HP-35s Calculator Program –

CANTILEVER RETAINING WALL DESIGN

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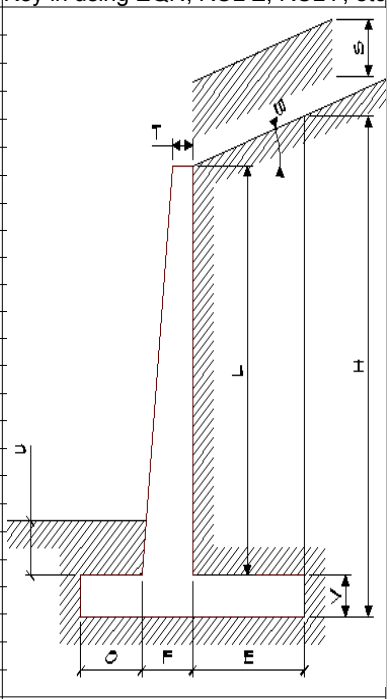
Line	Instruction	Process	User Instruction
O001	LBL O	Establishing the library	
O002	CANT-RET-WALL	Title: RETAINING WALL SAFETY FACTOR	Key in using EQN, RCL E, RCL F, etc
O003	PSE	Short Pause	
O004	1	Storing a default value “1” for σR to calculate the internal	
O005	STO R	angle of friction φ	
O006	2.2	Storing a default value “2.2” for σA to calculate the	
O007	STO A	Internal angle of friction φ	
O008	CLSTACK	Clearing Stack	
O009	STO D	Storing value of 0 on variable D	
O010	SOIL SP WEIGHT		
O011	PSE		
O012	INPUT G		
O013	1000		
O014	÷		
O015	STO G		
O016	ANG INT FRICT	Calculating φ Angle of Internal Friction	
O017	PSE		
O018	AXIAL STRESS	Value taken after triaxial stress test	
O019	PSE		
O020	LEAVE IF UNKNOWN	A default avg value will be generated	
O021	INPUT A	Irrelevant if value not given – May just use value of 1	
O022	RADIAL STRESS	Value taken after triaxial stress test	
O023	PSE		
O024	1 IF UNKNOWN		
O025	INPUT R	Irrelevant if value not given – May just use value of 1	
O026	RCL A	Determining φ angle based on default or modified data	
O027	2		
O028	÷		
O029	+		Nomenclature:
O030	2		
O031	×		A = Base length
O032	1/x		B = β - Angle beta
O033	×		C = specific weight γ of concrete
O034	ASIN		D = δ Angle of External Friction
O035	STO Q	Storing calculated φ angle	E = Heel distance from Stem's
O036	VERIFY PHI ANGLE		Interior Surface
O037	PSE		E =Eccentricity
O038	AROUND 32	The φ angle is usually around 30°-34°	F = Inserted as Footprint of wall
O039	INPUT Q	Option - input φ Angle or verify result	F = Difference in thickness of top to
O040	ADHESION COEFF		bottom of wall
O041	PSE		G = Specific weight of Soil (1st stage)
O042	IN LBF÷FT		H=Total Height
O043	PSE		I=Cumulative Load P (Horizontal
O044	i	Value of “i” is used to force the user to add any value	Components)
O045	STO R	for coeff. of adhesion CA used for sliding safety factor	J=Cumulative Moment M (Horizontal
O046	INPUT R		Components)
O047	STEM HEIGHT		K = Ka – Rankine Active Earth
O048	PSE		Pressure factor
O049	INPUT L		L=Wall Height
O050	WALL THICKNESS		M = Overturning Moment (Vertical
O051	PSE		Components)
O052	INPUT T		N = Cumulative Moment (Vertical
O053	BETA ANGLE		components)
O054	PSE		O = Toe length (initial use)
O055	INPUT B		O = Ovt. Factor of Safety (final use)
O056	SCHARGE HEIGHT		P = Load
O057	PSE		Q = Angle of Internal Friction “φ”
O058	INPUT S		R = Constant of Adhesion
O059	SP WEIGHT CONC		R= Resultant location % on Base Lgth
O060	PSE		S = Surcharge
O061	INPUT C		T = Width of wall on top

