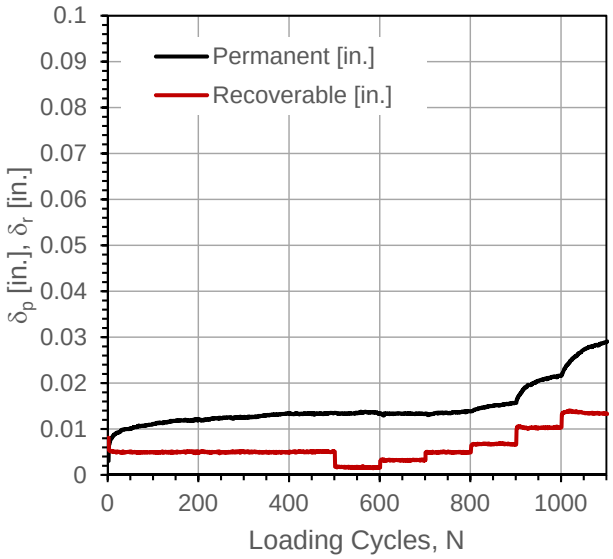
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	12:38:00 PM	Test ID	**I5_NCC_TX5_0.85_pt14**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047016	Longitude,W:	117.286790	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.97	---	---	0.0135	---	0.134	---
1	100	4.25	35,712	35,393	0.0133	-0.0002	0.230	Y
2	100	8.09	34,122	35,002	0.0133	-0.0002	0.058	Y
3	100	12.97	35,458	35,115	0.0139	0.0003	0.328	Y
4	100	17.93	36,163	35,480	0.0157	0.0022	0.631	Y
5	100	27.55	35,891	36,466	0.0217	0.0081	0.594	N
6	100	37.61	37,785	37,650	0.0290	0.0155	0.719	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,294.3	7.62E-08
k^*_2	-0.054	3.29E-01
k^*_3	0.610	1.67E-01
Adj. R^2	0.677	
Std. Error [psi]	581	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		37,818
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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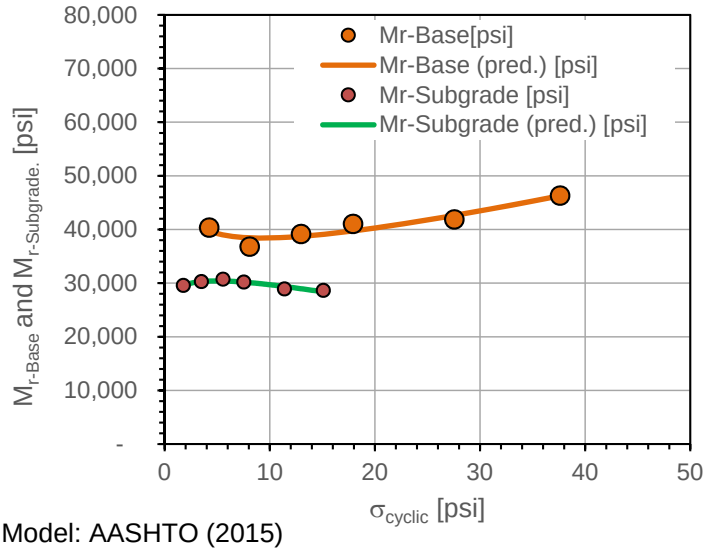
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	12:38:00 PM	Test ID	I5_NCC_TX5_0.85_pt14
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.047016	Longitude, W:	117.286790	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

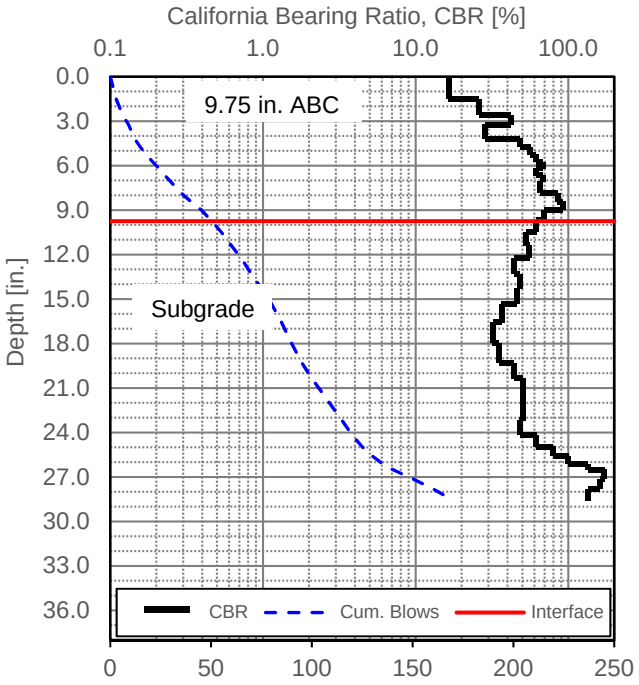
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.97	---	---	---	---	---	---
1	100	4.25	40,340	39,671	1.79	29,541	29,604	1.37
2	100	8.09	36,810	38,450	3.51	30,254	30,286	1.22
3	100	12.97	39,154	38,715	5.56	30,727	30,400	1.27
4	100	17.93	41,042	39,732	7.55	30,171	30,185	1.36
5	100	27.55	41,871	42,619	11.41	28,899	29,366	1.45
6	100	37.61	46,321	46,282	15.10	28,631	28,375	1.62

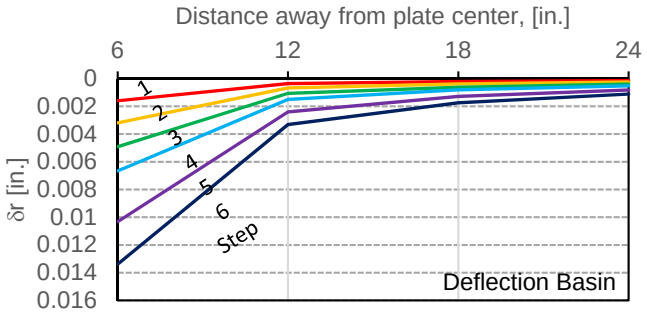


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2375.7	3.02E-07
$k^*_{2\ (Base)}$	-0.144	1.45E-01
$k^*_{3\ (Base)}$	1.593	5.85E-02
Adj. R^2	0.861	
Std. Error [psi]	1125	
$k^*_{1\ (Subgrade)}$	2375.1	3.46E-07
$k^*_{2\ (Subgrade)}$	0.111	5.06E-02
$k^*_{3\ (Subgrade)}$	-1.407	2.99E-02
Adj. R^2	0.854	
Std. Error [psi]	293	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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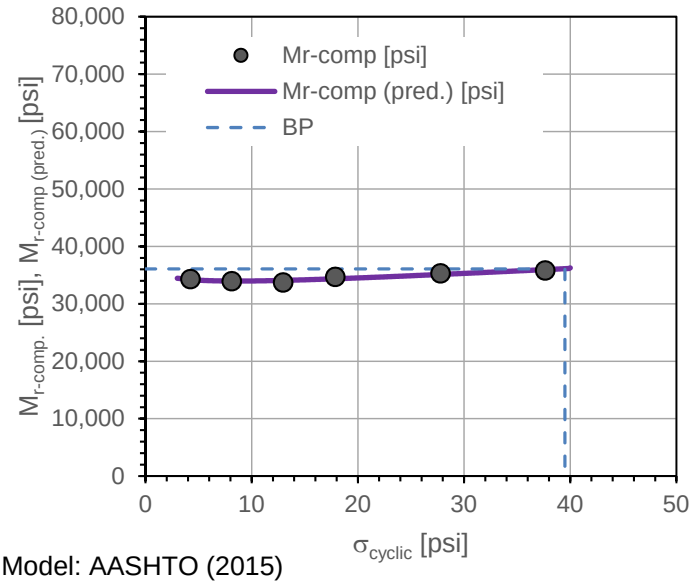
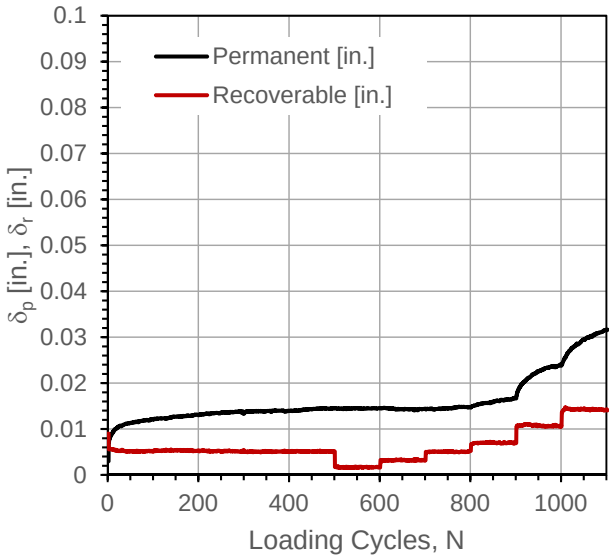
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	1:07:23 PM	Test ID	**I5_NCC_TX5_0.85_pt15**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047031	Longitude,W:	117.286790	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.96	---	---	0.0145	---	0.124	---
1	100	4.24	34,292	34,209	0.0146	0.0000	0.017	Y
2	100	8.12	33,923	33,970	0.0144	-0.0001	-0.207	Y
3	100	12.96	33,713	34,082	0.0147	0.0002	0.372	Y
4	100	17.87	34,678	34,361	0.0167	0.0022	0.573	Y
5	100	27.79	35,300	35,116	0.0238	0.0092	0.583	N
6	100	37.64	35,795	35,958	0.0316	0.0171	0.722	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,247.3	5.72E-09
k^*_2	-0.038	1.48E-01
k^*_3	0.450	4.98E-02
Adj. R^2	0.883	
Std. Error [psi]	265	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		36,077
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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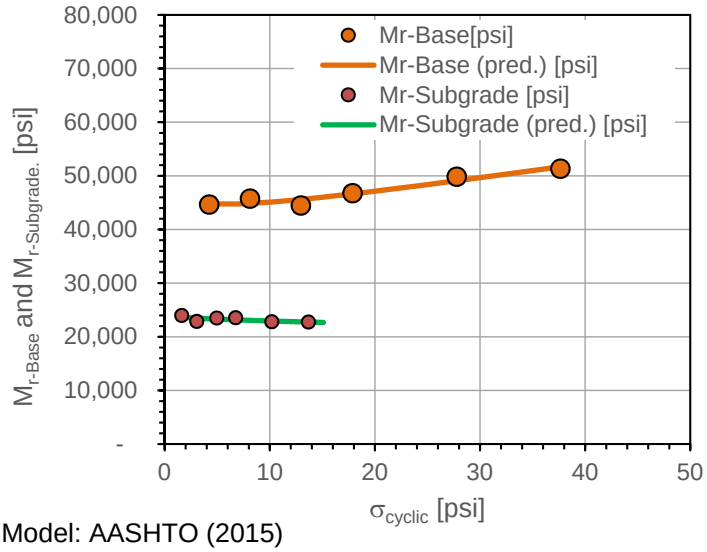
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	1:07:23 PM	Test ID	I5_NCC_TX5_0.85_pt15
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude, N:	33.047031	Longitude, W:	117.286790	Elev. (ft):	NA
Comments:	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geoid at the base and subgrade interface.				

