5. Structural Steel

5.1 Use and Exposure. Structural steel is not used extensively in the work of the Soil Conservation Service, and hence this discussion is general and brief. Structural shapes have limited use in the construction of (1) small I-beam bridges, (2) light trusses for supporting irrigation flumes and pipes, (3) interlocking sheet steel piling drop spillways, (4) bents for supporting flumes, pipes, and suspension span cables, (5) trash racks, (6) drainage, irrigation, and flood control gates, and (7) other structural accessories such as ladders, foot bridges, etc.

Such varied use provides wide differences in exposure conditions and probable corrosion hazard. In most cases the steel will be unprotected from the natural forces of wind, rain, sleet, snow, etc.; and in some cases it will be in direct contact with the earth and subject to alternate wet and dry conditions.

5.2 Design. The latest edition of the "Standard Specifications for Highway Bridges" adopted by The American Association of State Highway Officials should be used as the basic reference for unit stresses and design criteria insofar as they are applicable to the problem under study. Section 4, page 144 of the fifth edition (1949) of the above reference presents allowable unit stresses and Section 6, page 166, presents design criteria. These unit stresses should be used where exposure conditions are comparable to those normally encountered in highway bridges. For more severe exposure conditions it is recommended that the basic allowable unit stresses be reduced 10 percent.

The principles, procedure, and formulas required in the design of the relatively simple structures encountered in our work are readily available in many texts and handbooks, and it seems unnecessary to duplicate them here.

STRUCTURAL DESIGN:
STRUCTURAL TIMBER, UNIT WORKING STRESSES OF VARIOUS SPECIES FOR DIFFERENT EXPOSURE CONDITIONS

BENDING AND SHEARING STRESSES, IN POUNDS PER SQUARE INCH

Species of Timber	Transverse Bending Stresses										Horizontal Shearing Stress	
	All Sizes		Thickness, 5" and Over				Thickness, 4" and Under					
	Continuously Dry		Occasionally Wet		Usually Wet		Occasionally Wet		Usually Wet		Dry or Wet	
	Select	Common	Select	Common	Select	Common	Select	Common	Select	Common	Select	Common
Ash, White, commercial	1400	1120	1200	960	1000	800	1070	910	890	760	125	100
Beech and Birch, Yellow	1500	1200	1300	1040	1000	800	1150	980	890	760	125	100
Cedar, Port Orford and Alaska	1100	880	1000	800	900	720	890	760	800	680	90	72
Cedar, Western Red	900	720	800	640	750	600	710	600	670	570	80	64
Cedar, Northern and Southern White	750	600	650	520	600	480	580	490	530	450	70	56
Chestnut	950	760	850	680	700	560	760	650	620	530	90	72
Cypress, Southern	1300	1040	1100	880	900	720	980	830	800	680	100	80
Douglas Fir, Coast Region	1600	1200	1385	1040	1065	800	1235	985	950	755	90	72
Douglas Fir, Coast Region, Dense	1750	1400	1515	1215	1165	935	1350	1150	1035	880	105	84
Douglas Fir, Rocky Mountain	1100	880	900	720	700	560	800	680	620	530	85	68
Fir, White, commercial	1100	880	900	720	800	640	800	680	710	600	70	56
Fir, Balsam	900	720	750	600	600	480	670	570	530	450	70	56
Hemlock, Western	1300	1040	1100	880	900	720	980	830	800	680	75	60
Hemlock, Eastern	1100	880	900	720	800	640	800	680	710	600	70	56
Hickory	1900	1520	1500	1200	1200	960	1330	1130	1070	910	140	112
Larch, Western	1200	960	1100	880	900	720	980	830	800	680	100	80
Maple, Sugar and Black	1500	1200	1300	1040	1000	800	1150	980	890	760	125	100
Maple, Red and Silver	1000	800	900	720	700	560	800	680	620	530	100	80
Oak, Red and White, commercial	1400	1120	1200	960	1000	800	1070	910	890	760	125	100
Pine, Southern Yellow	....	1200	....	1040	....	800	....	985	...	755	...	88
Pine, Southern Yellow, Dense	1750	1400	1515	1215	1165	935	1350	1145	1035	880	128	103
Pine, White, Yellow, Sugar, Ponderosa	900	720	800	640	750	600	710	600	670	570	85	68
Pine, Norway	1100	880	1000	800	800	640	890	760	710	600	85	68
Poplar, Yellow	1000	800	900	720	800	640	800	680	710	600	80	64
Redwood	1200	960	1000	800	800	640	890	760	710	600	70	56
Spruce, Red, White and Sitka	1100	880	900	720	800	640	800	680	710	600	85	68
Spruce, Engelmann	750	600	650	520	500	400	580	490	440	370	70	56
Tamarack	1200	960	1100	880	900	720	980	830	800	680	95	76