O062	1000		U = Surcharge on Toe
O063	÷		V = Footing Thickness
O064	STO C		W = Cumulative Vertical Load P
O065	CLSTK		Z = Temporary variable
O066	TOE DISTANCE	YOU CAN USE THIS AS E AS GIVEN IN DIAGRAM	
O067	PSE		
O068	INPUT O		
O069	DIST HEEL STEM		
O070	PSE		
O071	INPUT E		
O072	STEM FOOTPRINT		
O073	PSE		
O074	INPUT F		
O075	+		
O076	+		
O077	STO A	Storing A as base length variable	
O078	RCL F		
O079	RCL T		
O080	-		
O081	STO F	Modifying value of “F” to difference between “T” and “F”	
O082	TOE SURCHARGE		
O083	PSE		
O084	INPUT U		
O085	FTNG THICKNESS		
O086	PSE		
O087	INPUT V		
O088	RCL B	Solving for H	
O089	TAN		
O090	RCL E		
O091	×		
O092	+		
O093	RCL L		
O094	+		
O095	STO H	Storing Height of Earth Surface - No Surcharge - above Heel	
O096	CORRECT H VALUE		
O097	PSE		
O098	IF GIVEN		
O099	PSE		
O100	INPUT H	Verifying H Value (If H is given process solves for B)	
O101	RCL L	Solving for β angle if H is given and β was unknowm	
O102	-		
O103	RCL V		
O104	-		
O105	RCL E		
O106	x=0?		
O107	0.00001		
O108	÷		
O109	ATAN		
O110	STO B		
O111	VERIFYING B		
O112	PSE		
O113	VIEW B	Viewing β angle based on “H” height given	
O114	EXT FRICT ANGLE		
O115	PSE		
O116	INPUT D		
O117	RCL Q	Solving for the K factor Using Coulomb	
O118	RCL D	Note, this applies only for 90 degree angle walls	
O119	+		
O120	SIN		
O121	RCL Q		
O122	RCL B		
O123	-		
O124	SIN		
O125	×		
O126	RCL B		
O127	COS		
O128	÷		
O129	RCL D		
O130	COS		

O131	÷		
O132	√x		
O133	1		
O134	+		
O135	x^2		
O136	RCL D		
O137	COS		
O138	×		
O139	1/x		
O140	RCL Q		
O141	COS		
O142	x^2		
O143	×		
O144	STO K		
O145	ATTN ON K FCTR		
O146	IN CASE GIVEN		
O147	PSE		
O148	PLEASE VERIFY		
O149	PSE		
O150	INPUT K	Option to give a different K in case given	
O151	STEM P + M		
O152	PSE		
O153	RCL C		
O154	RCL L		
O155	×		
O156	RCL T		
O157	×		
O158	STO P	Storing Axial Load due to Triangular Stem Portion in “P”	
O159	STO W	Storing Axial Load in Cumulative Moment Variable “W”	
O160	RCL T		
O161	2		
O162	÷		
O163	RCL E		
O164	+		
O165	×		
O166	STO M		
O167	STO N	Storing additional Stem Moment to cumulative “N” var.	
O168	RCL F		
O169	RCL L		
O170	2		
O171	÷		
O172	×		
O173	RCL C		
O174	×		
O175	STO P		
O176	RCL W		
O177	+		
O178	STO W		
O179	RCL P		
O180	RCL E		
O181	RCL F		
O182	3		
O183	÷		
O184	+		
O185	RCL T		
O186	+		
O187	×		
O188	RCL N		
O189	+		
O190	STO N		
O191	STO M		
O192	RCL W		
O193	STO P		
O194	VIEW P	Viewing P of Stem	
O195	VIEW M	Viewing M due to Stem Weight	
O196	BASE P + M	Solving for Load and Moment due to Base	
O197	PSE		
O198	RCL V		
O199	RCL A		