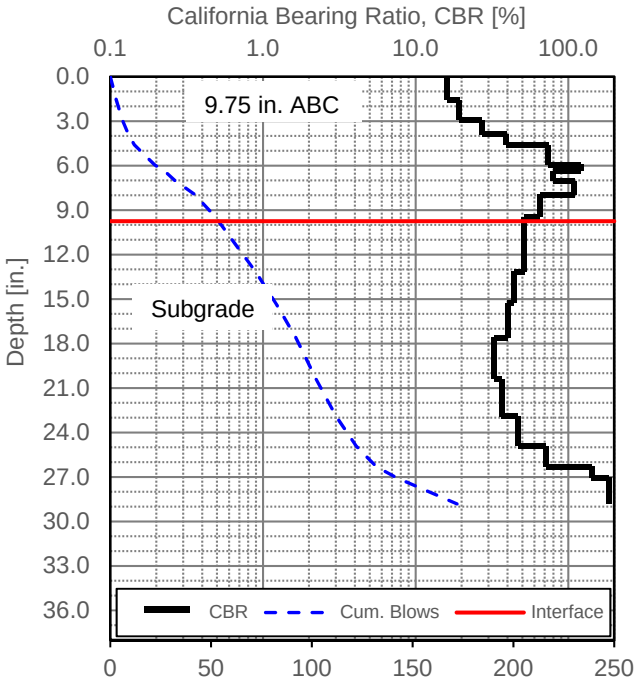
Step	N	$\sigma_{cyclic_surface}$ [psi]	$M_{r\text{-}Base}$[psi]	$M_{r\text{-}Base\ (pred.)}$ [psi]	$\sigma_{cyclic_Int.}$ [psi]	$M_{r\text{-}Subgrade}$ [psi]	$M_{r\text{-}Subgrade\ (pred.)}$ [psi]	Modulus Ratio
Conditioning	500	12.96	---	---	---	---	---	---
1	100	4.24	44,651	44,835	1.63	23,940	23,658	1.87
2	100	8.12	45,745	44,863	3.07	22,837	23,476	2.00
3	100	12.96	44,450	45,602	4.97	23,472	23,295	1.89
4	100	17.87	46,755	46,642	6.76	23,523	23,157	1.99
5	100	27.79	49,831	49,083	10.21	22,783	22,935	2.19
6	100	37.64	51,316	51,693	13.70	22,725	22,745	2.26

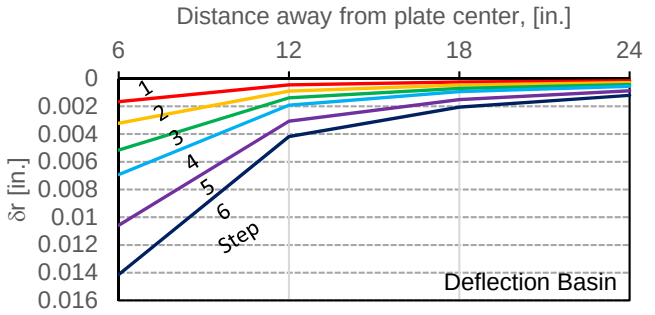


Model: AASHTO (2015)

$$M_r = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
$k^*_{1\ (Base)}$	2877.7	6.15E-08
$k^*_{2\ (Base)}$	-0.051	3.37E-01
$k^*_{3\ (Base)}$	0.860	7.55E-02
Adj. R^2	0.911	
Std. Error [psi]	817	
$k^*_{1\ (Subgrade)}$	1596.5	2.37E-06
$k^*_{2\ (Subgrade)}$	-0.011	8.60E-01
$k^*_{3\ (Subgrade)}$	-0.119	8.69E-01
Adj. R^2	0.327	
Std. Error [psi]	278	





In-situ Resilient Modulus [Mr]: Cyclic Loading, Layered Analysis, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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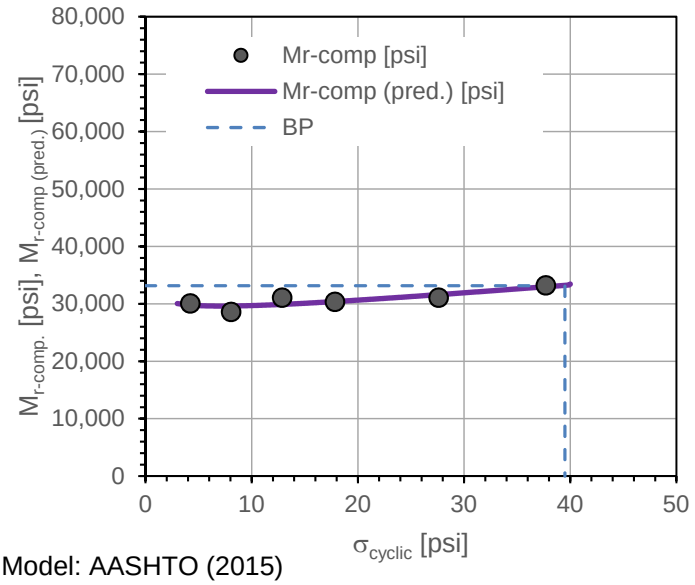
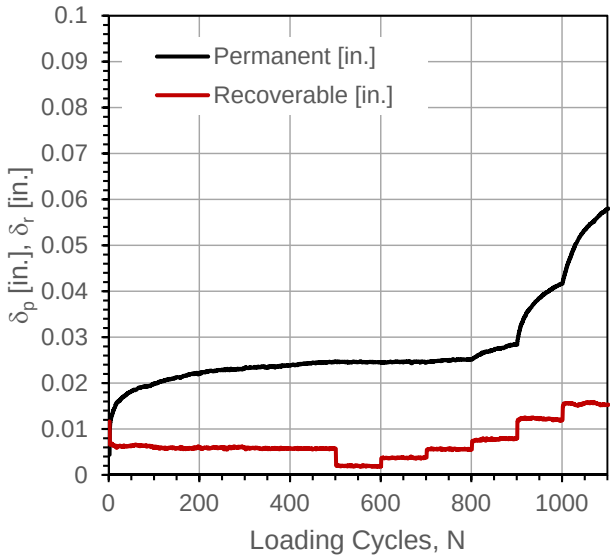
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	1:38:12 PM	Test ID	I5_NCC_CTRL_2.25_pt16
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047310	Longitude,W:	117.286880	Elev. (ft):	NA
Comments:	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.87	---	---	0.0246	---	0.152	---
1	100	4.22	30,063	29,782	0.0246	-0.0001	-0.089	Y
2	100	8.06	28,580	29,617	0.0244	-0.0002	0.107	Y
3	100	12.87	31,071	29,900	0.0251	0.0004	0.432	Y
4	100	17.85	30,334	30,396	0.0284	0.0038	0.719	N
5	100	27.61	31,069	31,602	0.0416	0.0170	0.653	N
6	100	37.71	33,202	32,975	0.0579	0.0332	0.807	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,920.7	2.61E-07
k^*_2	-0.052	4.97E-01
k^*_3	0.735	2.33E-01
Adj. R^2	0.690	
Std. Error [psi]	735	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		33,154
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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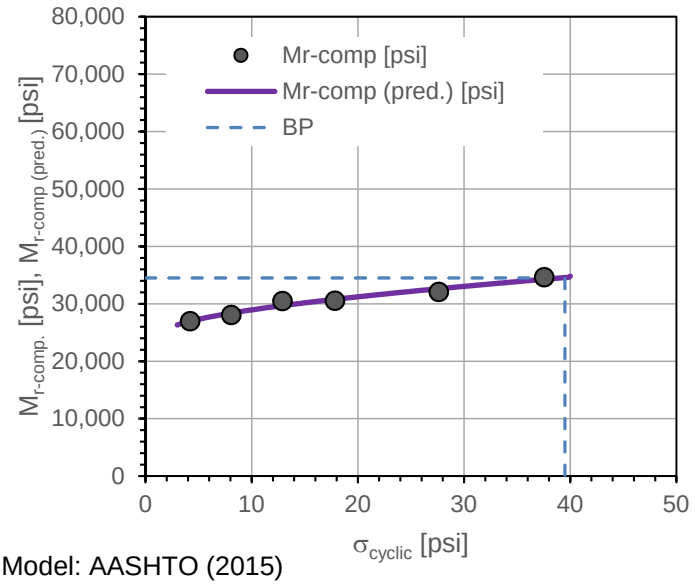
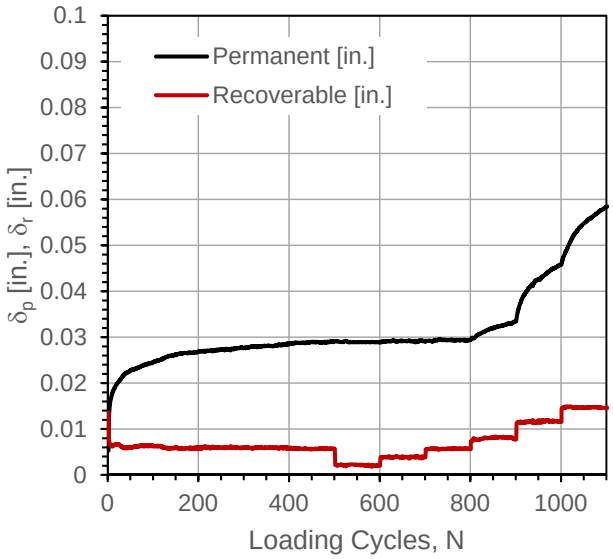
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	2:07:30 PM	Test ID	I5_NCC_CTRL_2.25_pt17
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047333	Longitude,W:	117.286880	Elev. (ft):	NA
Comments:	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.90	---	---	0.0291	---	0.138	---
1	100	4.21	26,972	26,958	0.0289	-0.0002	-0.249	Y
2	100	8.08	28,054	28,392	0.0292	0.0001	0.170	Y
3	100	12.90	30,491	29,687	0.0294	0.0003	0.196	Y
4	100	17.84	30,541	30,784	0.0334	0.0043	0.680	N
5	100	27.63	32,069	32,634	0.0457	0.0166	0.653	N
6	100	37.55	34,618	34,269	0.0584	0.0293	0.724	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,842.0	7.29E-08
k^*_2	0.055	2.98E-01
k^*_3	0.406	2.94E-01
Adj. R^2	0.958	
Std. Error [psi]	551	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	34,494
$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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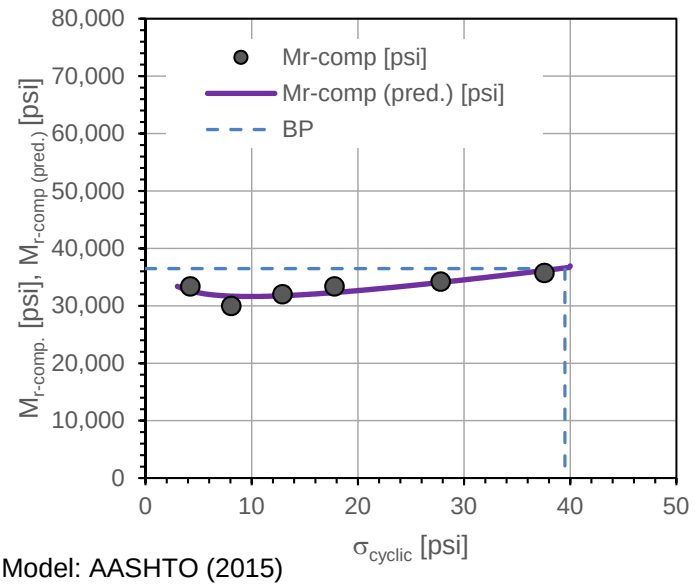
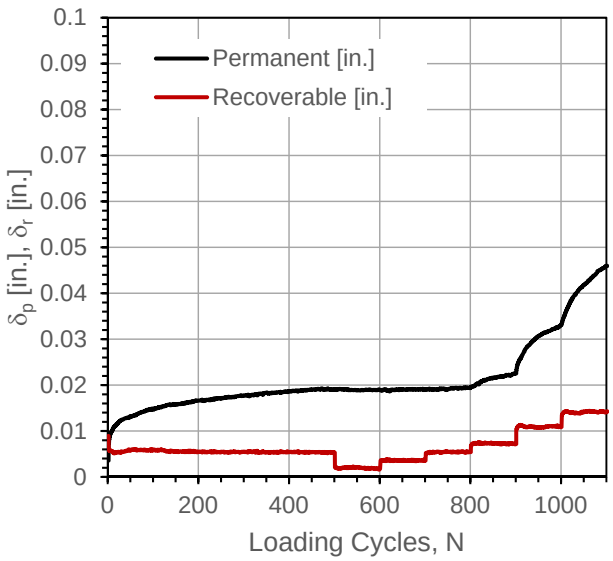
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	2:38:59 PM	Test ID	**I5_NCC_CTRL_2.25_pt18**
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047352	Longitude,W:	117.286880	Elev. (ft):	NA
Comments:	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.90	---	---	0.0190	---	0.172	---
1	100	4.22	33,364	32,587	0.0190	0.0000	-0.241	Y
2	100	8.08	29,981	31,686	0.0191	0.0001	0.162	Y
3	100	12.90	32,009	31,757	0.0195	0.0005	0.282	Y
4	100	17.80	33,365	32,318	0.0225	0.0035	0.668	N
5	100	27.81	34,222	34,078	0.0331	0.0141	0.614	N
6	100	37.57	35,718	36,158	0.0460	0.0270	0.781	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,005.9	4.91E-07
k^*_2	-0.116	2.63E-01
k^*_3	1.216	1.42E-01
Adj. R^2	0.682	
Std. Error [psi]	976	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	36,481
$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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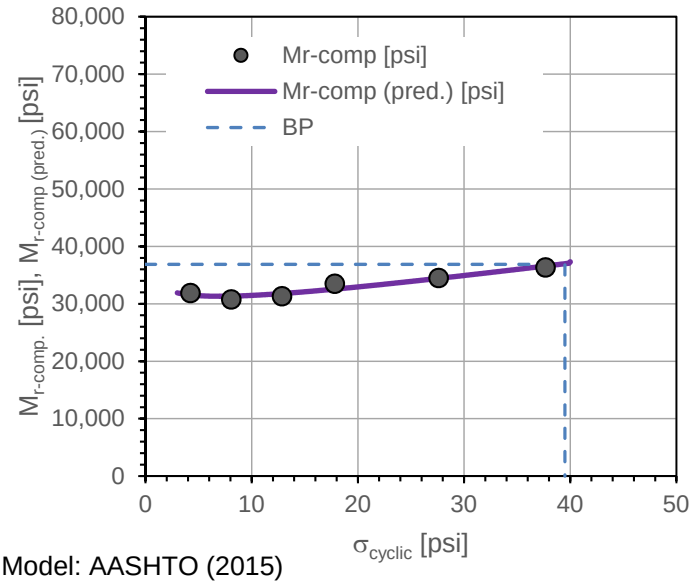
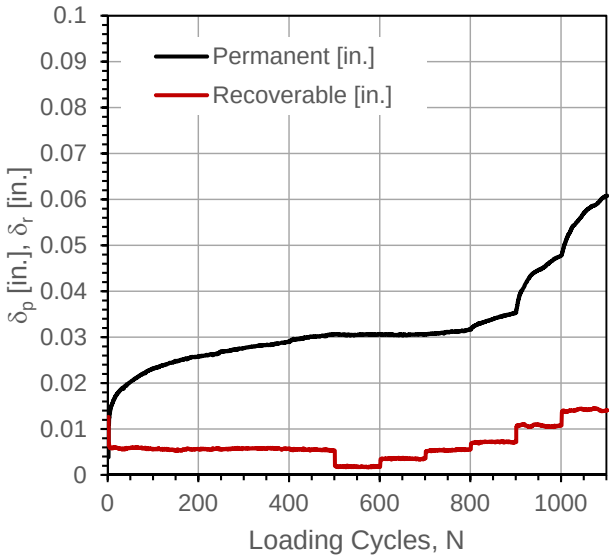
Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	3:13:26 PM	Test ID	I5_NCC_CTRL_2.25_pt19
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047379	Longitude,W:	117.286890	Elev. (ft):	NA
Comments:	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.86	---	---	0.0306	---	0.185	---
1	100	4.24	31,871	31,543	0.0306	0.0000	-0.017	Y
2	100	8.09	30,770	31,340	0.0306	0.0000	-0.016	Y
3	100	12.86	31,319	31,790	0.0317	0.0011	0.514	Y
4	100	17.84	33,495	32,561	0.0353	0.0048	0.611	N
5	100	27.61	34,497	34,434	0.0478	0.0172	0.641	N
6	100	37.67	36,321	36,581	0.0607	0.0302	0.776	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,991.5	8.55E-08
k^*_2	-0.072	2.24E-01
k^*_3	1.039	5.63E-02
Adj. R^2	0.912	
Std. Error [psi]	615	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		36,875
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

