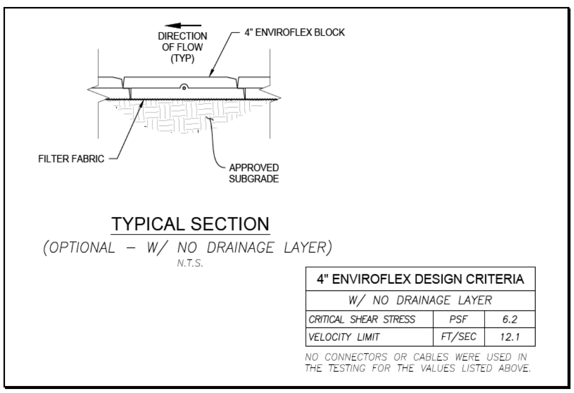
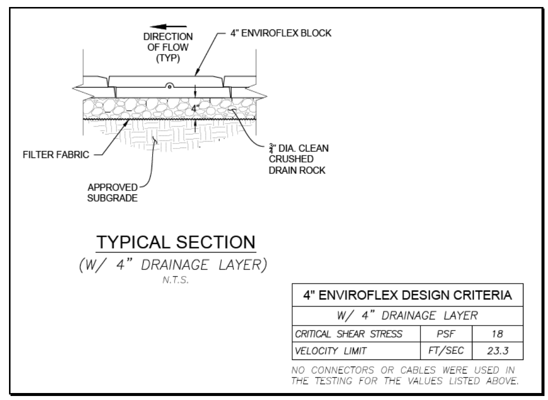
SOIL RETENTION
PRODUCTS INC.

PAVEMENT DESIGN WORKSHEET FOR *ENVIROFLEX®* ARTICULATING CONCRETE BLOCK SYSTEM

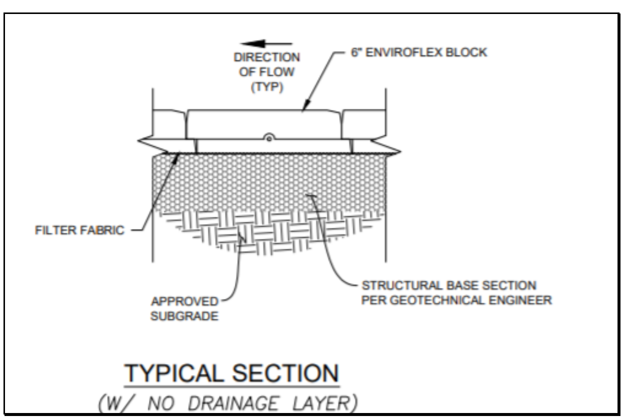
The ***Enviroflex®*** product is an Articulating Concrete Block System intended for scour protection for soil subgrades and is used in a wide array of applications. Sometimes the ***Enviroflex®*** system has a dual function for both scour protection but also can serve as a primary access to/within aquatic environments. In these cases, a qualified design engineer should consider a structural pavement design for the ***Enviroflex®*** application depending upon the service needs and site conditions. The ***Enviroflex®*** block is manufactured in both 4-inch and 6-inch thicknesses. Typical hydraulic applications consist of the ***Enviroflex®*** block underlain by optional drainage rock layer, over a filter fabric over a subgrade material to be protected as shown in the figures below:

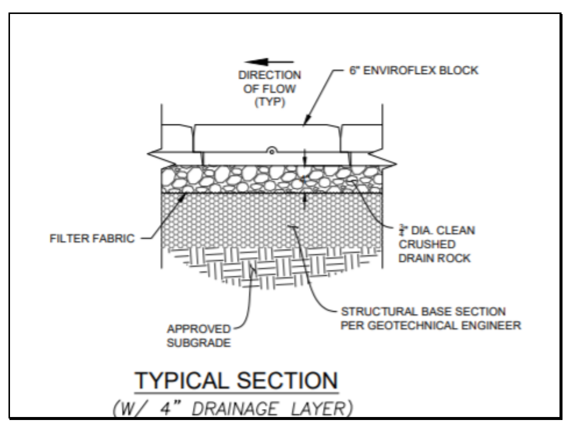




*Typical Drainage Design Sections for **Enviroflex®***

Where the ***Enviroflex®*** system is used as an access road, an additional thickness of aggregate base material may be necessary below the upper drainage design section to improve the subgrade condition for the expected loading conditions. The typical pavement design sections are as follows:





*Typical Structural Based Sections Below Drainage Design Sections for **Enviroflex®***

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GRAVAL EQUIVALENCE METHOD FOR PAVEMENT THICKNESS CALCULATIONS

The required gravel equivalence for a specific traffic and subgrade condition is outlined below:

GE_{Total} = 0.0032 * (TI) * (100 – R) (ft)

where: GE_{Total} = Gravel Equivalence (GE) Total for Pavement Section

TI = Traffic Index

R = R Value of Subgrade Soils

Notes:	Typical values for TI: • 4.0 for light vehicular infrequent usage • 5.0 for heavy vehicular with infrequent usage • 6.0 for heavy vehicular with frequent usage or infrequent usage with regularly submerged conditions • Site specific calculation for heavier loading/usage applications (See attached worksheet)
	Typical R-Values for subgrade soils (R): • Gravels/Clean Sand – Range from 30 to 70 • Silty to Clayey Sands – Range from 10 to 40 • Clays/Silts – Range from 5 to 15 (potentially less in continuously saturated areas) • Consult a geotechnical engineer for site specific testing • Correlation formula between California Bearing Ratio (CBR) and R-Value (See attached worksheet)

Calculations:

Required gravel equivalence for application:

GE_{Total} = 0.0032 * (TI) * (100 – R) = 0.0032 * (______) * (100 - _____) = **________________________ (ft)**

The need for an aggregate base section below the ***Enviroflex®*** drainage section can be determined per below:

GE_{Total} - ***Enviroflex®*** Block (GE_{EFLEX})** - Drainage Rock Layer (GE_{DR})** = _____________

If ≥ 0 - **Aggregate base is needed**

If ≤ 0 – **No aggregate base is needed**

See attached table for recommendations for ***Enviroflex®* Structural Components (GE_{EFLEX} and GE_{DR})

__________ (ft) - ____________ (ft) - ____________ (ft) = _________________

If ≥ 0, the result = Gravel Equivalence for Aggregate Base (GE_{AB}) = _______________

Aggregate Base Thickness ($AB_{THICKNESS}$) = GE_{AB} / GF_{AB} = _________ / _________ = **________________ (ft)**

= **________________ (inches)**

Where: GF_{AB} = Gravel Equivalence Factor for Aggregate Base = 1.1

Notes:

Recommendations for ***Enviroflex®*** Structural Components (GE_{EFLEX} and GE_{DR}) are provided below:

Typically:

- For light vehicular loading – 4-Inch Thick ***Enviroflex®*** Blocks are recommended
- For heavier vehicular loading – 6-Inch Thick ***Enviroflex®*** Blocks are recommended
- ***Enviroflex®*** blocks should be infilled with drainage aggregate or native infills for all driving applications

4-Inch Thick Enviroflex® Block ($GE_{EFLEX-4}$)

$GE_{EFLEX-4}$ = ***Enviroflex®*** Block Thickness * GF_{EFLEX}

Where: GF_{EFLEX} = Gravel Equivalence Factor for ***Enviroflex®*** Block = 2.0

$GE_{EFLEX-4}$ = (4 inches / [12 inches/ft]) * 2.0

$GE_{EFLEX-4}$ = 0.667 ft

6-Inch Thick Enviroflex® Block ($GE_{EFLEX-6}$)

$GE_{EFLEX-6}$ = ***Enviroflex®*** Block Thickness * GF_{EFLEX}

Where: GF_{EFLEX} = Gravel Equivalence Factor for ***Enviroflex®*** Block = 2.0

$GE_{EFLEX-6}$ = (6 inches / [12 inches/ft]) * 2.0

$GE_{EFLEX-6}$ = 1.0 ft

Gravel Equivalence of Drainage Rock Layer (GE_{DR})

Drainage Rock Layer thickness – Typical 4 inches

GE_{DR} = 4 inches * GF_{DR}

Where: GF_{DR} = Gravel Equivalence Factor for Drainage Rock = 1.0

GE_{DR} = (4 inches * / [12 inches/ft]) * 1.0

GE_{DR} = 0.333 ft

TRAFFIC INDEX WORKSHEET FOR HEAVIER LOADING/USAGE APPLICATIONS

From ASCE 68-18, the following guideline is provided for Traffic Index (TI) considering Equivalent Single Axle Load (ESALs) counts:

Table 4-1. Roadway and Pavement Classifications and Typical Design Traffic

Pavement Class	Description	Design ESALs	Design TI
Arterial	Through traffic with access to high-density, regional, commercial, and office developments or downtown streets. General traffic mix.	9,000,000	11.5
Major collector	Traffic with access to low-density, local, commercial, and office development or high-density, residential subdivisions. General traffic mix.	3,000,000	10
Minor collector	Through traffic with access to low-density, neighborhood, commercial development or low-density, residential subdivisions. General traffic mix.	1,000,000	9
Bus passenger drop-off	Public transport centralized facility for buses to pick up passengers from other modes of transport, or for parking of city or school buses.	500,000	8.5
Local commercial	Commercial and limited through traffic with access to commercial premises and multi-family and single-family residential roads. Used by private automobiles, service vehicles and heavy delivery trucks This category includes large parking lots at commercial retail facilities.	330,000	8
Residential	No through traffic with access to multi-family and single-family residential properties. Used by private automobiles, service vehicles and light delivery trucks, including limited construction traffic.	110,000	7
Facility parking and alleys	Parking areas for private automobiles at large facilities with access for emergency vehicles and occasional use by service vehicles or heavy delivery trucks.	90,000	7
Commercial parking	Restricted parking and drop-off areas associated with business premises, mostly used by private automobiles and occasional light delivery trucks. No construction traffic over finished surfaces.	30,000	6
Commercial plaza	Predominantly pedestrian traffic, but with access for occasional heavy maintenance and emergency vehicles. No construction traffic over finished surfaces.	10,000	5

Source: Courtesy of Brick Industry Association (2003); reproduced with permission.

One ESAL is equal to a single 18,000-lb axle load. A simplified method for calculating a site-specific TI based on anticipated ESALs is included below. This method is primarily intended for infrequently used fire access lanes. Minimum TI values listed above should be considered by the designer as well as environmental considerations for drainage and/or other conditions.

Traffic Index (TI) = 9.0 * (ESAL * LDF / 10^6) $^{0.119}$

Where: ESAL = Equivalent Single Axle Load

LDF = Lane Distribution Factor = Typically 1

ESAL = LEF * (# Trips/Day) * (# days/year) * Pavement Service Life

Where: LEF = Load Equivalence Factor – ESAL/truck (per attached table)

Example Design Axle Load – 40 kips/axle (for H-25 or HS-25 loading) – LEF = 39.3

ESAL = _______ * (_______ / day) * (_______ days / year) * (________ years) = ______________ ESALs

Traffic Index (TI) = 9.0 * (______________*__________ / 10^6) $^{0.119}$ = _______________

Note: *More detailed ESAL and TI calculations are available through publicly available sources.*

WORKSHEET FOR CORRELATION OF CALIFORNIA BEARING RATIO (CBR) TO R-VALUE

From ASCE 68-18, the information below can be used to correlate California Bearing Ratio (CBR) to R-Value for pavement design using the Gravel Equivalence Method.

Resilient modulus (M_R) is calculated through the following expressions (expressed in psi) for both CBR and R-Value:

$$M_R = 2{,}555 * (CBR)^{0.64}$$

$$M_R = 1{,}155 + 555*(R)$$

As a result, CBR and R-Value can be generally correlated between the two formulas as follows:

$$R = [2{,}555 * (CBR)^{0.64} – 1{,}155] / 555$$

R = [2,555 * (_____)$^{0.64}$ – 1,155] / 555 = ___________________

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APPENDIX 76.A

Axle Load Equivalency Factors for Flexible Pavements
(single axles and p_t of 2.5)

axle load (kips)	pavement structural number (SN) 1	2	3	4	5	6
2	0.0004	0.0004	0.0003	0.0002	0.0002	0.0002
4	0.003	0.004	0.004	0.003	0.002	0.002
6	0.011	0.017	0.017	0.013	0.010	0.009
8	0.032	0.047	0.051	0.041	0.034	0.031
10	0.078	0.102	0.118	0.102	0.088	0.080
12	0.168	0.198	0.229	0.213	0.189	0.176
14	0.328	0.358	0.399	0.388	0.360	0.342
16	0.591	0.613	0.646	0.645	0.623	0.606
18	1.00	1.00	1.00	1.00	1.00	1.00
20	1.61	1.57	1.49	1.47	1.51	1.55
22	2.48	2.38	2.17	2.09	2.18	2.30
24	3.69	3.49	3.09	2.89	3.03	3.27
26	5.33	4.99	4.31	3.91	4.09	4.48
28	7.49	6.98	5.90	5.21	5.39	5.98
30	10.3	9.5	7.9	6.8	7.0	7.8
32	13.9	12.8	10.5	8.8	8.9	10.0
34	18.4	16.9	13.7	11.3	11.2	12.5
36	24.0	22.0	17.7	14.4	13.9	15.5
38	30.9	28.3	22.6	18.1	17.2	19.0
40	39.3	35.9	28.5	22.5	21.1	23.0
42	49.3	45.0	35.6	27.8	25.6	27.7
44	61.3	55.9	44.0	34.0	31.0	33.1
46	75.5	68.8	54.0	41.4	37.2	39.3
48	92.2	83.9	65.7	50.1	44.5	46.5
50	112	102	79	60	53	55