COMPRESSIVE STRESSES AND ELASTIC MODULI, IN POUNDS PER SQUARE INCH

Species of Timber	Compressive Stresses									Average Modulus of Elasticity
	Perpendicular to Grain			Parallel with Grain						
	Continuously Dry	Occasionally Wet	Usually Wet	Continuously Dry		Occasionally Wet		Usually Wet		
	Select or Common			Select	Common	Select	Common	Select	Common	All Classes
Ash, White, commercial	500	375	300	1100	880	1000	800	900	720	1,500,000
Beech and Birch, Yellow	500	375	300	1200	960	1100	880	900	720	1,600,000
Cedar, Alaska	250	200	150	800	640	750	600	650	520	1,200,000
Cedar, Port Orford	250	200	150	900	720	825	660	750	600	1,200,000
Cedar, Western Red	200	150	125	700	560	700	560	650	520	1,000,000
Cedar, Northern and Southern White	175	140	100	550	440	500	400	450	360	800,000
Chestnut	300	200	150	800	640	700	560	600	480	1,000,000
Cypress, Southern	300	225	200	1100	880	1000	800	800	640	1,200,000
Douglas Fir, Coast Region	345	240	215	1175	880	1065	800	905	680	1,600,000
Douglas Fir, Coast Region, Dense	380	260	235	1285	1025	1165	935	990	795	1,600,000
Douglas Fir, Rocky Mountain	275	225	200	800	640	800	640	700	560	1,200,000
Fir, White, commercial	300	225	200	700	560	700	560	600	480	1,100,000
Fir, Balsam	150	125	100	700	560	600	480	500	400	1,000,000
Hemlock, Western	300	225	200	900	720	900	720	800	640	1,400,000
Hemlock, Eastern	300	225	200	700	560	700	560	600	480	1,100,000
Hickory	600	400	350	1500	1200	1200	960	1000	800	1,800,000
Larch, Western	325	225	200	1100	880	1000	800	800	640	1,300,000
Maple, Sugar and Black	500	375	300	1200	960	1100	880	900	720	1,600,000
Maple, Red and Silver	350	250	200	800	640	700	560	600	480	1,100,000
Oak, Red and White, Commercial	500	375	300	1000	800	900	720	800	640	1,500,000
Pine, Southern Yellow	...	...	...	....	880	....	800	...	680	1,600,000
Pine, Southern Yellow, Dense	380	260	235	1285	1025	1165	935	990	795	1,600,000
Pine, White, Yellow, Sugar and Ponderosa	250	150	125	750	600	750	600	650	520	1,000,000
Pine, Norway	300	175	150	800	640	800	640	700	560	1,200,000
Poplar, Yellow	250	150	125	800	640	700	560	600	480	1,100,000
Redwood	250	150	125	1000	800	900	720	750	600	1,200,000
Spruce, Red, White and Sitka	250	150	125	800	640	750	600	650	520	1,200,000
Spruce, Engelmann	175	140	100	600	480	550	440	450	360	800,000
Tamarack	300	225	200	1000	800	900	720	800	640	1,300,000

REFERENCE

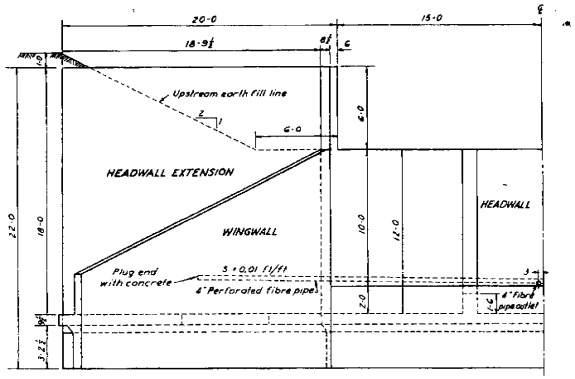
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. Bennett, Chief