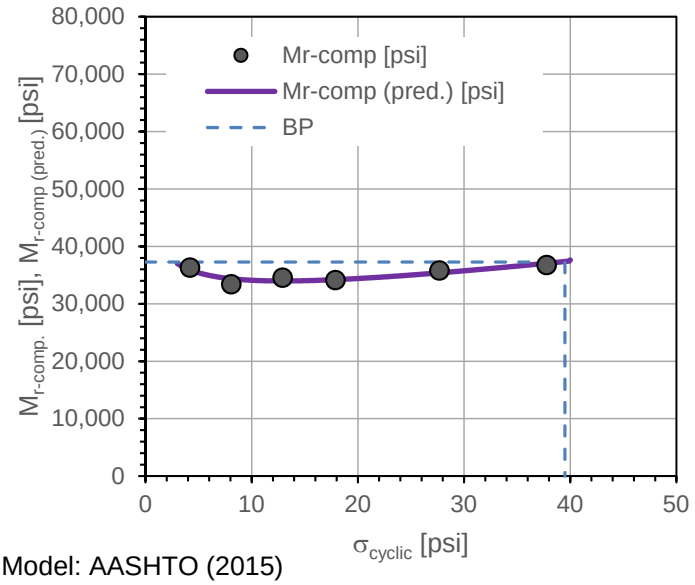
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

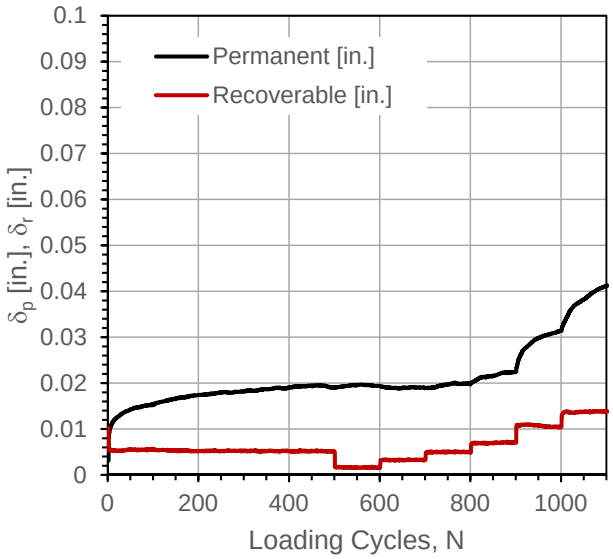
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/1/2019	Time:	3:44:23 PM	Test ID	I5_NCC_CTRL_2.25_pt20
Tested By	PV, LC, HG	Location:	I-5_NCC Test Sections	Sta.	NA
Latitude,N:	33.047455	Longitude,W:	117.286910	Elev. (ft):	NA
Comments:	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	d =Δlog(δ_p)/ Δlog(N)	Near-linear Elastic
Conditioning	500	12.91	---	---	0.0190	---	0.154	---
1	100	4.20	36,293	35,904	0.0193	0.0003	0.376	Y
2	100	8.08	33,414	34,366	0.0189	-0.0001	-0.139	Y
3	100	12.91	34,550	33,982	0.0197	0.0007	0.714	Y
4	100	17.88	34,130	34,211	0.0225	0.0035	0.626	Y
5	100	27.68	35,804	35,394	0.0314	0.0124	0.569	N
6	100	37.78	36,747	37,058	0.0411	0.0221	0.685	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,207.9	7.11E-08
k^*_2	-0.131	6.02E-02
k^*_3	1.085	4.42E-02
Adj. R^2	0.763	
Std. Error [psi]	582	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		37,275
	$\sigma_{cyclic\text{-}BP}$ [psi]	39.5

No Picture

In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_TX5_pt1	Operator	HG, LC	ASTM	D6951
Latitude, N	33.04591		Longitude, W	117.286450		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.35 ft (measured = 4.0 in.) thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-4.0 in.]	5.6	42.8	28.2	6,617
Avg. Bottom Layer [4.0-24 in.]	Refusal	Refusal	Refusal	Refusal
Ratio of Avg.0-4.0 in./4.3-24 in.	NA	NA	NA	NA
Stdev Top Layer [0-4.0 in.]	0.9	9.0	10.4	2,355
Stdev. Bottom Layer [4.0-24 in.]	Refusal	Refusal	Refusal	Refusal

NOTES:

Subgrade is assumed as silty sand.

[1]$CBR = 292/DPI^{1.12}$

[1]$CBR = 1/(0.002871*DPI)$

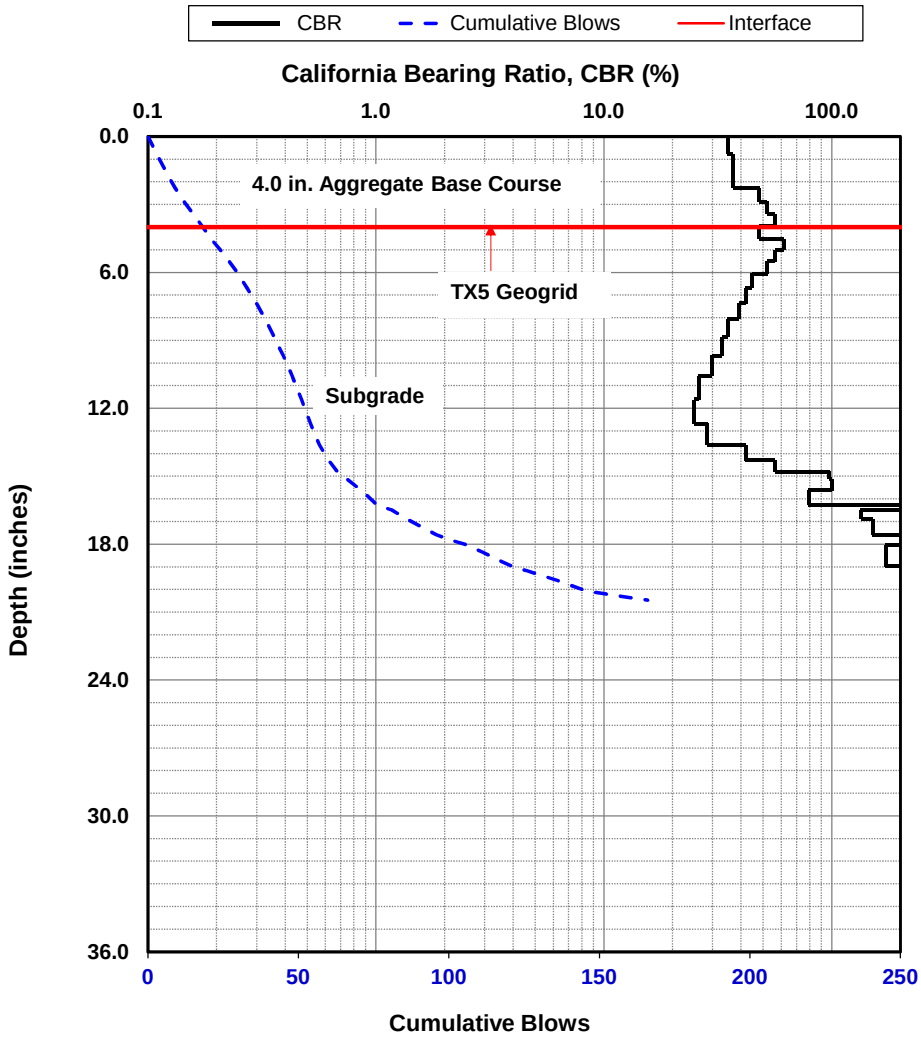
[2]$E\ (ksi) = (17.6\ CBR^{0.64}) \times 0.1450377$

[3]$S_u\ (psf) = (3.794 \times CBR^{0.664}) \times 144$

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_TX5_pt2	Operator	HG, LC	ASTM	D6951
Latitude, N	33.04592		Longitude, W	117.286450		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.35 ft (measured = 4.2 in.) thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-4.2 in.]	7.4	31.0	23.0	5,346
Avg. Bottom Layer [4.2-24 in.]	Refusal	Refusal	Refusal	Refusal
Ratio of Avg.0-4.2 in./4.2-24 in.	NA	NA	NA	NA
Stdev Top Layer [0-4.2 in.]	2.1	13.4	13.5	3,064
Stdev. Bottom Layer [4.2-24 in.]	Refusal	Refusal	Refusal	Refusal

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

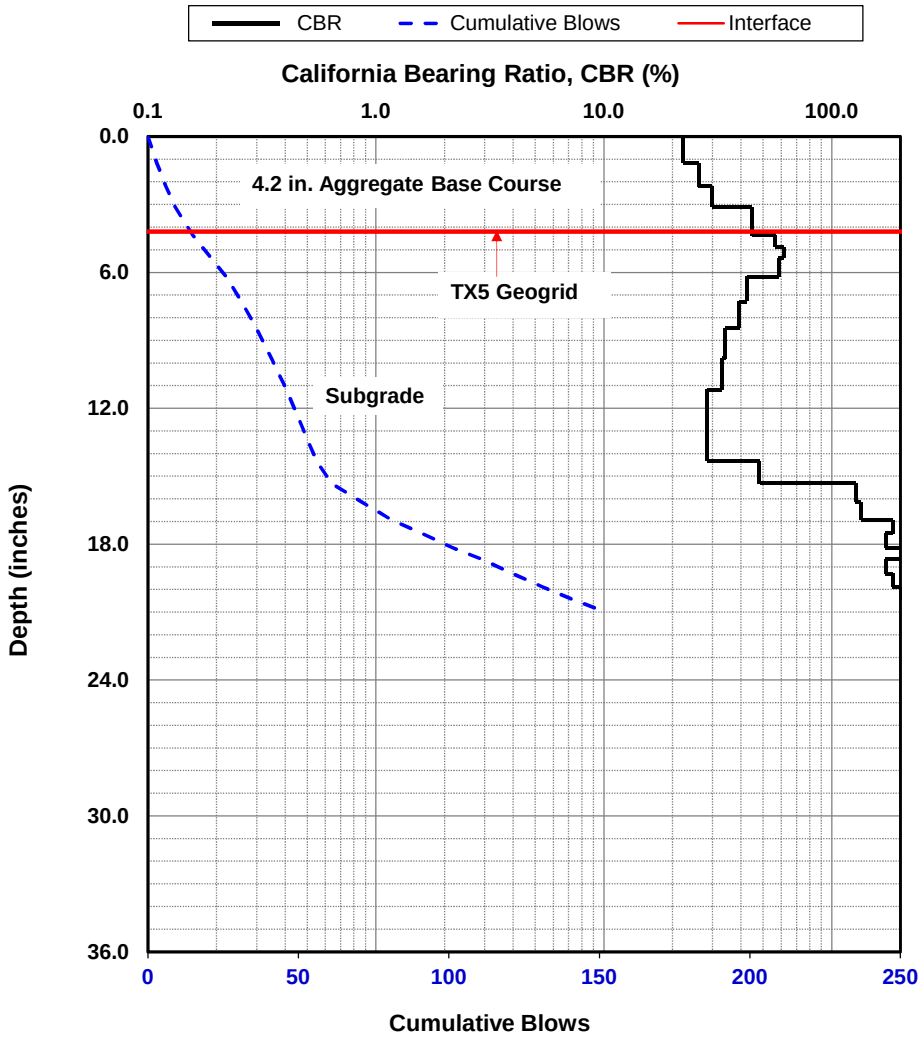
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_TX5_pt3	Operator	HG, LC	ASTM	D6951
Latitude, N	33.04593		Longitude, W	117.286460		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-4.2 in.]	8.8	25.7	20.4	4,720
Avg. Bottom Layer [4.2-24 in.]	Refusal	Refusal	Refusal	Refusal
Ratio of Avg.0-4.2 in./4.2-24 in.	NA	NA	NA	NA
Stdev Top Layer [0-4.2 in.]	1.8	7.5	9.3	2,088
Stdev. Bottom Layer [4.2-24 in.]	Refusal	Refusal	Refusal	Refusal

