The Use of Terrafix TBX Biaxial Geogrids in an MTO Empirical Pavement Design

The use of TBX geogrids to replace granular base material depth within a paved roadway design is accomplished by utilizing the TerrafixDesign Software to determine an equivalent aggregate thickness per geogrid type, and applying an appropriate Granular Base Equivalency (GBE) value to each layer of geogrid used. Within the Giroud Han design (the methodology the TerrafixDesign Software is based upon), the resilient modulus of the subbase granular material is taken from AASHTO's 'Design guide for Paved Roads 1993" and is used to derive the equivalent aggregate thickness that a specific geogrid can replace. The subbase material specified by AASHTO can be considered equivalent to the subbase material specified for use in MTO "Pavement Design and Rehabilitation, 1990 because their resilient moduli are equal.

The sub base material specified by MTO is a Granular B, with a specified GBE factor of 0.67 (67% of the strength given by a unit depth of Granular 'A' Basecourse aggregate). The TBX Geogrids ranging from the TBX1500 to the TBX3000 can be considered to have the same GBE factor of Granular B subbase (the TerrafixDesign Software calculates an equivalent subbase granular thickness that each of these geogrids can replace); and therefore it is reasonable to allow the reduced aggregate thickness achieved by the use of TBX geogrids to be considered when designing an MTO paved roadway cross section of a required GBE value (AADT= Average Annual Daily Traffic).

TABLE 6.03 b
STRUCTURAL DESIGN GUIDELINES FOR FLEXIBLE PAVEMENTS - SECONDARY HIGHWAYS
(After: "Pavement Design and Rehabilitation Manual", 1990)