ENGINEERING STANDARDS UNIT

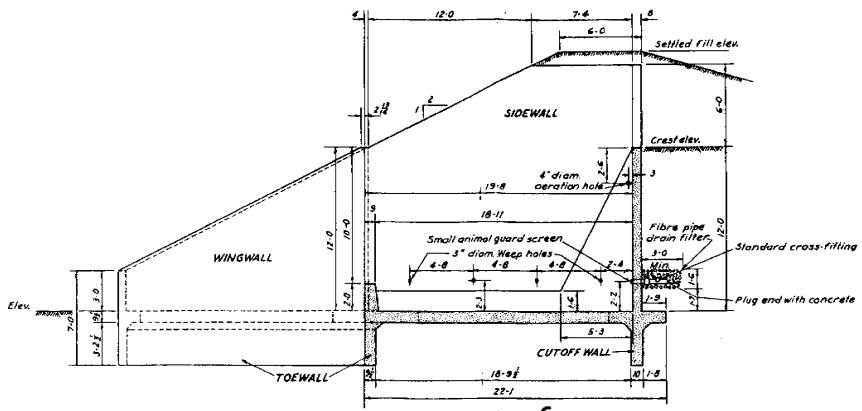
STANDARD DWG. NO.
ES - 26
SHEET 1 OF 1
DATE 5-4-50

shown, but the drawing should not be cluttered up with unnecessary views, marks, and notes. The first sheet of this drawing will be the layout sheet which will show the over-all structure features and dimensions. This sheet will usually contain a bill of materials and lumber cutting bill. The following detail sheets will show the detailed construction information, such as details of members, joints, etc. If the structure is complex and has numerous detail sheets, it is best to show a bill of material and lumber cutting bill on each detail sheet with a summary shown on the layout sheet. The allowable unit stresses used in the design should be indicated on the layout sheet along with whether the design is based on standard dressed, standard rough, or special sizes of lumber.

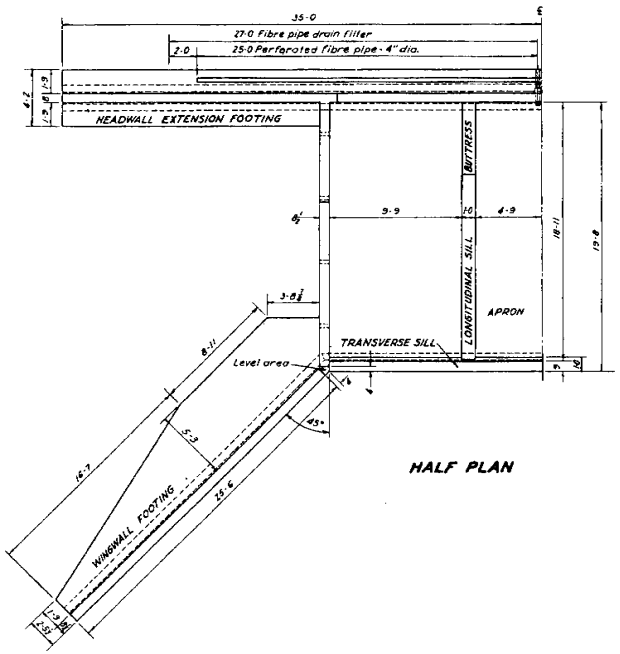
*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-727-744/1701



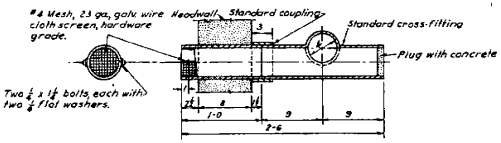
HALF DOWNSTREAM ELEVATION



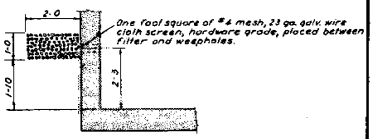
CROSS-SECTION ALONG ℄



HALF PLAN



DETAIL OF SMALL ANIMAL GUARD SCREEN AND OUTLET END OF 4" FIBRE PIPE



SECTION OF WEEP HOLE DRAIN FILTER

NOTES:

The structure is symmetrical about its centerline except the 4" fibre pipe and drain filter which are symmetrical about the outlet of the fibre pipe.
The fibre pipe shall be Orangeburg fibre pipe or equal.
The fibre pipe drain filter shall be a clean pit run sand and gravel mixture and shall be continuous along the pipe and extend 2'-0" beyond the ends of the pipe.
The weep hole drain filter shall be a clean pit-run sand and gravel mixture and shall extend the length of the sidewall.
Chamfer all exposed edges ¾"
All fillets 6"
The longitudinal and transverse sills shall be poured monolithically with the apron and without the use of a horizontal construction joint.
All reinforcing steel shall have at least 2" of concrete cover and in faces poured against earth, it shall have at least 3" of concrete cover.
All reinforcing bar lengths shall be in increments of 3"

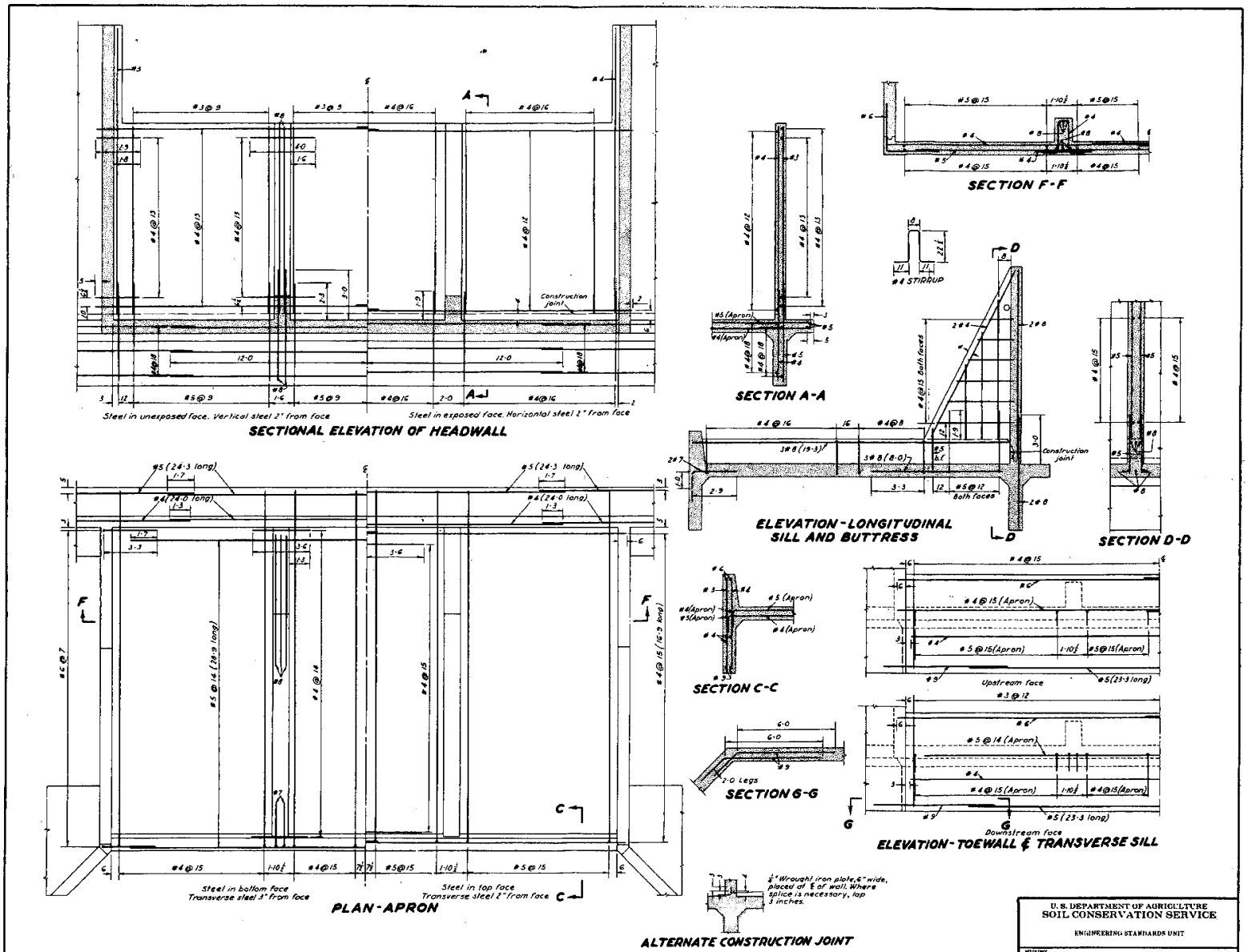
ENGINEERING DRAWING

R/C Drop Spillway: F = 10'-0, h = 6'-0, L = 30'-0

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING STANDARDS UNIT

REFERENCE

ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL J. J. Carey
DESIGNED BY C.A. Reese	DRAWN BY R. Bayeson
CHECKED BY J.R. Brownell	STANDARD DWG. NO. ES-2108-30 BE
DATE 1-13-51	SHEET 1 OF 3 SHEETS