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

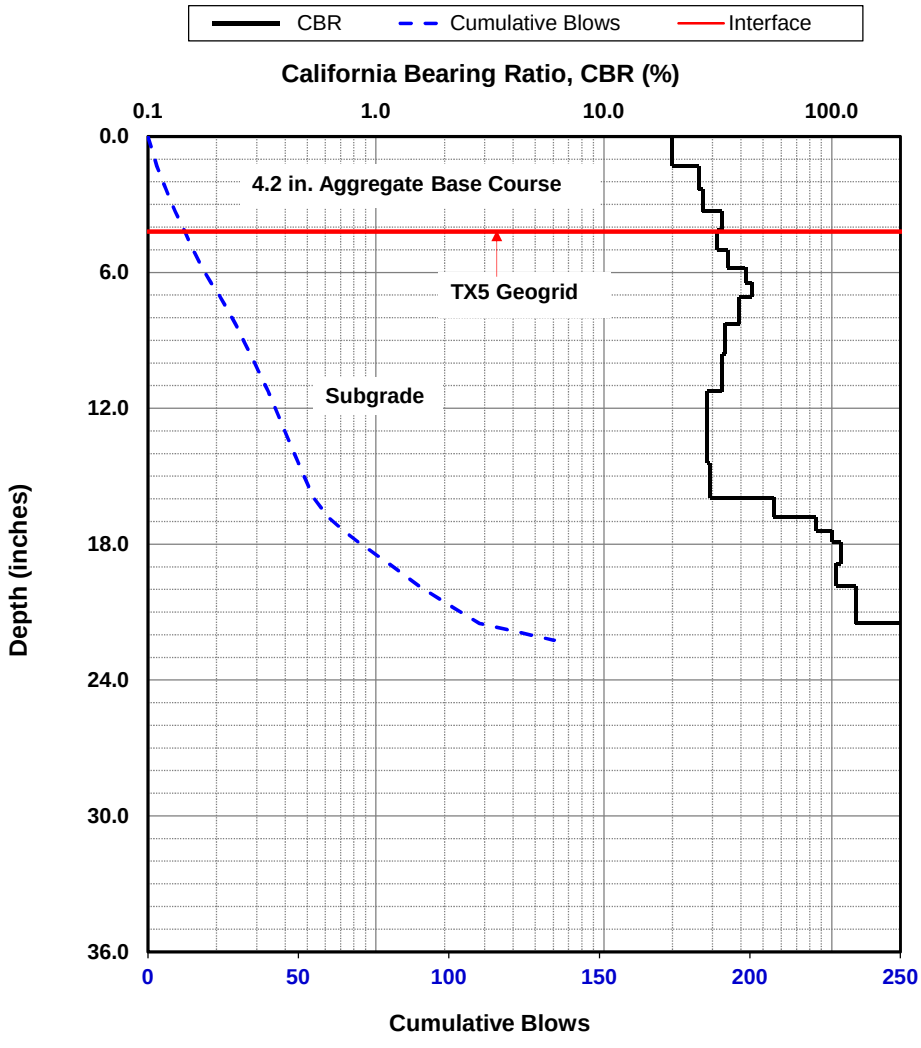
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_TX5_pt4	Operator	HG, LC	ASTM	D6951
Latitude, N	33.04596		Longitude, W	117.286480		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.35 ft (measured = 4.3 in.) thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-4.3 in.]	7.3	31.4	23.2	5,382
Avg. Bottom Layer [4.3-24 in.]	5.5	43.2	28.4	6,661
Ratio of Avg.0-4.3 in./4.3-24 in.	1.3	0.7	0.8	0.8
Stdev Top Layer [0-4.3 in.]	0.8	3.7	5.9	1,314
Stdev. Bottom Layer [4.3-24 in.]	1.4	12.4	12.8	2,903

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

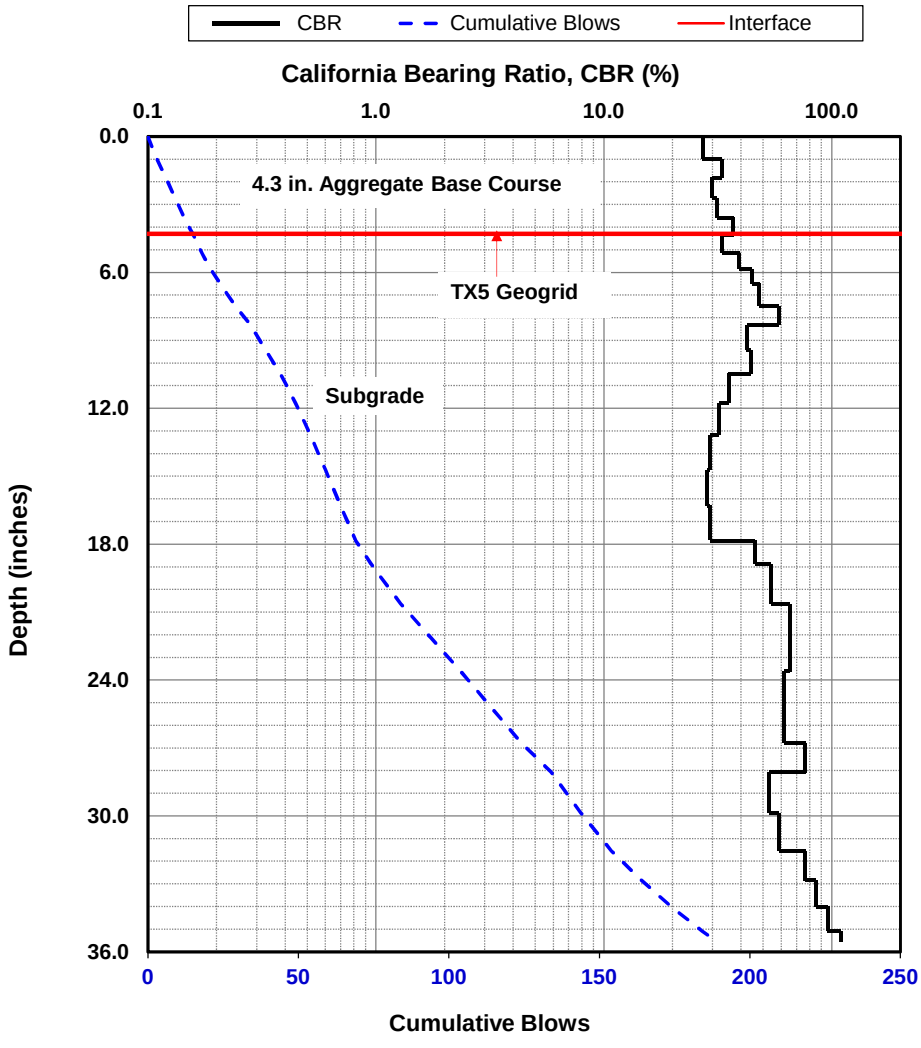
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_TX5_pt5	Operator	HG, LC	ASTM	D6951
Latitude, N	33.04598		Longitude, W	117.286480		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.35 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial georid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-4.2 in.]	7.3	31.7	23.3	5,419
Avg. Bottom Layer [4.2-24 in.]	4.0	61.7	35.7	8,435
Ratio of Avg.0-4.2 in./4.2-24 in.	1.8	0.5	0.7	0.6
Stdev Top Layer [0-4.2 in.]	1.1	5.8	7.8	1,749
Stdev. Bottom Layer [4.2-24 in.]	2.0	52.4	32.2	7,573

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

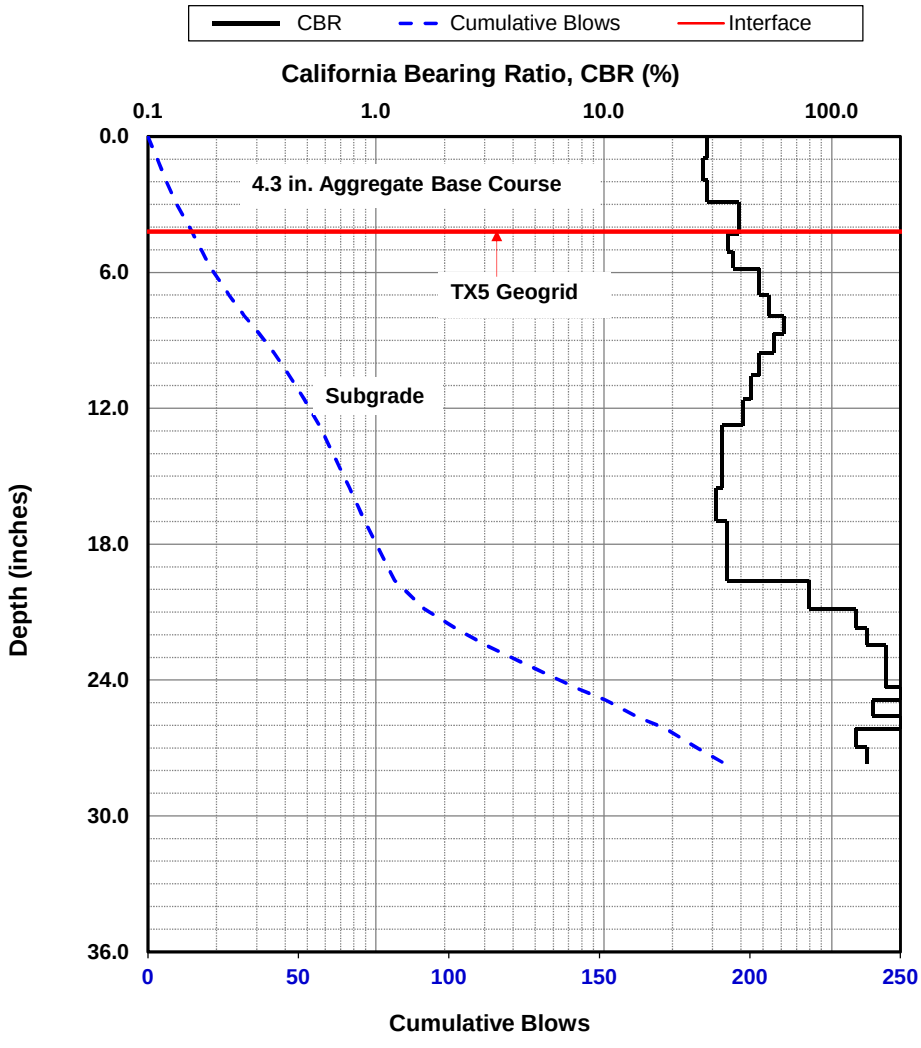
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_pt6	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0461240		Longitude, W	117.286520		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.70 ft (measured = 9.0 in.) thick recycled aggregate base course layer over subgrade (control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.0 in.]	5.0	47.7	30.3	7,111
Avg. Bottom Layer [9.0-24 in.]	6.1	38.4	26.4	6,160
Ratio of Avg.0-9.0 in./9.0-24 in.	0.8	1.2	1.1	1.2
Stdev Top Layer [0-9.0 in.]	2.3	16.3	15.3	3,492
Stdev. Bottom Layer [9.0-24 in.]	1.4	11.6	12.2	2,780