O200	×		
O201	RCL C		
O202	×		
O203	STO P		
O204	RCL W		
O205	+		
O206	STO W	Adding Load of Base to Cumulative Load	
O207	CLSTK		
O208	RCL P	Solving for Base Moment	
O209	RCL A		
O210	×		
O211	2		
O212	÷		
O213	STO M	Storing Moment value	
O214	RCL N		
O215	+		
O216	STO N	Adding Base Moment to Cumulative Moment value	
O217	CLSTK		
O218	VIEW P		
O219	VIEW M		
O220	SURCHARGE VERT	Solving for Vertical component due to Surcharge Load	
O221	PSE		
O222	RCL G	γ of Soil	
O223	RCL E		
O224	×		
O225	RCL S	Surcharge	
O226	×		
O227	STO P		
O228	RCL W		
O229	+		
O230	STO W		
O231	RCL P		
O232	RCL E		
O233	×		
O234	2		
O235	÷		
O236	STO M	Storing Moment due to Surcharge	
O237	RCL N		
O238	+		
O239	STO N	Adding Surcharge Moment to Cumulative Moment	
O240	VIEW P	Viewing P due to Surcharge	
O241	VIEW M	Viewing M due to Surcharge	
O242	SOIL P + M	Solving for Load and Moment from Soil above Heel	
O243	PSE	(Vertical component)	
O244	RCL G		
O245	RCL E		
O246	×		
O247	RCL L		
O248	×		
O249	STO P		
O250	RCL E		
O251	×		
O252	2		
O253	÷		
O254	STO M		
O255	RCL H		
O256	RCL L		
O257	-		
O258	RCL V		
O259	-		
O260	RCL G		
O261	×		
O262	RCL E		
O263	×		
O264	2		
O265	÷		
O266	STO Z	Using Z as temporary var. for triangular portion of load	
O267	RCL P	Adding triangular and rectangular portions of soil load	
O268	+		

O269	STO P		
O270	RCL W	Adding soil load to cumulative load	
O271	+		
O272	STO W		
O273	RCL Z	Solving for Moment due to triangular portion	
O274	RCL E		
O275	×		
O276	3		
O277	÷		
O278	RCL M	Adding Moment of Triangular portion to Moment of Rectangular Portion	
O279	+		
O280	STO M		
O281	RCL N	Adding soil moment to cumulative Moment	
O282	+		
O283	STO N		
O284	VIEW P	Viewing Load due to Soil (Vertical Component)	
O285	VIEW M	Viewing Moment due to Soil (Vertical Component)	
O286	SURCHARGE TOE		
O287	PSE		
O288	RCL O		
O289	RCL G		
O290	RCL U		
O291	×		
O292	×		
O293	STO P		
O294	RCL W		
O295	+		
O296	STO W		
O297	RCL P		
O298	RCL A		
O299	RCL O		
O300	2		
O301	÷		
O302	-		
O303	×		
O304	STO M		
O305	RCL N		
O306	+		
O307	STO N	Adding soil moment to cumulative Moment	
O308	VIEW P	Viewing Load due to Soil (Vertical Component)	
O309	VIEW M	Viewing Moment due to Soil (Vertical Component)	
O310	CUMULATIVE VERT	Cumulative Vertical Processing	
O311	PSE		
O312	RCL N		
O313	STO M		
O314	RCL W		
O315	STO P		
O316	VIEW P		
O317	VIEW M		
O318	SL SAFETY FCTR		
O319	PSE		
O320	RCL K		
O321	RCL G		
O322	×		
O323	RCL H		
O324	x^2		
O325	×		
O326	500		
O327	×		
O328	STO Z		
O329	RCL D		
O330	SIN		
O331	×		
O332	STO Y		
O333	RCL D		
O334	COS		
O335	RCL Z		
O336	×		
O337	STO X		

O338	CLSTK		
O339	STO Z		
O340	IF KEYED 0		
O341	PSE		
O342	KEYLESS 1		
O343	PSE		
O344	0		
O345	STO Z		
O346	INPUT Z		
O347	X≠0?		
O348	GTO O346		
O349	KEYED		
O350	PSE		
O351	RCL Y		
O352	RCL P		
O353	1000		
O354	×		
O355	+		
O356	RCL Q		
O357	TAN		
O358	×		
O359	RCL R		
O360	RCL A		
O361	×		
O362	+		
O363	RCL X		
O364	÷		
O365	STO Z		
O366	GTO O363		
O367	KEYLESS		
O368	PSE		
O369	RCL Y		
O370	RCL P		
O371	1000		
O372	×		
O373	+		
O374	RCL D		
O375	TAN		
O376	×		
O377	RCL R		
O378	RCL A		
O379	×		
O380	+		
O381	RCL X		
O382	÷		
O383	STO Z		
O384	VIEW Z		
O385	SURCH HRIZ P+M	Horizontal Component of Surcharge	
O386	PSE		
O387	RCL L		
O388	RCL V		
O389	+		
O390	RCL S		
O391	RCL K		
O392	×		
O393	×		
O394	RCL G		
O395	×		
O396	STO P		
O397	STO I		
O398	RCL L		
O399	RCL V		
O400	+		
O401	×		
O402	2		
O403	÷		
O404	STO M		
O405	STO J		
O406	VIEW P		

