HY-8 Polynomial Coefficients

HY-8: POLYNOMIAL COEFFICIENTS

Table 1. Polynomial Coefficients – Circular

HY-8 Equation	Inlet Configuration	KE	SR	A	BS	C	DIP	EE	F
1	Thin Edge Projecting	0.9	0.5	0.187321	0.56771	-0.156544	0.0447052	-0.00343602	8.96610E-05
2	Mitered to Conform to Slope	0.7	-0.7	0.107137	0.757789	-0.361462	0.1233932	-0.01606422	0.00076739
3	Square Edge with Headwall (Steel/Aluminum/Corrugated PE)	0.5	0.5	0.167433	0.538595	-0.149374	0.0391543	-0.00343974	0.000115882
4	Grooved End Projecting	0.2	0.5	0.108786	0.662381	-0.233801	0.0579585	-0.0055789	0.000205052
5	Grooved End in Headwall	0.2	0.5	0.114099	0.653562	-0.233615	0.0597723	-0.00616338	0.000242832
6	Beveled Edge (1:1)	0.2	0.5	0.063343	0.766512	-0.316097	0.0876701	-0.009836951	0.00041676
7	Beveled Edge (1.5:1)	0.2	0.5	0.08173	0.698353	-0.253683	0.065125	-0.0071975	0.000312451
8	Square Projecting	0.2	0.5	0.167287	0.558766	-0.159813	0.0420069	-0.00369252	0.000125169
9	Square Edge with Headwall (Concrete/PVC/HDPE)	0.5	0.5	0.087483	0.706578	-0.253295	0.0667001	-0.00661651	0.000250619
10	End Section	0.4	0.5	0.120659	0.630768	-0.218423	0.0591815	-0.00599169	0.000229287

EQ #’s: REFERENCE

- 1-9: Calculator Design Series (CDS) 3 for TI-59, FHWA, 1980, page 60
- 1-10: Hydraulic Computer Program (HY) 1, FHWA, 1969, page 18

Table 2. Polynomial Coefficients – Embedded Circular

HY-8 Equation	Inlet Configuration	KE	SR	A	BS	C	DIP	EE	F
1	20% Embedded, Projecting End, Pond	1.0	0.5	0.0608834861787302	0.485734308768152	-0.138194248908661	0.027539172439404	-0.00214546773150856	0.0000642768838741702
2	40% Embedded, Projecting End, Pond	1.0	0.5	0.0888877561313819	0.431529135749154	-0.073866511532321	0.0159200223783949	-0.00103390288198853	0.0000262133369282047
3	50% Embedded, Projecting End, Pond	1.0	0.5	0.0472950768985916	0.59879374328307	-0.191731763062064	0.0480749069653899	-0.00424418228907681	0.00014115316932528
4	20% Embedded, Square Headwall	0.55	0.5	0.0899367985347424	0.363046722229086	-0.0683746513605387	0.0109593856642167	-0.000706535544154146	0.0000189546410047092
5	40% Embedded, Square Headwall	0.55	0.5	0.074298531535586	0.4273662972292	-0.0849120530113796	0.0157965200237501	-0.00102651687866388	0.0000260155937601425
6	50% Embedded, Square Headwall	0.55	0.5	0.212469378699735	0.511461899639209	-0.174199884499934	0.0410961018431149	-0.00366309685788592	0.000123085395227651
7	20% Embedded, 45 degree Beveled End	0.35	0.5	0.0795781442396077	0.373319755852658	-0.0821508852481996	0.0148670702428601	-0.00121876746632593	0.0000406896111847521

8	40% Embedded, 45 degree Beveled End	0.35	0.5	0.0845740029462746	0.389113662011417	-0.0685090654986062	0.0117190357464366	-0.000790440416133214	0.0000226453591207209
9	50% Embedded, 45 degree Beveled End	0.35	0.5	0.0732498224366533	0.426296207882289	-0.0825309806843494	0.0158108288973248	-0.00103586921012557	0.0000265873062363919
10	20% Embedded, Mitered End 1.5H:1V	0.9	0.5	0.075018832861494	0.404532870578638	-0.0959305677963978	0.0172402567402576	-0.00121896053512953	0.0000338251697138414
11	40% Embedded, Mitered End 1.5H:1V	0.9	0.5	0.086819906748455	0.362177446931189	-0.048309284166457	0.00870598247307798	-0.000359506993503941	2.89144278309283E-06
12	50% Embedded, Mitered End 1.5H:1V	0.9	0.5	0.0344461003984492	0.574817400258578	-0.204079127155295	0.0492721656480291	-0.00436372397619383	0.000144794982321005