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

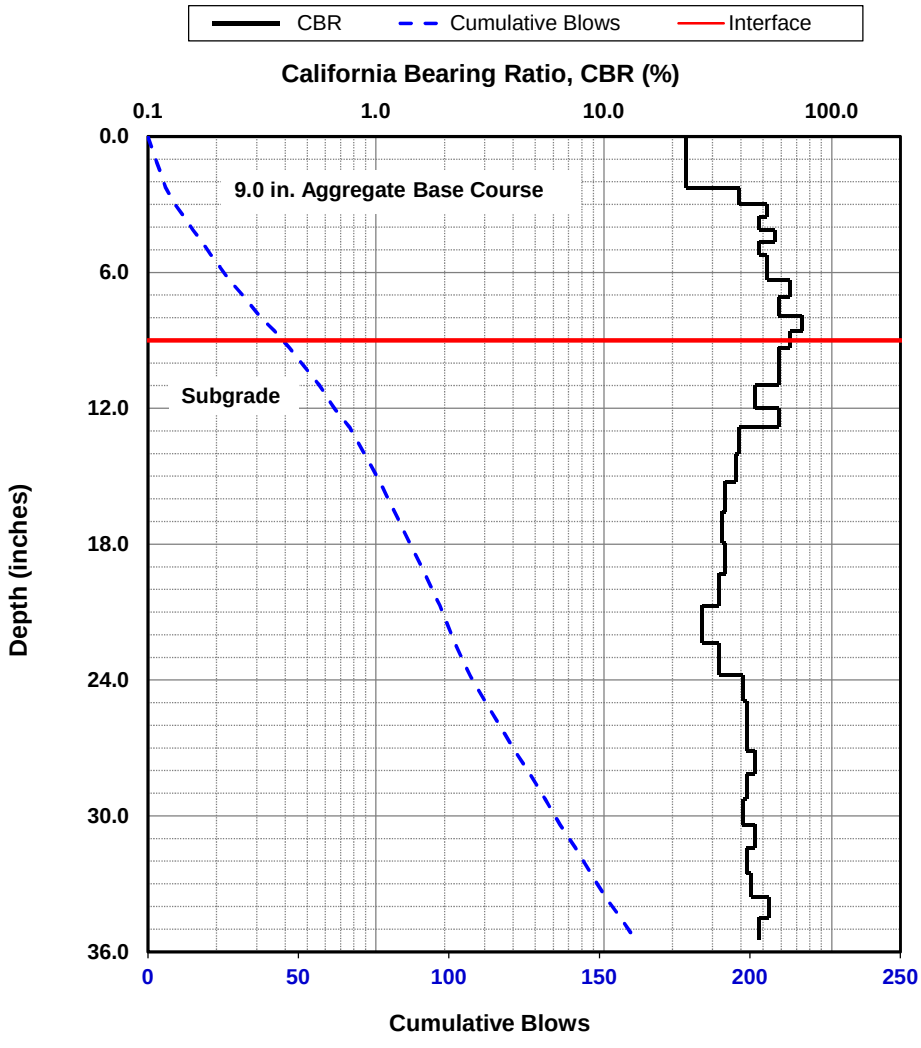
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_pt7	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0461580		Longitude, W	117.286520		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.0 in.]	6.0	39.4	26.8	6,268
Avg. Bottom Layer [9.0-24 in.]	4.6	52.6	32.2	7,590
Ratio of Avg.0-9.0 in./9.0-24 in.	1.3	0.7	0.8	0.8
Stdev Top Layer [0-9.0 in.]	2.0	14.9	14.4	3,288
Stdev. Bottom Layer [9.0-24 in.]	0.8	8.9	10.3	2,328

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

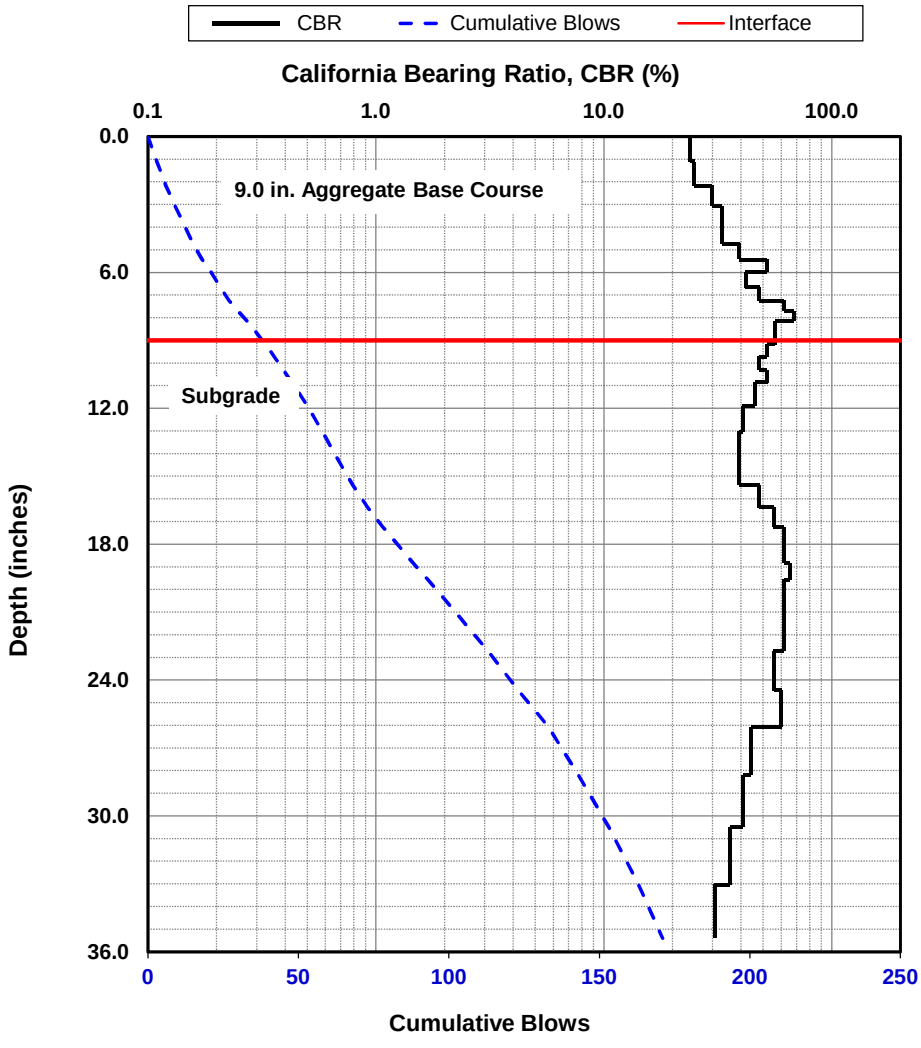
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_pt8	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0461810		Longitude, W	117.286530		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.70 ft (measured = 8.75 in.) thick recycled aggregate base course layer over subgrade (control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-8.75 in.]	5.1	46.7	29.9	7,011
Avg. Bottom Layer [8.75-24 in.]	4.5	54.3	32.9	7,747
Ratio of Avg.0-8.75 in./8.75-24 in.	1.1	0.9	0.9	0.9
Stdev Top Layer [0-8.75 in.]	2.0	14.3	14.0	3,189
Stdev. Bottom Layer [8.75-24 in.]	0.7	8.0	9.7	2,182

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

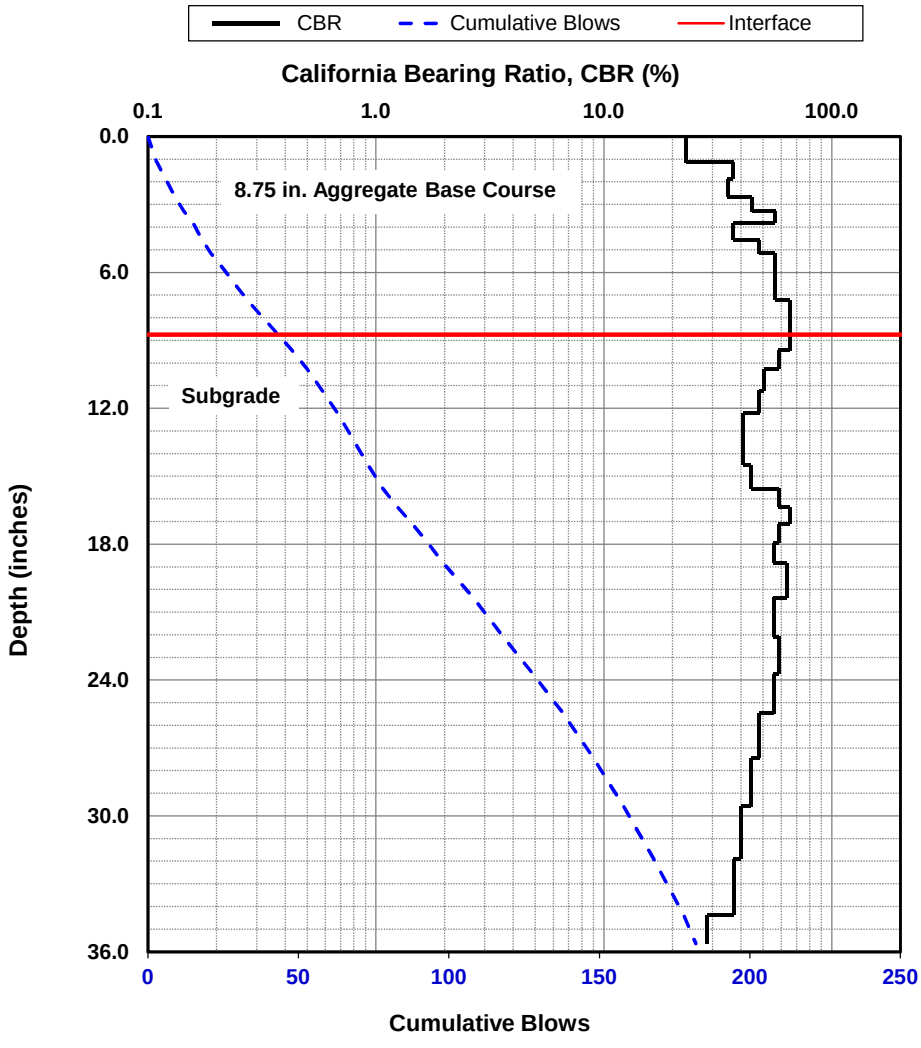
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_pt9	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0462040		Longitude, W	117.286540		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.0 in.]	4.6	52.6	32.2	7,589
Avg. Bottom Layer [9.0-24 in.]	Refusal	Refusal	Refusal	Refusal
Ratio of Avg.0-9.0 in./9.0-24 in.	NA	NA	NA	NA
Stdev Top Layer [0-9.0 in.]	1.7	28.3	21.7	5,034
Stdev. Bottom Layer [9.0-24 in.]	Refusal	Refusal	Refusal	Refusal

NOTES:

Subgrade is assumed as silty sand.

[1]$CBR = 292/DPI^{1.12}$

[1]$CBR = 1/(0.002871*DPI)$

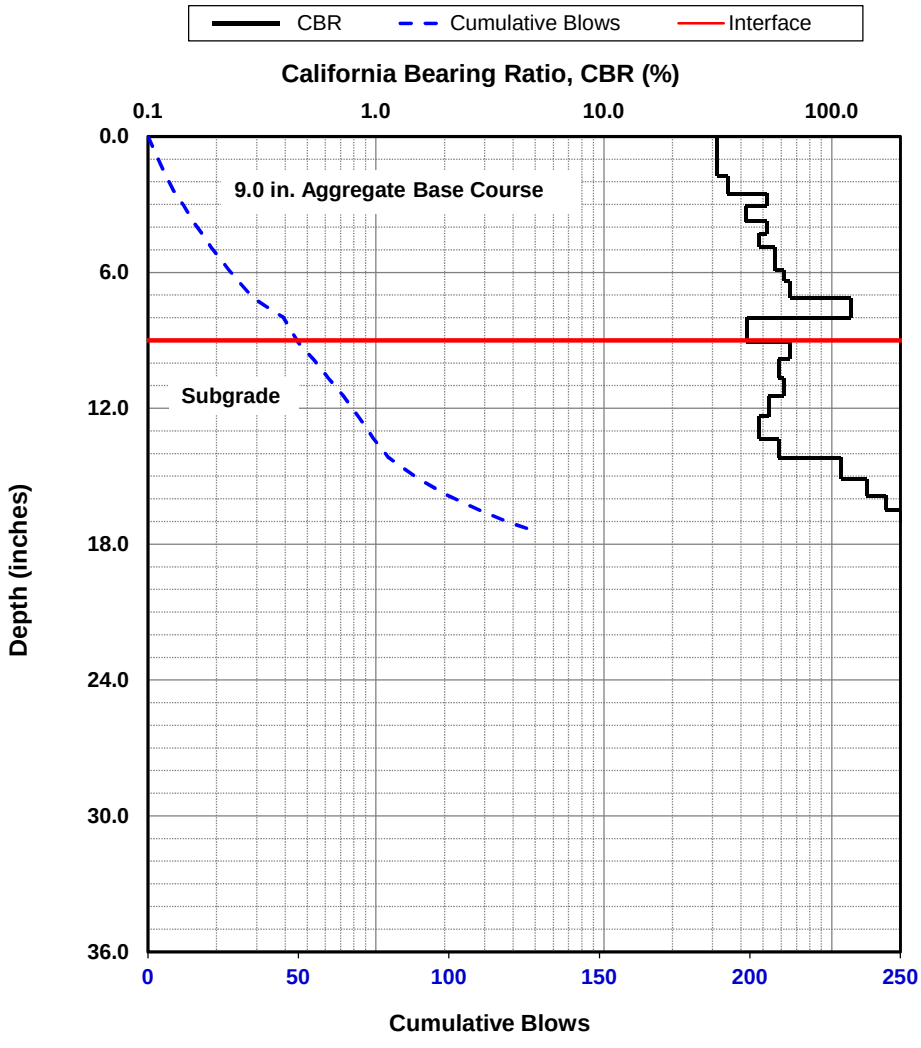
[2]$E\ (ksi) = (17.6\ CBR^{0.64}) \times 0.1450377$