ENGINEERING DRAWING

R/C Drop Spillway - F=10-0, h=6-0, L=30-0

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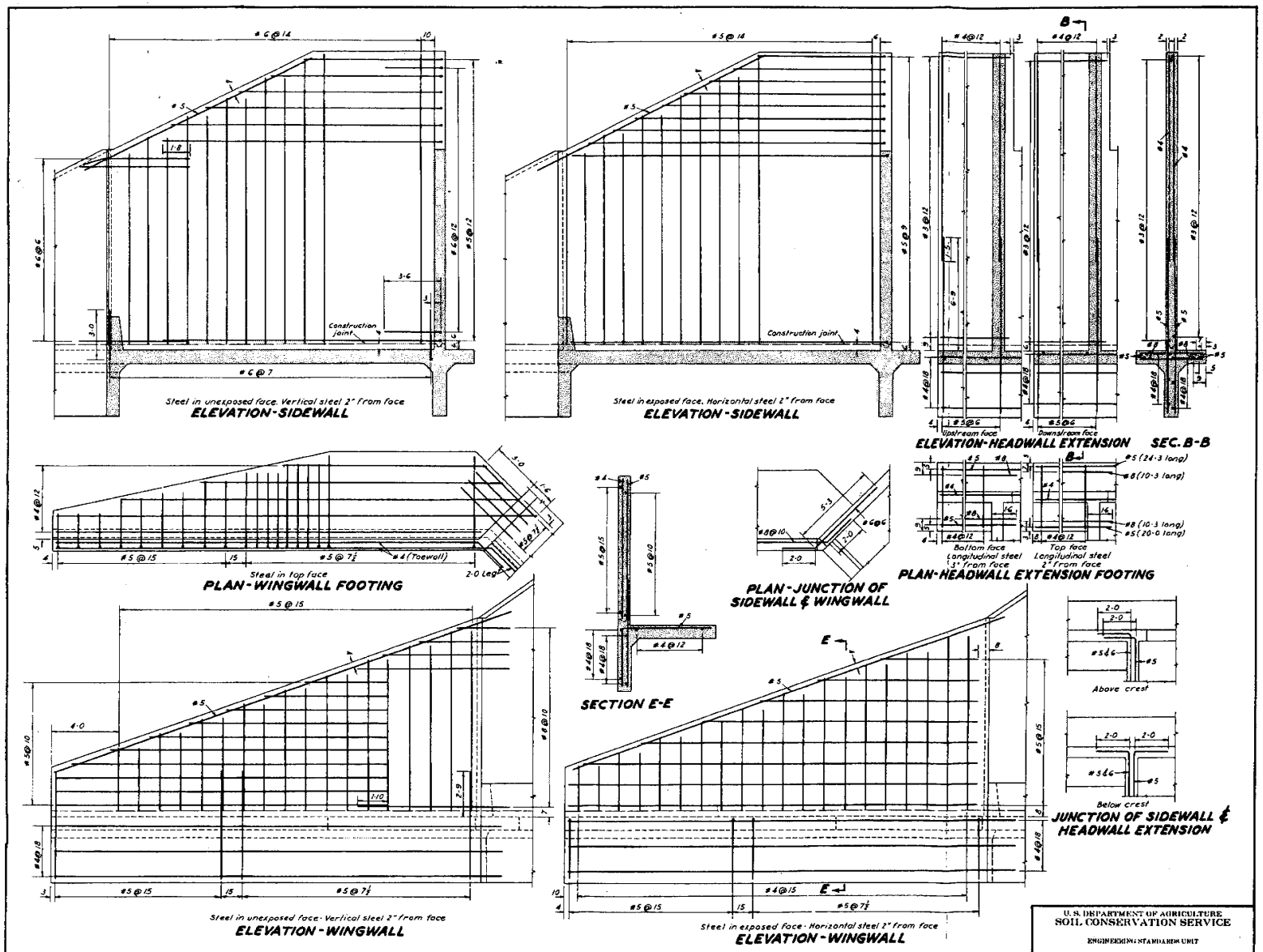
ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL J. T. Carey
DESIGNED BY C.A. Reese	DRAWN BY R. Boyeson
CHECKED BY J.R. Brownell	STANDARD DWG. NO. ES-2108-30 BE
DATE 1-13-51	SHEET 2 OF 3 SHEETS