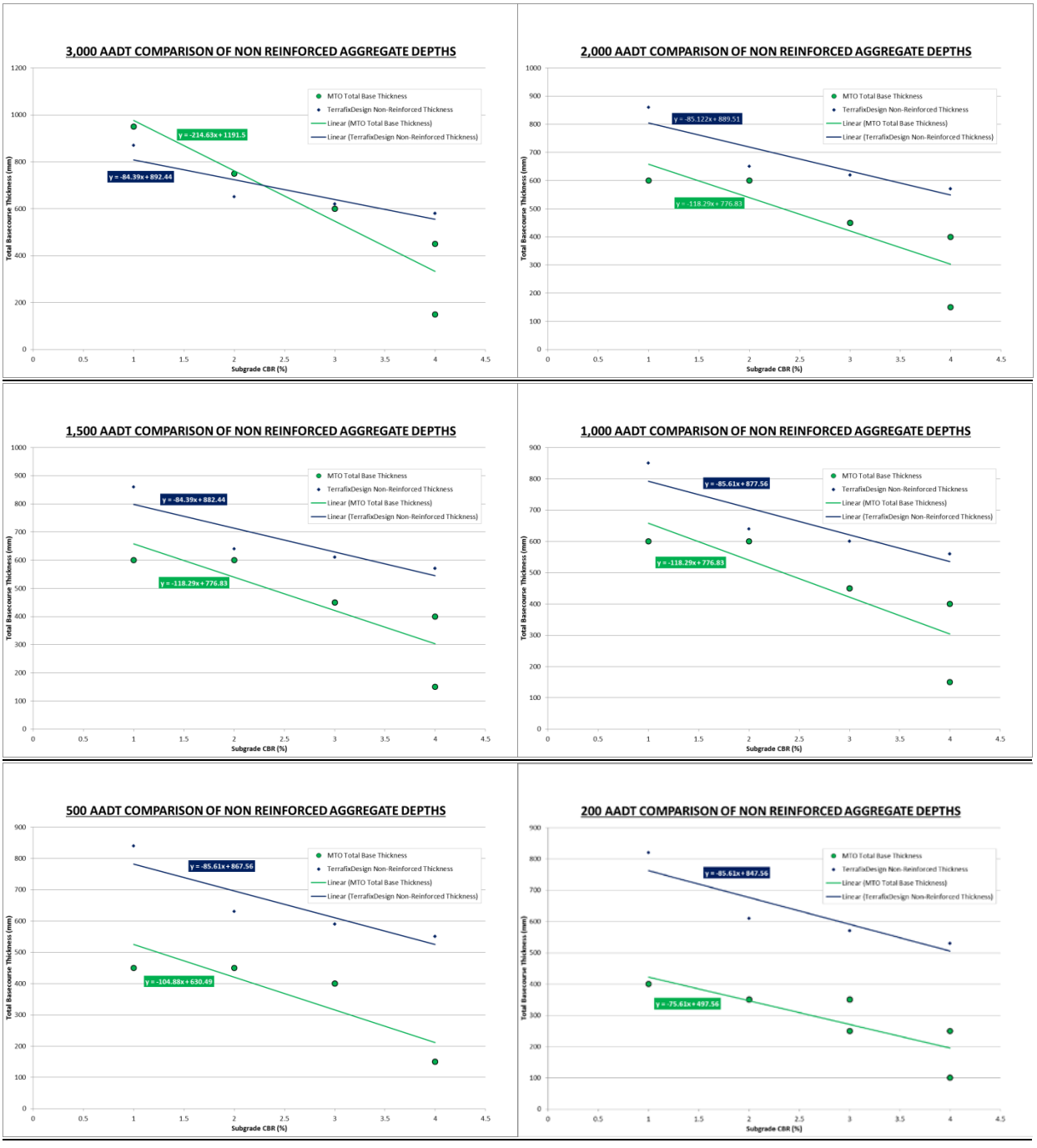
Range of AADT	Pavement Structure Elements	Subgrade Material					
		Gravels and Sands Suitable as Gran. Borrow	SANDS AND SILTS Percent Passing No. 200 Sieve			Lacustrine Clays	Varved & Leda Clays
			<40%	40 - 55%	>55%		
2000 - 3000	HM	90	90	90	90	90	90
	B	150	150	150	150	150	150
	SB**	---	300	450	600	450	800
	GBE	330	530	630	730	630	865
1500 - 2000	HM	50	50	50	50	50	50
	B	150	150	150	150	150	150
	SB**	---	250	300	450	300	450(300 - 600)
	GBE	250	415	450	550	450	550 (450 - 650)
1000 - 1500	CL	50	50	50	50	50	50
	B	150	150	150	150	150	150
	SB**	---	250	300	450	300	450 (300 - 600)
	GBE	240	405	440	540	450	640 (450 - 640)
500 - 1000	ST*	---	--	--	--	---	--
	B	150	150	150	150	150	150
	SB**	---	150	250	300	250	350 (250 - 450)
	GBE	150	250	315	350	315	385 (315 - 450)
200 - 500	ST*	---	--	--	--	---	--
	B	150	150	150	150	150	150
	SB**	---	150	250	300	250	300
	GBE	150	250	315	350	315	350
< 200	Gravel	---	--	--	--	---	--
	B	100	100	100	100	100	100
	SB**	---	150	250	300	250	300
	GBE	100	200	265	300	265	300

Notes: All AADT Volumes refer to Present Traffic
HM: Hot Mix Asphalt & Thickness (mm)
B: Base Thickness (mm)
SB: Subbase Thickness (mm)
GBE: Equivalent Thickness of Granular Base (mm)
(1 mm HM = 2 mm B = 3 mm SB = 1.11 mm CL)
CL: Cold Mixed, Cold Laid or Road Mixed Mulch
ST: Double Surface Treatment or Single Surface Treatment with Prime

To allow for the equivalent aggregate thickness calculated by the TerrafixDesign software to be utilized, aggregate reductions for each soil/traffic volume combination shown on MTO CV301 Table 6.03b (Secondary Highways) are calculated and added into the 6.03b chart to show an optimal aggregate reduction. This allows a quick and effective comparison between the recommended aggregate depths and GBE value for each of the scenarios to be compared with the TBX-reinforced options.