[3]$S_u\ (psf) = (3.794 \times CBR^{0.664}) \times 144$

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_pt10	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0462190		Longitude, W	117.286540		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.70 ft thick recycled aggregate base course layer over subgrade (control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.0 in.]	4.8	50.6	31.5	7,396
Avg. Bottom Layer [9.0-24 in.]	Refusal	Refusal	Refusal	Refusal
Ratio of Avg.0-9.0 in./9.0-24 in.	NA	NA	NA	NA
Stdev Top Layer [0-9.0 in.]	3.0	21.1	18.0	4,137
Stdev. Bottom Layer [9.0-24 in.]	Refusal	Refusal	Refusal	Refusal

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

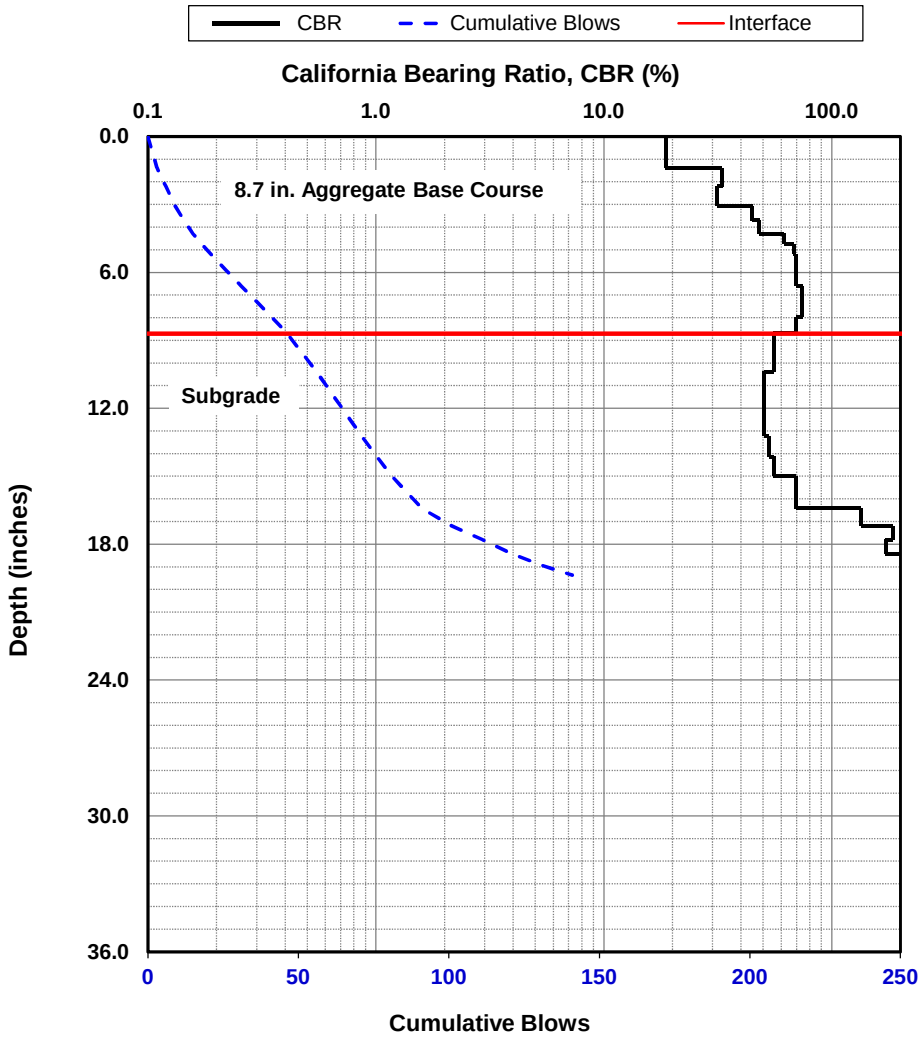
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_TX5_0.85_pt11	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0469590		Longitude, W	117.286770		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.85 ft (measured = 9.75 in.) thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.75 in.]	6.2	37.9	26.1	6,105
Avg. Bottom Layer [9.75-24 in.]	4.6	53.2	32.5	7,647
Ratio of Avg.0-9.75 in./9.75-24 in.	1.4	0.7	0.8	0.8
Stdev Top Layer [0-9.75 in.]	4.5	22.6	18.8	4,334
Stdev. Bottom Layer [9.75-24 in.]	0.6	8.7	10.2	2,291

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

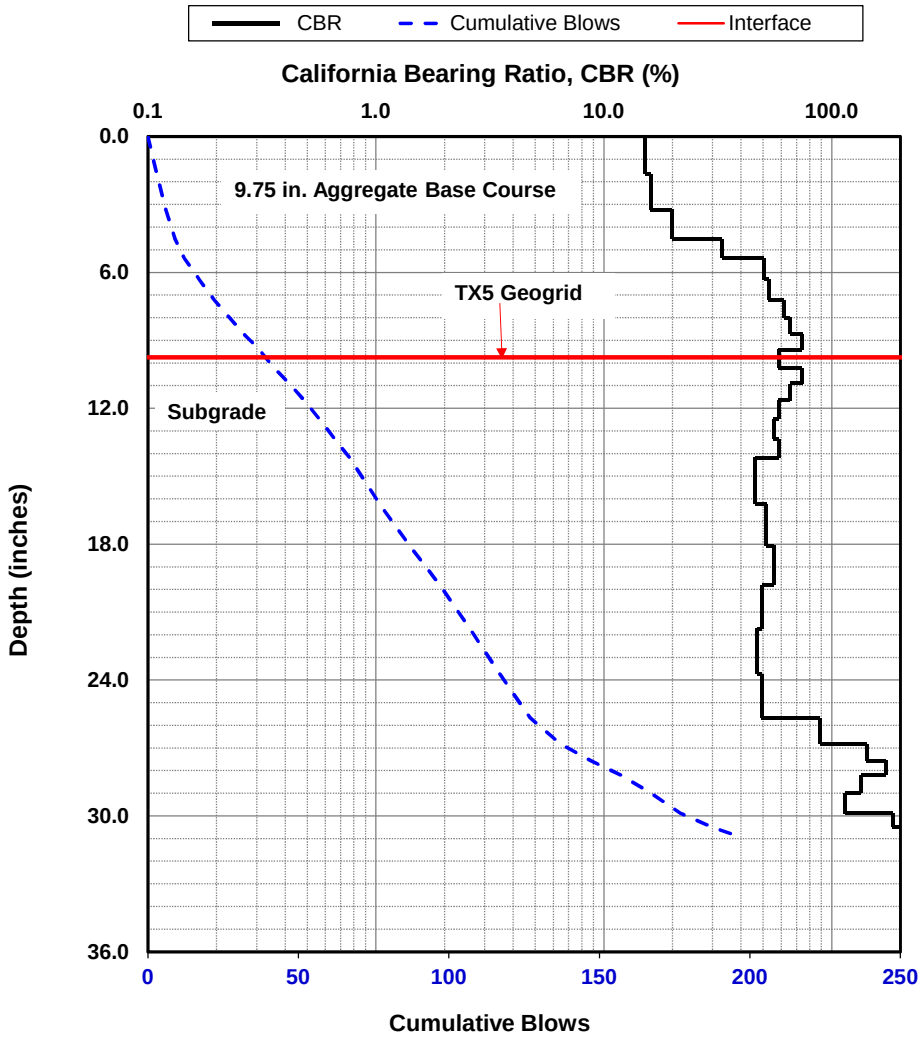
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_TX5_0.85_pt12	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0469780		Longitude, W	117.286780		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.75 in.]	6.3	36.9	25.7	6,002
Avg. Bottom Layer [9.75-24 in.]	4.3	56.3	33.7	7,943
Ratio of Avg.0-9.75 in./9.75-24 in.	1.5	0.7	0.8	0.8
Stdev Top Layer [0-9.75 in.]	5.3	22.0	18.5	4,257
Stdev. Bottom Layer [9.75-24 in.]	0.6	6.9	8.8	1,965

NOTES:

Subgrade is assumed as silty sand.

[1]$CBR = 292/DPI^{1.12}$

[1]$CBR = 1/(0.002871*DPI)$

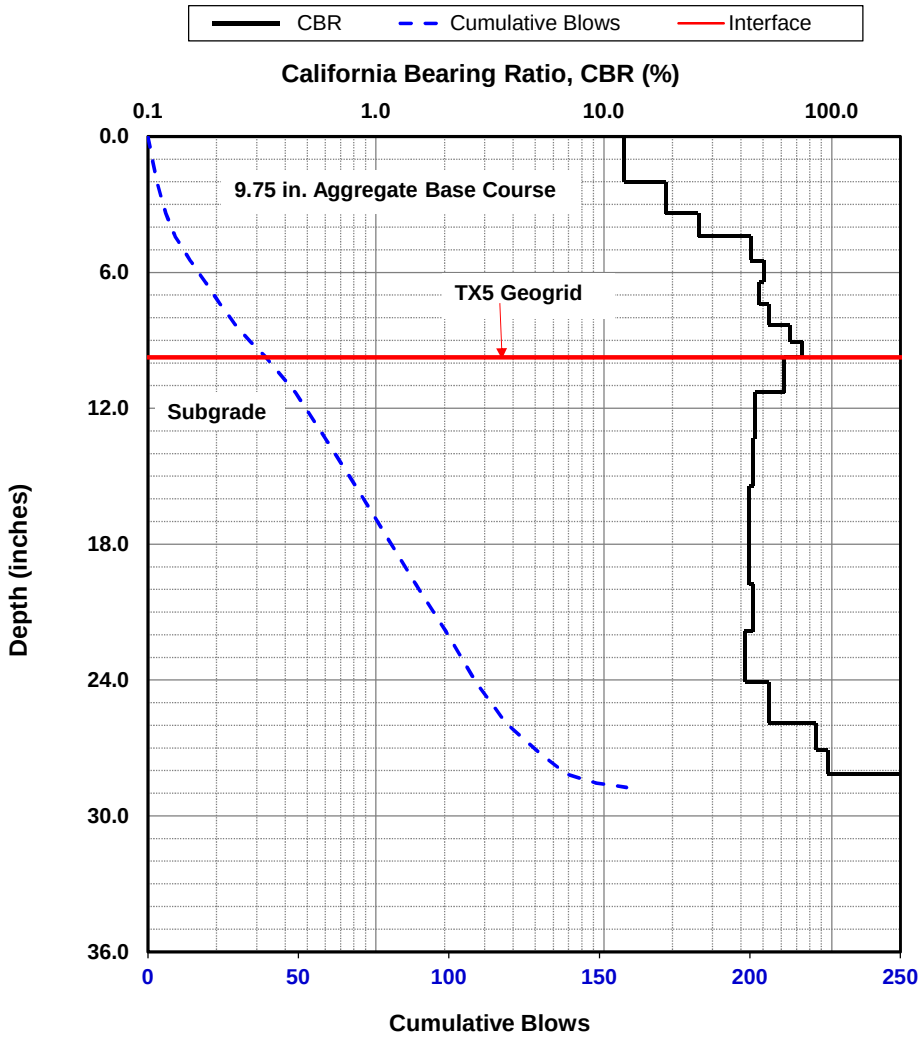
[2]$E\ (ksi) = (17.6\ CBR^{0.64}) \times 0.1450377$

[3]$S_u\ (psf) = (3.794 \times CBR^{0.664}) \times 144$

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_TX5_0.85_pt13	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0469930		Longitude, W	117.286770		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.85 ft (measured = 9.75 in.) thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.75 in.]	4.7	52.2	32.1	7,548
Avg. Bottom Layer [9.75-24 in.]	4.5	54.2	32.9	7,739
Ratio of Avg.0-9.75 in./9.75-24 in.	1.0	1.0	1.0	1.0
Stdev Top Layer [0-9.75 in.]	4.7	32.7	23.8	5,532
Stdev. Bottom Layer [9.75-24 in.]	0.7	9.2	10.6	2,388