O407	VIEW M		
O408	SOIL HORIZ P+M	Horizontal Component of Soil	
O409	PSE		
O410	RCL L		
O411	RCL V		
O412	+		
O413	x^2		
O414	2		
O415	÷		
O416	RCL K		
O417	×		
O418	RCL G		
O419	×		
O420	STO P		
O421	RCL I		
O422	+		
O423	STO I		
O424	RCL P		
O425	RCL L		
O426	RCL V		
O427	+		
O428	×		
O429	3		
O430	÷		
O431	STO M		
O432	RCL J		
O433	+		
O434	STO J		
O435	VIEW P		
O436	VIEW M		
O437	SLOPED PORTION		
O438	PSE		
O439	RCL H		
O440	RCL L		
O441	-		
O442	RCL V		
O443	-		
O444	RCL V		
O445	RCL L		
O446	+		
O447	×		
O448	RCL G		
O449	×		
O450	RCL K		
O451	×		
O452	2		
O453	÷		
O454	STO P		
O455	RCL I		
O456	+		
O457	STO I		
O458	RCL P		
O459	RCL L		
O460	RCL V		
O461	+		
O462	2		
O463	÷		
O464	×		
O465	STO M		
O466	RCL J		
O467	+		
O468	STO J		
O469	VIEW P		
O470	VIEW M		
O471	TOE SOIL REACTION		
O472	PSE		
O473	RCL U		
O474	x^2		
O475	2		

O476	÷		
O477	RCL K		
O478	×		
O479	RCL G		
O480	×		
O481	+/-		
O482	STO P		
O483	RCL I		
O484	+		
O485	STO I		
O486	RCL P		
O487	RCL U		
O488	×		
O489	3		
O490	÷		
O491	STO M		
O492	RCL J		
O493	+		
O494	STO J		
O495	VIEW P		
O496	VIEW M		
O497	CUMULATIVE HOR		
O498	PSE		
O499	RCL I		
O500	STO P		
O501	RCL J		
O502	STO M		
O503	VIEW P		
O504	VIEW M		
O505	OVT MOMENT	Solving for Overturning Moment	
O506	PSE		
O507	RCL N		
O508	RCL J		
O509	+		
O510	STO M		
O511	VIEW M		
O512	OVT SAFETY FCTR	Determining Overturning Safety Factor	
O513	PSE		
O514	CLSTK		
O515	RCL N		
O516	RCL W		
O517	÷		
O518	+/-		
O519	RCL A		
O520	+		
O521	RCL W		
O522	×		
O523	RCL J		
O524	÷		
O525	STO O	Assigning variable “O” to Overturning Moment now	
O526	VIEW O	Viewing Safety Factor	
O527	RES KERN	Determining Resultant	
O528	PSE		
O529	BETN 0.33 0.67	(Hoping between .333 & .667 of Base)	
O530	PSE		
O531	RCL M		
O532	RCL W		
O533	÷		
O534	RCL A		
O535	÷		
O536	STO R	Storing Resultant Percentage in Variable “R”	
O537	VIEW R		
O538	ECCENTRICITY	Determining the eccentricity of the resultant force	
O539	PSE		
O540	RCL A		
O541	×		
O542	RCL A		
O543	2		
O544	÷		

O545	-		
O546	STO E		
O547	VIEW E	Viewing the eccentricity	
O548	STRESS TOE KSF	Solving for Stress at Toe	
O549	PSE		
O550	RCL R		
O551	RCL A		
O552	×		
O553	RCL A		
O554	2		
O555	÷		
O556	-		
O557	RCL W		
O558	×		
O559	6		
O560	×		
O561	RCL A		
O562	x^2		
O563	÷		
O564	STO Z	Using Z as temporary variable	
O565	RCL W		
O566	RCL A		
O567	÷		
O568	RCL Z		
O569	+		
O570	STO F	Storing Stress of Toe at Variable “F” at this point	
O571	VIEW F		
O572	STRESS HEEL	Solving for Stress at Heel	
O573	PSE		
O574	RCL F		
O575	RCL Z		
O576	2		
O577	×		
O578	-		
O579	STO F	Storing Stress at Heel on Variable “F” now	
O580	VIEW F		
O581	STOP		
O582	RTN		