Verifying that the implementation of the equivalent aggregate depth found for each geogrid is appropriate for use in the MTO Pavement Design, the non-reinforced aggregate depth found

by the TerrafixDesign software was compared to the combined base and sub-base thickness published in the 6.03b chart. The results are shown below:



The charts above show two distinct, consistent characteristics:

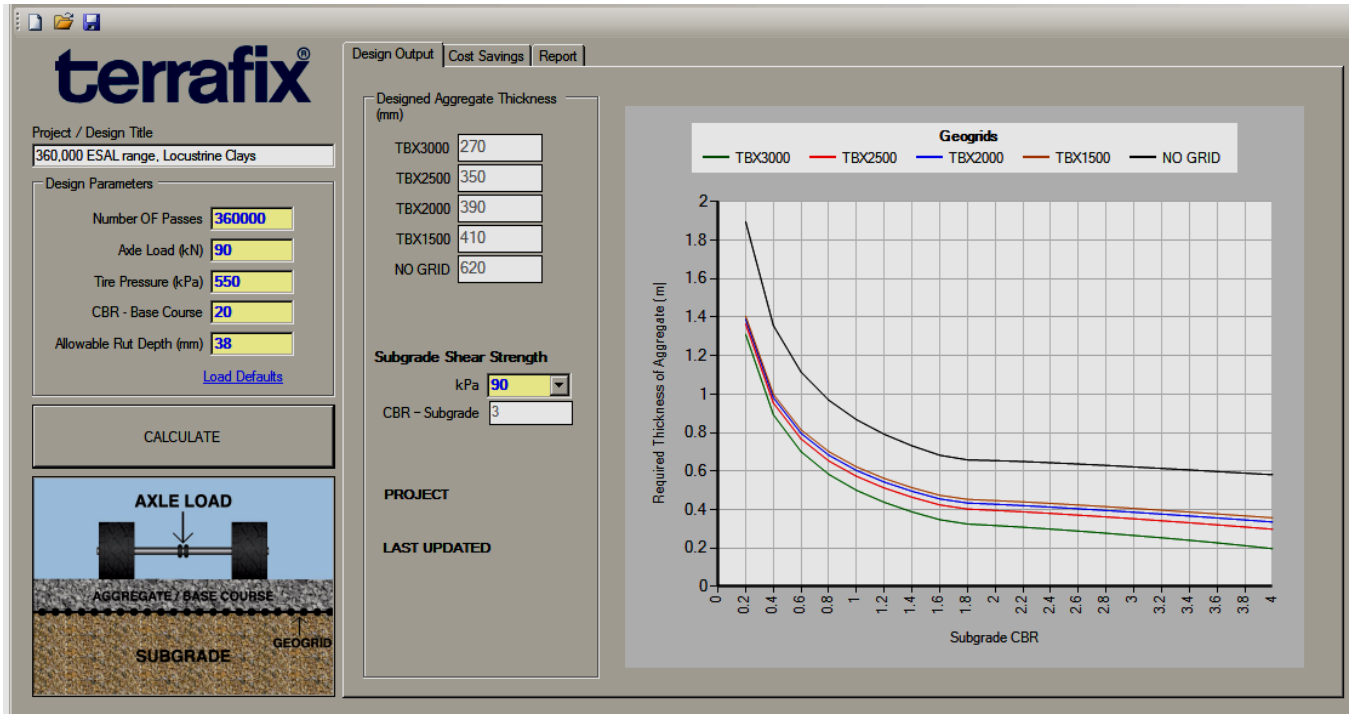
1. The input values selected within the TerrafixDesign software gives a conservative, deeper non-reinforced aggregate depth for all AADT/CBR combinations than the existing MTO basecourse depths.

2. The negative slope of the TerrafixDesign non-reinforced values is at a lower value (less steep) than the MTO values, giving a more conservative recommendation as the subgrade improves.

Due to the conservative nature of the results shown, the recommended aggregate reductions calculated for each of the TBX geogrids may be implemented into the MTO Flexible Pavement Design Guidelines.

