A list of countries for foundations and retaining structures projects includes:

- *United Kingdom: M1-M62 Motor way Interchange, Hinkley Point "C" Nuclear Power Station foundation investigation and foundation design, M4-Bryn Glas By-Pass, A40 Oxford By-Pass, A36 Salisbury By-Pass, Shrewsbury By-Pass, Royal Portbury Docks Quay Walls and Coal Store, Fawley Power Station, Southport Waste Treatment Works, Portishead Power Station Redevelopment, Plymouth Shell Oil Store.*
- *Sierra Leone: Beach Hotel Foundation Design*
- *Pakistan: Indus Highway Project, Bridge Foundation Report*
- *India: Bombay Sewerage project (two 3km marine outfall tunnels and twin IPS 45m rock shafts)*
- *Hong Kong: Risk analysis and slope protection design for Ting Kau rock slopes on Tuen Mun Highway.)*

Antonio Associates

4 Berrow Road Burnham-on-Sea Somerset TA8 2ET United Kingdom
telephone: +44 (0)1278 764000 / 786787
facsimile: +44 (0)1278 764004 / 795577
e-mail: **edward.antonio@ukonline.co.uk**

Registered in England number 3537680

Foundations and Retaining Structures

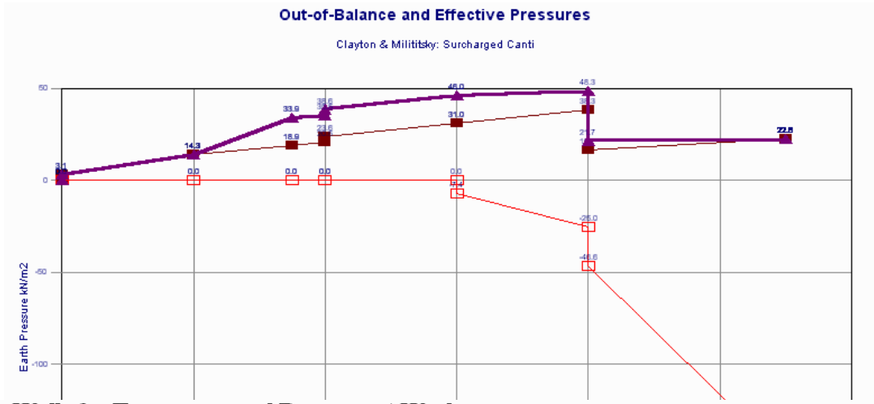
All structures, large and small, require adequate foundations. For structures placed on soil or rock the foundation materials must be assessed in terms of:

- *material type and strength,*
- *soil consolidation characteristics and rock material and joint compressibility,*
- *foundation load distribution and active and passive load estimates,*
- *the effects of water, and,*
- *an understanding of how these measurements are applied to the scale of the engineering project.*

Large foundation loads must be distributed throughout the foundation so as to minimise total and differential settlements and maintain an adequate factor of safety over failure.

Heavy foundations for power stations, bridges and retaining structures have been investigated and designed by Antonio Associates. Foundation materials have ranged from weak and compressible alluvial soils through tropical residual soils and soft rocks such as chalk, to hard rocks with compressible joint sets.

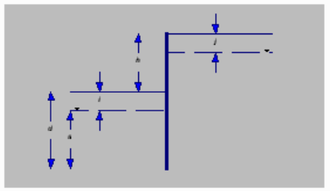
Highways projects generally bring a series of foundation problems not only for the highway construction itself but also for the foundations of bridges and embankments.