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

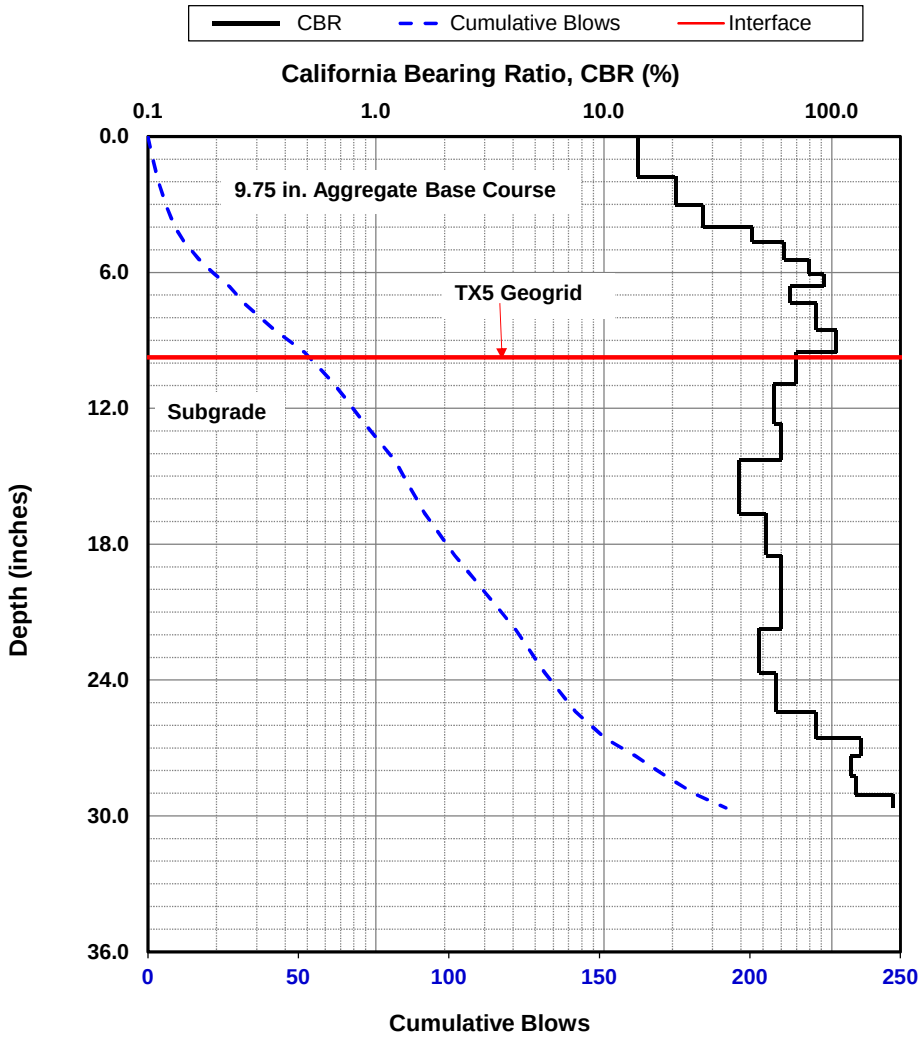
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_TX5_0.85_pt14	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0470160		Longitude, W	117.286790		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.75 in.]	4.9	49.0	30.8	7,242
Avg. Bottom Layer [9.75-24 in.]	5.3	45.5	29.4	6,894
Ratio of Avg.0-9.75 in./9.75-24 in.	0.9	1.1	1.0	1.1
Stdev Top Layer [0-9.75 in.]	3.4	23.6	19.3	4,452
Stdev. Bottom Layer [9.75-24 in.]	0.9	8.1	9.7	2,191

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

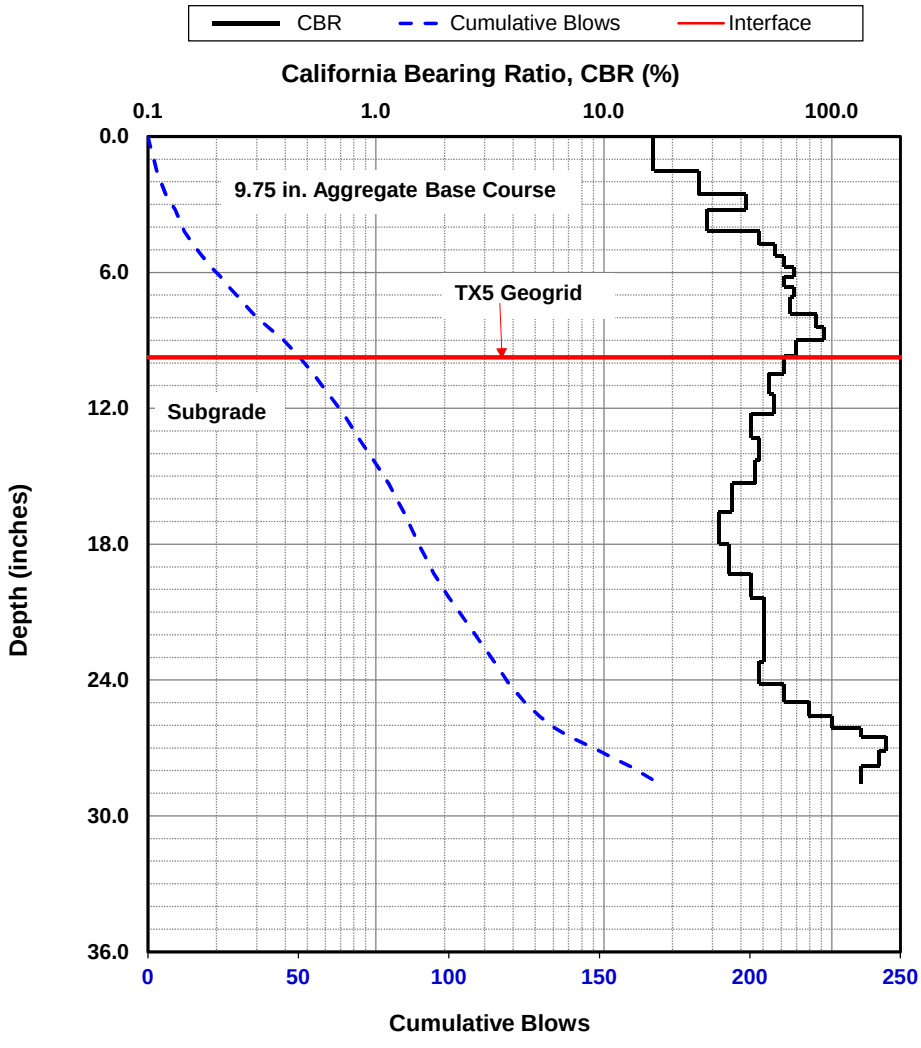
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_TX5_0.85_pt15	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0470310		Longitude, W	117.286790		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 0.85 ft thick recycled aggregate base course layer over subgrade, with TX5 multiaxial geogrid at the base and subgrade interface.						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-9.75 in.]	4.6	52.7	32.3	7,595
Avg. Bottom Layer [9.75-24 in.]	5.6	42.3	28.0	6,565
Ratio of Avg.0-9.75 in./9.75-24 in.	0.8	1.2	1.2	1.2
Stdev Top Layer [0-9.75 in.]	4.4	37.3	25.9	6,046
Stdev. Bottom Layer [9.75-24 in.]	0.9	7.4	9.2	2,059

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

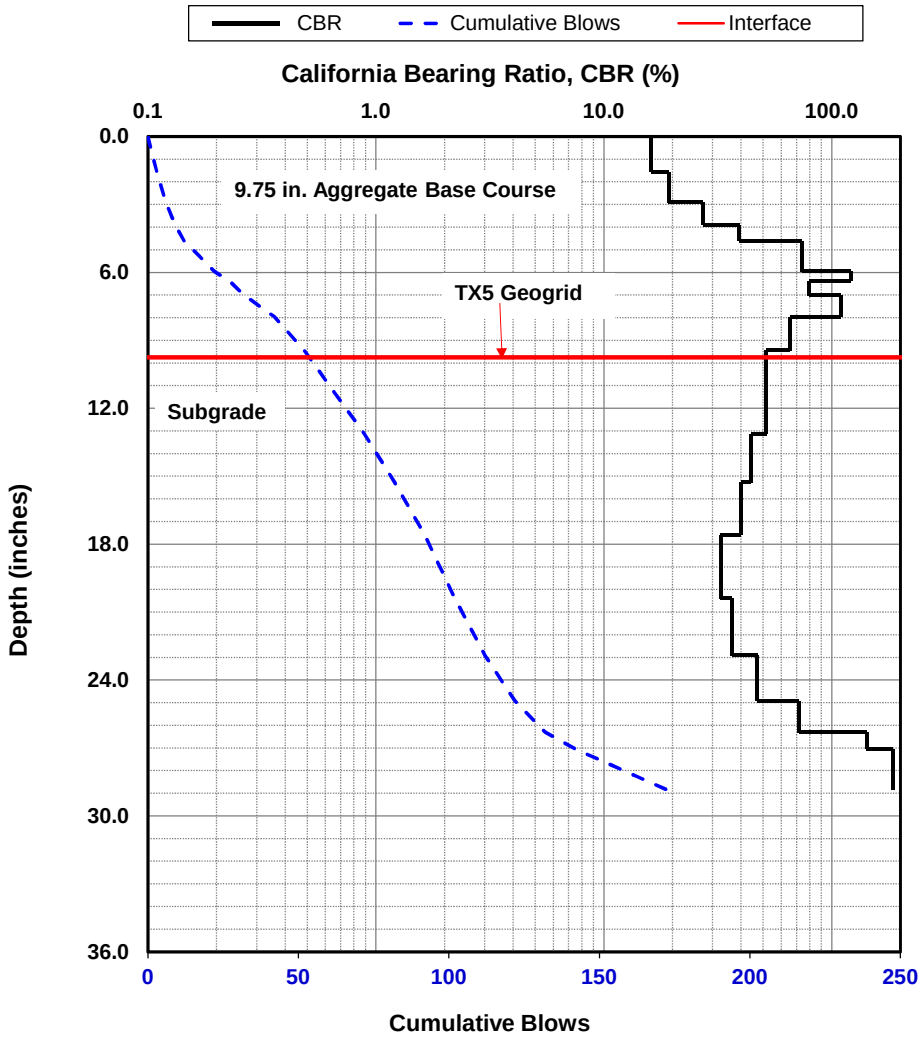
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_2.25_pt16	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0473100		Longitude, W	117.286880		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-27 in.]	3.6	69.9	38.7	9,168
Avg. Bottom Layer [> 27 in.]	NA	NA	NA	NA
Ratio of Avg.0-27 in./> 27 in.	NA	NA	NA	NA
Stdev Top Layer [0-27 in.]	4.4	52.1	32.0	7,539
Stdev. Bottom Layer [> 27 in.]	NA	NA	NA	NA

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

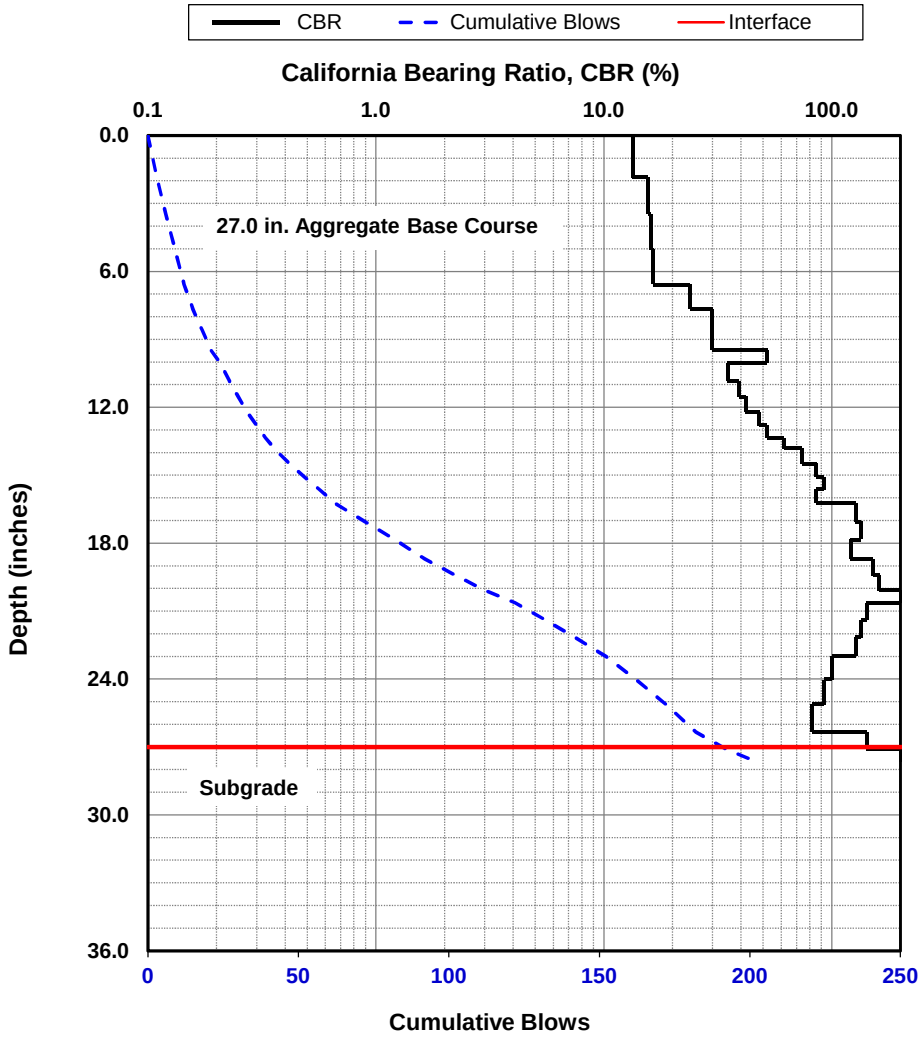
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_2.25_pt17	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0473330		Longitude, W	117.286880		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-27 in.]	3.1	82.6	43.0	10,238
Avg. Bottom Layer [> 27 in.]	NA	NA	NA	NA
Ratio of Avg.0-27 in./> 27 in.	NA	NA	NA	NA
Stdev Top Layer [0-27 in.]	4.2	54.3	32.9	7,747
Stdev. Bottom Layer [> 27 in.]	NA	NA	NA	NA