ENGINEERING DRAWING

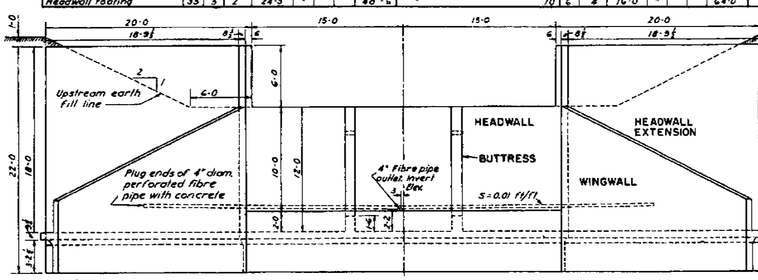
D/C Drop Spillway F=10-0, h=6-0, L=30-0

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING STANDARDS UNIT

REFERENCE	
ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL J. T. Casey
DESIGNED BY C.A. Reese	DRAWN BY R. Boyeson
CHECKED BY J.R. Brownell	STANDARD DWG. NO. ES-2108-30 BE
DATE 1-13-51	SHEET 3 OF 3 SHEETS

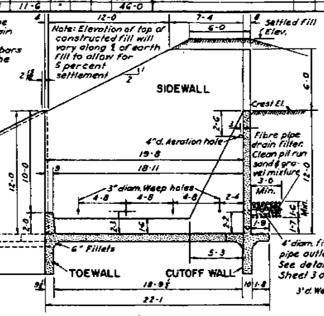
STEEL SCHEDULE

LOCATION	MARK	SIZE	QUAN.	LENGTH	TYPE	A	B	TOTAL FT.
Toewall	1	3	4	8-0	16	2-0	6-0	32-0
"	2	5	2	23-3	St			46-6
"	3	4	2	30-6	"			61-0
Toewall and transverse sill	4	3	31	5-6	"			170-6
" " " "	5	4	25	5-6	"			137-6
Toewall and wingwall	6	5	46	6-6	"			299-0
" " "	7	5	18	6-6	"			117-0
Wingwall footing	8	4	2	25-6	"			51-0
" "	9	4	2	29-0	"			58-0
" "	10	4	2	23-9	"			47-6
" "	11	4	2	18-3	"			36-6
" "	12	4	2	12-3	"			24-6
Wingwall footing and apron	13	5	8	4-6	"			36-0
Toewall and wingwall footing	14	5	30	9-0	2	3-6	5-6	270-0
" " " "	15	5	8	8-6	"	3-6	5-0	68-0
" " " "	16	5	8	8-0	"	3-6	4-6	64-0
" " " "	17	5	4	7-6	"	3-6	4-0	30-0
" " " "	18	5	4	6-9	"	3-6	3-3	27-0
" " " "	19	5	4	6-6	"	3-6	3-0	26-0
" " " "	20	5	6	5-6	"	3-6	2-0	33-0
Toewall under wingwall	21	4	6	27-6	16	25-6	2-0	165-0
" " "	22	4	6	28-0	"	26-0	2-0	168-0
Cutoff wall	23	4	18	24-0	St			432-0
Cutoff wall and headwall	24	5	39	6-0	"			234-0
" " " "	25	8	4	6-9	"			27-0
Cutoff wall and hdwl. ext.	26	5	156	10-6	"			1638-0
Cutoff wall and headwall	27	4	23	5-6	"			126-6
Apron and sidewall	28	6	68	6-3	2	3-3	3-0	425-0
Apron	29	5	17	28-9	St			488-9
"	30	4	34	3-6	"			119-0
Apron and toewall	31	4	24	22-9	2	21-9	1-0	546-0
Longitudinal sill	32	4	28	6-3	S4	See detail		175-0
Longitudinal sill and toewall	33	7	4	3-9	2	2-9	1-0	15-0
Longitudinal sill	34	8	6	8-0	St			48-0
Headwall footing	35	3	2	24-3	"			48-6
Headwall extension footing	36	4	76	3-9	St			285-0
" " "	37	5	4	20-0	"			80-0
" " "	38	8	8	10-3	"			82-0
" " "	39	9	4	24-3	"			97-0
Apron and toewall	40	5	24	22-3	2	21-3	1-0	534-0
Apron	41	4	32	16-9	St			536-0
"	42	4	15	7-0	"			105-0
Longitudinal sill	43	8	6	19-3	"			115-6
Transverse sill	44	6	4	17-0	"			68-0
Buttress	45	5	16	3-9	"			60-0
"	46	5	4	2-9	"			11-0
Wingwall	47	5	4	10-9	"			43-0
"	48	5	4	10-0	"			40-0
"	49	5	4	9-0	"			36-0
"	50	5	4	8-3	"			33-0
"	51	5	4	7-3	"			29-0
"	52	5	4	6-6	"			26-0
"	53	5	4	5-6	"			22-0
"	54	5	4	4-9	"			19-0
"	55	5	4	3-9	"			15-0