EQ #’s: REFERENCE

- 1-12: NCHRP 15-24 report

Table 3. Polynomial Coefficients – Box

HY-8 Equation	Inlet Configuration	KE	SR	A	BS	C	DIP	EE	F
1	Square Edge (90 degree) Headwall, Square Edge (90 & 15 degree flare) Wingwall	0.5	0.5	0.122117	0.505435	-0.10856	0.0207809	-0.00136757	0.00003456
2	1.5:1 Bevel (90 degree) Headwall, 1.5:1 Bevel (19-34 degree flare) Wingwall	0.2	0.5	0.1067588	0.4551575	-0.08128951	0.01215577	-0.00067794	0.0000148
3	1:1 Bevel Headwall	0.2	0.5	0.1666086	0.3989353	-0.06403921	0.01120135	-0.0006449	0.000014566
4	Square Edge (30-75 degree flare) Wingwall	0.4	0.5	0.0724927	0.507087	-0.117474	0.0221702	-0.00148958	0.000038
5	Square Edge (0 degree flare) Wingwall	0.7	0.5	0.144133	0.461363	-0.0921507	0.0200028	-0.00136449	0.0000358
6	1:1 Bevel (45 degree flare) Wingwall	0.2	0.5	0.0995633	0.4412465	-0.07434981	0.01273183	-0.0007588	0.00001774

EQ #’s: REFERENCE

- 1-6: Hydraulic Computer Program (HY) 6, FHWA, 1969, subroutine BEQUA
- 1,4,5: Hydraulic Computer Program (HY) 3, FHWA, 1969, page 16
- 1,3,4,6: Calculator Design Series (CDS) 3 for TI-59, FHWA, 1980, page 16

Table 4. Polynomial Coefficients — Ellipse

HY-8 Equation	PIPE	Inlet Configuration	KE	SR	A	BS	C	DIP	EE	F
27	CSPE	headwall	0.5	0.5	0.01267	0.79435	-0.2944	0.07114	-0.00612	0.00015
28	CSPE	mitered	0.7	-0.7	-0.14029	1.437	-0.92636	0.32502	-0.04865	0.0027
29	CSPE	bevel	0.3	0.5	-0.00321	0.92178	-0.43903	0.12551	-0.01553	0.00073
30	CSPE	thin	0.9	0.5	0.0851	0.70623	-0.18025	0.01963	0.00402	-0.00052
31	RCPE	square	0.5	0.5	0.13432	0.55951	-0.1578	0.03967	-0.0034	0.00011
32	RCPE	grv. hdwl	0.2	0.5	0.15067	0.50311	-0.12068	0.02566	-0.00189	0.00005
33	RCPE	grv. proj	0.2	0.5	-0.03817	0.84684	-0.32139	0.0755	-0.00729	0.00027

EQ #’s: REFERENCE

- 27-30: Calculator Design Series (CDS) 4 for TI-59, FHWA, 1982, page 20
- 31-33: Calculator Design Series (CDS) 4 for TI-59, FHWA, 1982, page 22