The TerrafixDesign screenshot below shows how the equivalent aggregate depth for each TBX geogrid is calculated. The grid-reinforced depth shown is subtracted from the non-reinforced recommended depth, giving an equivalent aggregate depth for each of the four TBX grids:

Example: 360,000 ESAL range, Locustrine Clays, approximate CBR of 3%



The following equivalent aggregate thicknesses can be determined for this particular set of conditions:

- TBX1500: (620mm – 410mm) = 210mm equivalent subbase (Gran B) thickness
- TBX2000: (620mm – 390mm) = 230mm equivalent subbase (Gran B) thickness
- TBX2500: (620mm – 350mm) = 270mm equivalent subbase (Gran B) thickness
- TBX3000: (620mm – 270mm) = 350mm equivalent subbase (Gran B) thickness

Importing these values into table 6.03b, geogrid-reinforced design options with significantly less sub-base thickness can be considered, whilst maintaining the existing GBE value:

MTO CV-301 TABLE 6.03b

STRUCTURAL DESIGN GUIDELINES FOR FLEXIBLE PAVEMENTS WITH TBX BIAXIAL GEOGRIDS - SECONDARY HIGHWAYS

[1] 10 YEAR ESAL RANGE		AADT RANGE		[2] APPROX CBR%	SANDS AND SILTS														
					4			4			3			2			3			1		
				PAVEMENT STRUCTURE ELEMENTS	% PASSING THRU #200 SIEVE																
					GRAVELS & SANDS			<40%			40-55%			>55%			LOCUSTRINE CLAYS			VARVED & LEDA CLAYS		
240,000	360,000	2000	3000	HM		90			90			90			90			90			90	
				B		150			150			150			150			150			150	
				SB		-		300	50	50	450	100	250	600	275	350	450	100	250	800	450	500
				TBX2500			280			280			210			250			210			300
				TBX3000		380			380			350			330			350			370	
				GBE	330	585	518	530	618	551	630	632	638	730	735	732	630	632	638	865	879	866
180,000	240,000	1500	2000	HM		50			50			50			50			50			50	
				B		150			150			150			150			150			150	
				SB		-		250	50	50	300	50	50	450	150	200	300	50	50	450	100	200
				TBX2500			280			280			270			260			270			290
				TBX3000		380			380			360			340			360			360	
				GBE	250	505	438	415	538	471	450	525	464	550	578	558	450	525	464	550	558	578
120,000	180,000	1000	1500	CL		50			50			50			50			50			50	
				B		150			150			150			150			150			150	
				SB		-		250	0	0	300	0	50	450	125	200	300	50	50	450	75	150
				TBX2500			280			280			270			250			270			300
				TBX3000		390			390			360			330			360			370	
				GBE	250	511	438	405	511	438	440	491	464	540	555	552	450	525	464	540	548	552
60,000	120,000	500	1000	ST																		
				B		150			150			150			150			150			150	
				SB		-		150	50	50	250	50	50	300	50	50	250	50	50	450	50	100
				TBX2500			280			280			270			260			270			290
				TBX3000		380			380			350			340			350			360	
				GBE	150	405	338	250	438	371	315	418	364	350	411	358	315	418	364	385	425	411
24,000	60,000	200	500	ST																		
				B		150			150			150			150			150			150	
				SB		50	50		50	50	250	50	50	300	75	100	250	50	50	300	50	50
				TBX1500			230			230			220			210			220			250
				TBX2000		250			250			230			230			230			260	
				GBE	150	351	338	250	351	338	315	338	331	350	354	358	315	338	331	350	358	351
24,000		200		GRAVEL																		
				B		100			100			100			100			100			100	
				SB		100	100	150	100	100	150	100	100	250	100	100	250	100	100	300	100	100
				TBX1500			230			230			210			210			210			240
				TBX2000		250			250			230			230			230			260	
				GBE	100	335	321	200	335	321	265	321	308	265	321	308	265	321	308	300	341	328

[1] BASED UPON 10% TRUCK TRAFFIC, ESAL FACTOR: 0.4, 300 DAYS: LOW VOLUME ROAD, 10 YR ESAL, REF: http://www.chow.com/how_7652268_calculate-esal-adt.html

(2) Approximate CBR based on USCS Soil Classification value and it limited to the maximum CBR value used in the Giroud-Han design methodology.

Input values for Equivalent aggregate thickness in TerrfixDesign Software: Maximum ESAL Value, 90kN axle load, 38mm rut depth, basecourse CBR of 20, tire pressue=550kPa