Design of Retaining Walls for Temporary and Permanent Works CIRIA Report 104: Appendix B2 pp 107..116

Effective Stress c'=0, phi' analysis: with Seepage around a Cantilever Wall

						F	L	M
internal excavation elevation	h	2.00	m	uf	45.00	Pa1	0.95	5.55	5.27
internal water depth	i	0.01	m	uc	12.63	Pa2	20.44	2.69	54.96
internal wall depth	d	3.88	m	Ka	0.38	Pa3	63.94	1.79	114.63
a=d-i	a	3.87	m	Kp	3.40	Pp1	-0.00	3.87	-0.01
external water depth	j	0.50	m	Sha'	27.58	Pp2	-2.63	1.93	-5.09
				Shp'	110.73	Pp3	-212.86	1.29	-274.49
water density	dw	10.00	kN/m2			Pw1	9.54	4.37	41.70
soil density	ds	20.00	kN/m3			Pw2	24.44	2.58	63.02
phi'	O'	25.00	degrees			SUM			0.00



As the site topography changes, so may the geology, water levels and ground structure. Adjacent foundations may requires different solutions and interactions can arise.

Coastal defenses, canals and water crossings require repair and upgrading, frequently with sheet piling.

On strong rock, the critical factor is often rock structure. Joints, particularly when weathered, give rise to compressible layers which cause settlement problems due to the very high loads generated by bridge abutments and other large structures.

Allowable Bearing Capacity on Rock

Foundation Size, Average Pressure and Wedge Angles

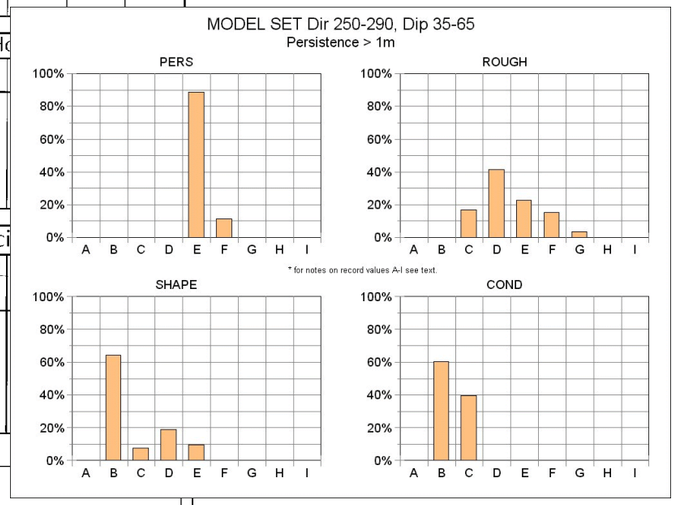
	Length m	Width m	Depth m	Shape Factor 1	Shape Factor 2	Found pressure	Active Wedge	Passive Wedge		
1	20.00	1.00	0.00	1.00	1.00	1.00	75.00	15.00		1
2	20.00	1.00	0.00	1.00	1.00	1.00	75.00	15.00		2
3	20.00	1.00	0.00	1.00	1.00	1.00	75.00	15.00		3

Rock Mass and Joint Properties, Strength, Hc

	density MPa	qc MPa	m value	s value	Spacing m	Modulus Ratio	c j1 MPa
1	0.025	25	3.288	0.009	0.10	300	0.30
2	0.025	15	2.123	0.005	0.10	300	0.30
3	0.025	10	1.132	0.001	0.05	150	0.20

Material Class	Allowable Bearing Capaci					
	B.S. 8004		Hoek-Brown		Bell Solution	
	Rqd Set Ratio	Qa MPa	Rqd. FoS	Qa MPa	Rqd. FoS	Qa MPa
1 A	0.5%	3.75	3.0	5.49	3.0	10.97
2 B	0.5%	2.25	3.0	2.26	3.0	4.44
3 C	0.5%	0.38	3.0	0.77	3.0	1.84

notes:
(1) all foundations calculations restricted to surface loading ONLY
(2) shape factors differ for BS8004
(3) Shape Factor 2 is used in this table; BS8004 use 1 (in Figure 1)
(4) Rock Modulus Ratio used will give lower E-mass values than RMR since these are conservative ratios consistent with BS8004
(5) Undisturbed m and s values used. Bearing Capacity may halve for disturbed masses



A thorough understanding of ground conditions and structure loading is developed and applied to each site.