Table 5. Polynomial Coefficients — Pipe Arch

HY-8 Equation	PIPE	Inlet Configuration	KE	SR	A	BS	C	DIP	EE	F
12	CSPA	proj.	0.9	0.5	0.08905	0.71255	-0.27092	0.07925	-0.00798	0.00029
13	CSPA	proj.	0.9	0.5	0.12263	0.4825	-0.00002	-0.04287	0.01454	-0.00117
14	CSPA	proj.	0.9	0.5	0.14168	0.49323	-0.03235	-0.02098	0.00989	-0.00086
15	CSPA	proj.	0.9	0.5	0.09219	0.65732	-0.19423	0.04476	-0.00176	-0.00012
16	CSPA	mitered	0.7	-0.7	0.0833	0.79514	-0.43408	0.16377	-0.02491	0.00141
17	CSPA	mitered	0.7	-0.7	0.1062	0.7037	-0.3531	0.1374	-0.02076	0.00117
18	CSPA	mitered	0.7	-0.7	0.23645	0.37198	-0.0401	0.03058	-0.00576	0.00045
19	CSPA	mitered	0.7	-0.7	0.10212	0.72503	-0.34558	0.12454	-0.01676	0.00081
20	CSPA	headwall	0.5	0.5	0.11128	0.61058	-0.19494	0.05129	-0.00481	0.00017
21	CSPA	headwall	0.5	0.5	0.12346	0.50432	-0.13261	0.0402	-0.00448	0.00021
22	CSPA	headwall	0.5	0.5	0.09728	0.57515	-0.15977	0.04223	-0.00374	0.00012
23	CSPA	headwall	0.5	0.5	0.09455	0.61669	-0.22431	0.07407	-0.01002	0.00054
24	RCPA	headwall	0.5	0.5	0.16884	0.38783	-0.03679	0.01173	-0.00066	0.00002
25	RCPA	grv. hdwl	0.2	0.5	0.1301	0.43477	-0.07911	0.01764	-0.00114	0.00002
26	RCPA	grv. proj	0.2	0.5	0.09618	0.52593	-0.13504	0.03394	-0.00325	0.00013

EQ #’s: REFERENCE

- 12-23: Calculator Design Series (CDS) 4 for TI-59, FHWA, 1982, page 17
- 24-26: Calculator Design Series (CDS) 4 for TI-59, FHWA, 1982, page 24
- 12,16,20: Hydraulic Computer Program (HY) 2, FHWA, 1969, page 17

Table 6. Polynomial Coefficients — Concrete Open-Bottom Arch

Span:Rise Ratio	Wingwall Angle (Inlet Configuration)	KE	SR	A	BS	C	DIP	EE	F	Diagram/Notes
2:1	0 Degrees (Mitered to Conform to Slope)	0.7	0.0	0.0389106557	0.6044131889	-0.1966160961	0.0425827445	-0.0035136880	0.0001097816	2:1 Coefficients are used if the span:rise ratio is less than or equal to 3:1.
2:1	45 Degrees (45-degree Wingwall)	0.5	0.0	0.0580199163	0.5826504262	-0.1654982156	0.0337114383	-0.0026437555	0.0000796275	2:1 Coefficients are used if the span:rise ratio is less than or equal to 3:1.
2:1	90 Degrees (Square Edge with Headwall)	0.5	0.0	0.0747688320	0.5517030198	-0.1403253664	0.0281511418	-0.0021405250	0.0000632552	2:1 Coefficients are used if the span:rise ratio is less than or equal to 3:1.
4:1	0 Degrees (Mitered to Conform to Slope)	0.7	0.0	0.0557401882	0.4998819105	-0.1249164198	0.0219465031	-0.0015177347	0.0000404218	4:1 coefficients are used if the span:rise ratio is greater than 3:1
4:1	45 Degrees (45-degree Wingwall)	0.5	0.0	0.0465032346	0.5446293346	-0.1571341119	0.0312822438	-0.0024007467	0.0000704011	4:1 coefficients are used if the span:rise ratio is greater than 3:1
4:1	90 Degrees (Square Edge with Headwall)	0.5	0.0	0.0401619369	0.5774418238	-0.1693724912	0.0328323405	-0.0024131276	0.0000668323	4:1 coefficients are used if the span:rise ratio is greater than 3:1

References for Concrete Open-bottom Arch polynomial coefficients:

- Thiele, Elizabeth A. Culvert Hydraulics: Comparison of Current Computer Models. (pp. 121-126), Brigham Young University Master’s Thesis (2007).
- Chase, Don. Hydraulic Characteristics of CON/SPAN Bridge Systems. Submitted Study and Report (1999)