Wingwall and sidewall	56	8	22	9-9	16	7-9	2-0	214-6
" " "	57	8	2	8-3	"	6-3	2-0	16-6
" " "	58	8	2	6-0	"	4-0	2-0	12-0
" " "	59	8	2	3-9	"	1-9	2-0	7-6
Wingwall	60	5	6	20-0	St			120-0
"	61	5	2	19-0	"			38-0
"	62	5	2	16-9	"			33-6
"	63	5	2	14-3	"			28-6
"	64	5	2	12-0	"			24-0
"	65	5	2	9-9	"			19-6
"	66	5	2	7-6	"			15-0
"	67	5	2	5-0	"			10-0
Sidewall	68	6	12	17-6	"			210-0
"	69	6	2	17-3	"			34-6
"	70	6	4	16-0	"			64-0
Sidewall	71	6	4	14-9	St			59-0
"	72	6	4	13-9	"			55-0
"	73	6	4	12-6	"			50-0
"	74	6	4	11-6	"			46-0
Sidewall and headwall ext.	75	5	26	18-9	2	16-9	2-0	487-6
" " " "	76	5	2	18-3	2	16-3	2-0	36-6
" " " "	77	5	2	16-3	2	14-3	2-0	32-6
" " " "	78	5	2	14-3	2	12-3	2-0	28-6
" " " "	79	5	2	12-3	2	10-3	2-0	24-6
" " " "	80	5	2	10-3	2	8-3	2-0	20-6
" " " "	81	6	34	5-6	2	3-6	2-0	187-0
Sidewall and wingwall	82	6	46	7-3	16	5-3	2-0	333-6
Wingwall	83	4	4	10-6	St			42-0
"	84	4	4	9-6	"			38-0
"	85	4	4	8-9	"			35-0
"	86	4	4	8-0	"			32-0
"	87	4	4	7-0	"			28-0
"	88	4	4	6-0	"			24-0
"	89	4	4	5-3	"			21-0
"	90	4	4	4-6	"			18-0
"	91	4	4	3-6	"			14-0
"	92	4	4	2-9	"			11-0
"	93	5	4	25-0	"			100-0
"	94	5	2	24-0	"			48-0
"	95	5	2	20-6	"			41-0
"	96	5	2	16-9	"			33-6
"	97	5	2	13-3	"			26-6
"	98	5	2	9-9	"			19-6
"	99	5	2	6-0	"			12-0
Wingwall and sidewall	100	5	4	28-3	16	26-3	2-0	113-0
Headwall extension	101	4	80	12-6	St			1000-0
" "	102	3	72	19-6	"			1404-0
Headwall	103	3	2	17-6	"			35-0
"	104	3	37	11-6	"			425-6
"	105	8	4	11-6	"			46-0
Headwall	106	4	22	17-3	St			379-6
"	107	4	20	2-9	"			55-0
"	108	8	20	4-0	"			80-0
Sidewall	109	5	14	17-6	"			245-0
"	110	5	4	16-0	"			64-0
"	111	5	4	15-0	"			60-0
"	112	5	4	13-9	"			55-0
"	113	5	4	12-6	"			50-0
"	114	5	4	11-6	"			46-0
Sidewall and headwall	115	5	32	21-3	2	19-3	2-0	680-0
Sidewall and headwall ext.	116	5	2	20-0	2	18-0	2-0	40-0
" " " "	117	5	2	18-6	2	16-6	2-0	37-0
" " " "	118	5	2	17-3	2	15-3	2-0	34-6
" " " "	119	5	2	15-6	2	13-6	2-0	31-0
" " " "	120	5	2	14-3	2	12-3	2-0	28-6
" " " "	121	5	2	12-9	2	10-9	2-0	25-6
" " " "	122	5	2	11-3	2	9-3	2-0	22-6
" " " "	123	5	2	9-9	2	7-9	2-0	19-6
Sidewall and wingwall	124	5	4	15-6	16	13-6	2-0	62-0
Headwall	125	4	2	17-6	St			35-0
"	126	4	21	11-6	"			241-6
"	127	4	24	17-0	"			408-0
Buttress	128	5	4	8-6	"			34-0
"	129	5	4	6-6	"			26-0
"	130	5	4	4-6	"			18-0
"	131	4	4	4-9	"			19-0
"	132	4	4	4-0	"			16-0
"	133	4	4	3-6	"			14-0
"	134	4	4	2-9	"			11-0
"	135	4	4	2-3	"			9-0
"	136	4	4	1-6	"			6-0
"	137	4	4	11-3	"			45-0