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

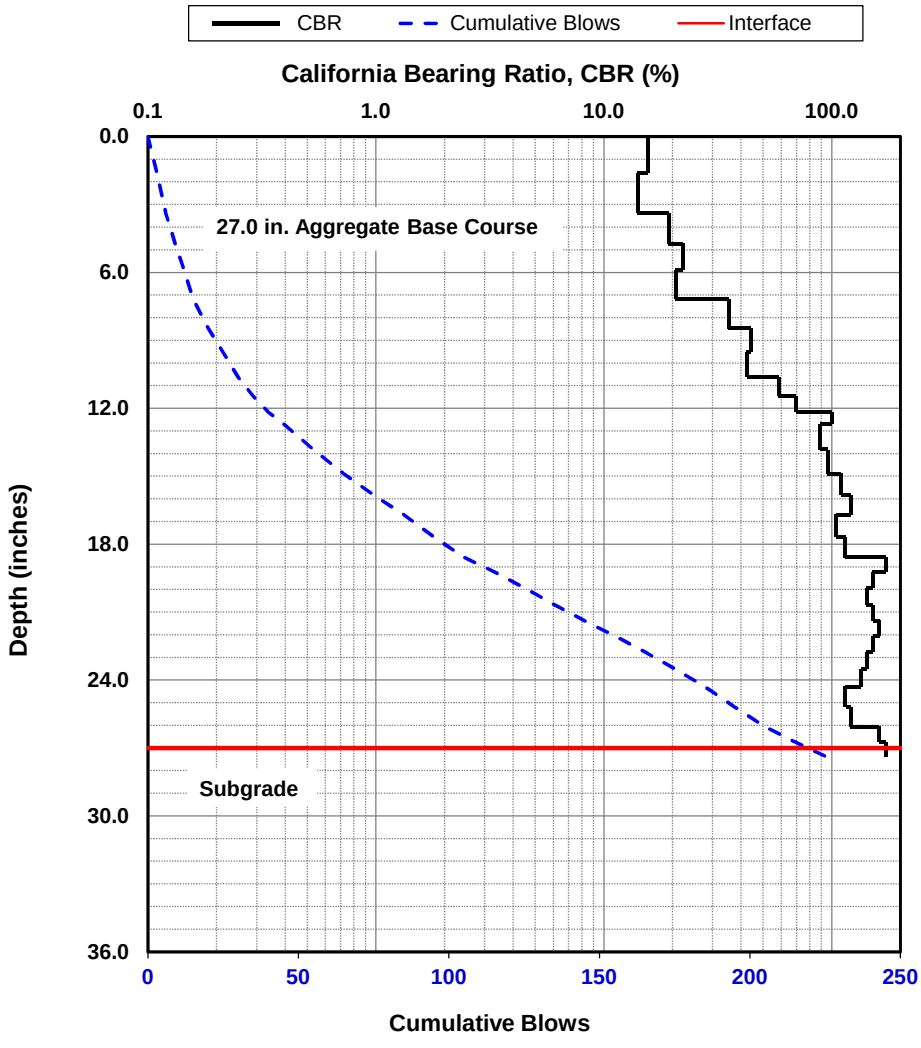
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

ingios GEOTECHNICS

Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_2.25_pt18	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0473520		Longitude, W	117.286880		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-27 in.]	2.9	87.4	44.6	10,631
Avg. Bottom Layer [> 27 in.]	NA	NA	NA	NA
Ratio of Avg.0-27 in./> 27 in.	NA	NA	NA	NA
Stdev Top Layer [0-27 in.]	3.4	51.2	31.7	7,453
Stdev. Bottom Layer [> 27 in.]	NA	NA	NA	NA

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

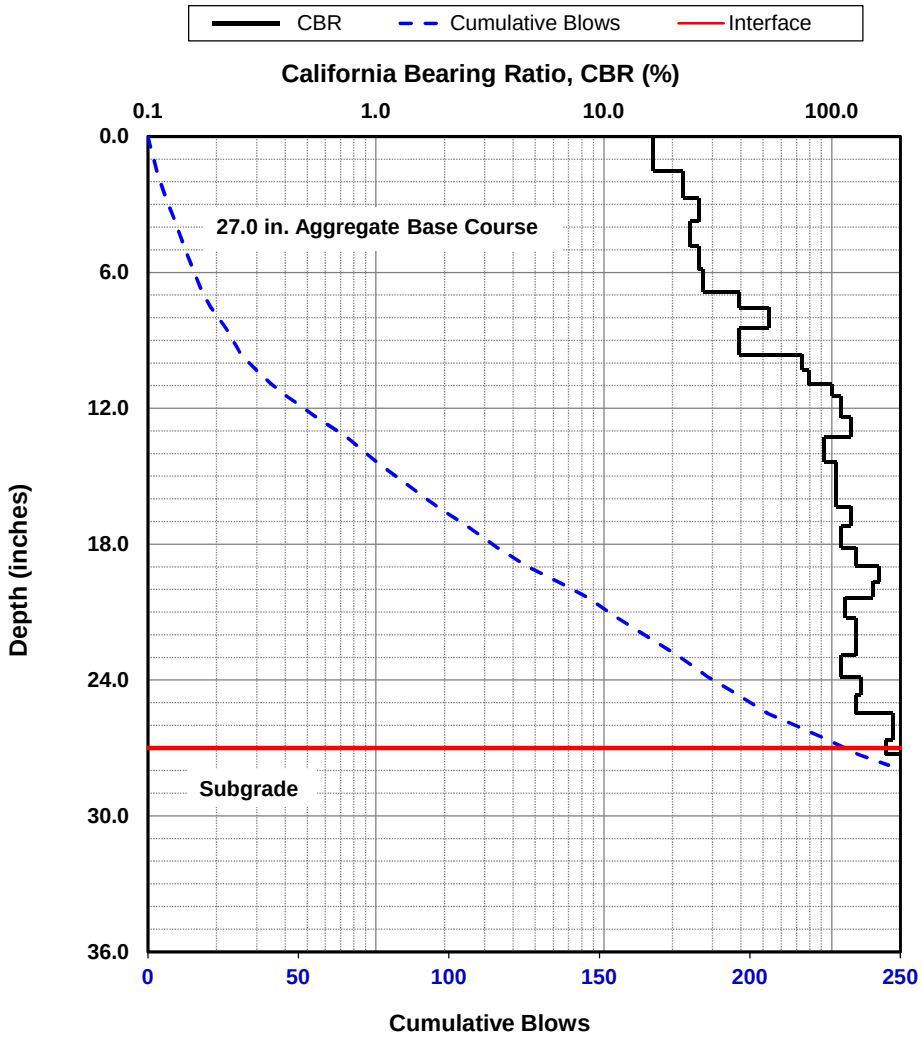
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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Date of Test	8/1/2019	Test ID	I5_NCC_CTRL_2.25_pt19	Operator	HG, LC	ASTM	D6951
Latitude, N	33.0473790		Longitude, W	117.286890		Elevation (ft)	NA
Location	I-5_NCC Test Sections		Station	NA			
Comments	Nominal 2.25 ft thick recycled aggregate base course layer over subgrade (Control).						

Parameter	DPI (mm/blow)	CBR (%)	E_{CBR}, Elastic Modulus (ksi) (non stress-dependent)	$S_{u\text{-}CBR}$, Bearing Capacity (psf)
Avg. Top Layer [0-27 in.]	2.9	90.1	45.5	10,849
Avg. Bottom Layer [> 27 in.]	NA	NA	NA	NA
Ratio of Avg.0-27 in./> 27 in.	NA	NA	NA	NA
Stdev Top Layer [0-27 in.]	2.7	46.0	29.6	6,938
Stdev. Bottom Layer [> 27 in.]	NA	NA	NA	NA

NOTES:

Subgrade is assumed as silty sand.

[1]CBR = 292/DPI$^{1.12}$

[1]CBR = 1/(0.002871*DPI)

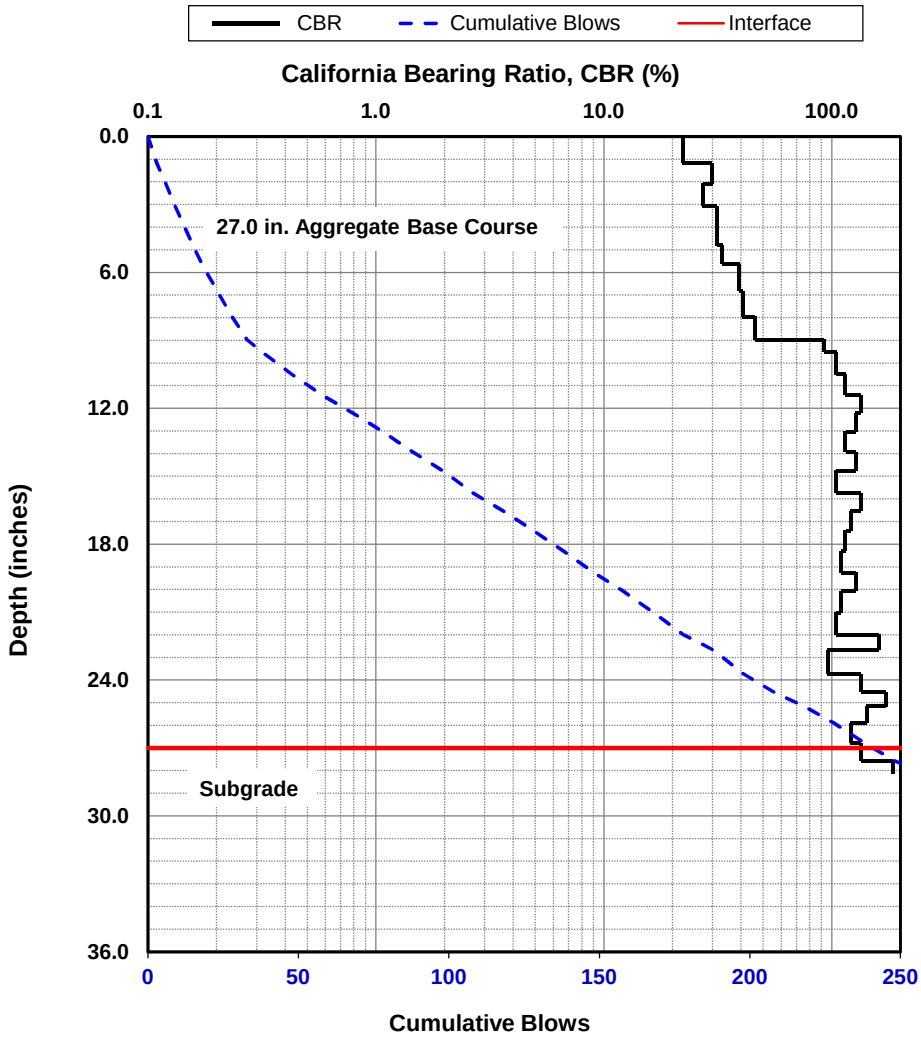
[2]E (ksi) = (17.6 CBR$^{0.64}$) x 0.1450377

[3]S_u (psf) =(3.794 x CBR$^{0.664}$) x 144

[1]ASTM D6951-03

[2]Powell et al. (1986)

[3]Portland Cement Assoc. (1955)



Dynamic Cone Penetrometer (DCP) Test Results

Project Name:	Interstate 5: North County Coastal Test Sections
Project ID:	TIC-00050
Location:	Encinitas, California

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