Table 7. Polynomial Coefficients — South Dakota Concrete Box

Description	KE	SR	A	BS	C	DIP	EE	F	Diagram/Notes

Sketch 1: 30 degree-flared wingwalls; top edge beveled at 45 degrees	0.5	0.5	0.0176998563	0.5354484847	-0.1197176702	0.0175902318	-0.0005722076	-0.0000080574	
Sketch 2: 30 degree-flared wingwalls; top edge beveled at 45 degrees; 2, 3, and 4 multiple barrels	0.5	0.5	0.0506647261	0.5535393634	-0.1599374238	0.0339859269	-0.0027470036	0.0000851484	
Sketch 3: 30 degree-flared wingwalls; top edge beveled at 45 degrees; 2:1 to 4:1 span-to-rise ratio	0.5	0.5	0.0518005829	0.5892384653	-0.1901266252	0.0412149379	-0.0034312198	0.0001083949	
Sketch 4: 30 degree-flared wingwalls; top edge beveled at 45 degrees; 15 degrees skewed headwall with multiple barrels	0.5	0.5	0.2212801152	0.6022032341	-0.1672369732	0.0313391792	-0.0024440549	0.0000743575	
Sketch 5: 30 degree-flared wingwalls; top edge beveled at 45 degrees; 30 degrees to 45 degrees skewed headwall with multiple barrels	0.5	0.5	0.2431604850	0.5407556631	-0.1267568901	0.0223638322	-0.0016523399	0.0000490932	
Sketches 6 & 7: 0 degree-flared wingwalls (extended sides); square-edged at crown and 0 degree-flared wingwalls (extended sides); top edge beveled at 45 degrees; 0- and 6-inch corner fillets	0.5	0.5	0.0493946080	0.7138391179	-0.2354755894	0.0473247331	-0.0036154348	0.0001033337	

Sketches 8 & 9: 0 degree-flared wingwalls (extended sides); top edge beveled at 45 degrees; 2, 3, and 4 multiple barrels and 0 degree-flared wingwalls (extended sides); top edge beveled at 45 degrees; 2:1 to 4:1 span-to-rise ratio	0.5	0.5	0.1013668008	0.6600937637	-0.2133066786	0.0437022641	-0.0035224589	0.0001078198	
Sketches 10 & 11: 0 degree-flared wingwalls (extended sides); crown rounded at 8-inch radius; 0- and 6-inch corner fillets and 0 degree-flared wingwalls (extended sides); crown rounded at 8-inch radius; 12-inch corner fillets	0.5	0.5	0.0745605288	0.6533033536	-0.1899798824	0.0350021004	-0.0024571627	0.0000642284	
Sketch 12: 0 degree-flared wingwalls (extended sides); crown rounded at 8-inch radius; 12-inch corner fillets; 2, 3, and 4 multiple barrels	0.5	0.5	0.1321993533	0.5024365440	-0.1073286526	0.0183092064	-0.0013702887	0.0000423592	
Sketch 13: 0 degree-flared wingwalls (extended sides); crown rounded at 8-inch radius; 12-inch corner fillets; 2:1 to 4:1 span-to-rise ratio.	0.5	0.5	0.1212726739	0.6497418331	-0.1859782730	0.0336300433	-0.0024121680	0.0000655665	

References for South Dakota Concrete Box polynomial coefficients:

- Thiele, Elizabeth A. Culvert Hydraulics: Comparison of Current Computer Models. (pp. 121-126), Brigham Young University Master’s Thesis (2007).
- Effects of Inlet Geometry on Hydraulic Performance of Box Culverts (FHWA

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Table 8. User Defined, Open Bottom Arch, Low-Profile Arch, High-Profile Arch, and Metal Box HW/D Values.

Q/A*D^.5 =				0.5	1	2	3	4	5	6	7	8	9
HY-8 Interpolation Coefficients	Inlet Configuration	KE	SR	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	A(9)	A(10)
1	Thin Edge Projecting	0.9	0.5	0.31	0.48	0.81	1.11	1.42	1.84	2.39	3.03	3.71	4.26
2	Mitered to Conform to Slope	0.7	-0.7	0.34	0.49	0.77	1.04	1.45	1.91	2.46	3.06	3.69	4.34
3	Square Edge with Headwall	0.5	0.5	0.31	0.46	0.73	0.96	1.26	1.59	2.01	2.51	3.08	3.64
4	Beveled Edge	0.2	0.5	0.31	0.44	0.69	0.89	1.16	1.49	1.81	2.23	2.68	3.18

Reference for User-defined interpolation coefficients: FHWA HDS-5, Appendix D, Chart 52B