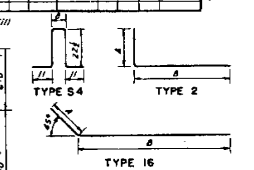


DOWNSTREAM ELEVATION

Note: The mark numbers indicate the respective bar locations and remain the same for all standard drop spillways in this series. Standard bars not required are not listed in the steel schedule.

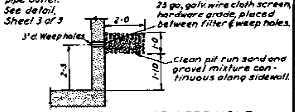


CROSS-SECTION ALONG ℄

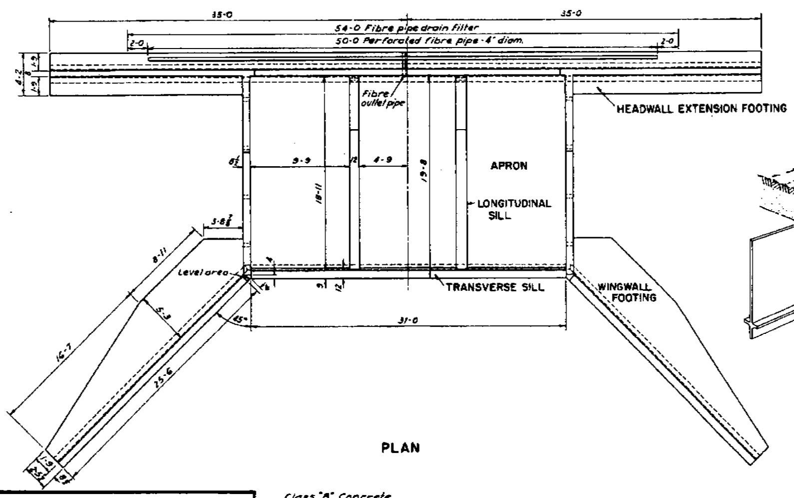


The bar schedule is listed in the approximate order of placement. Bars 1 through 46 are contained in the first pour. All reinforcing steel is round. "St" is an abbreviation for straight.

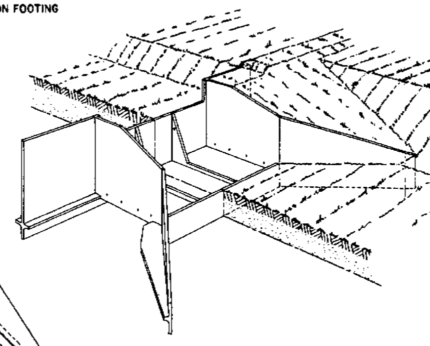
BAR TYPE DETAILS



SECTION OF WEEP HOLE AND DRAIN FILTER



PLAN



PERSPECTIVE VIEW

Not to scale.

QUANTITIES

Reinforced concrete		108.45 Cu. yds
Reinforcing steel		
# 3	2035.00 Ft.	765.16 Pounds
# 4	5655.50 "	3777.87 "
# 5	7361.25 "	7677.78 "
# 6	1532.00 "	2301.06 "
# 7	15.00 "	30.66 "
# 8	569.00 "	1519.23 "
# 9	32.00 "	108.80 "
Drainage-Perforated fibre pipe-4" d.		52.5 L.F.
Drainage-Drain filter		11.9 Cu. yd.

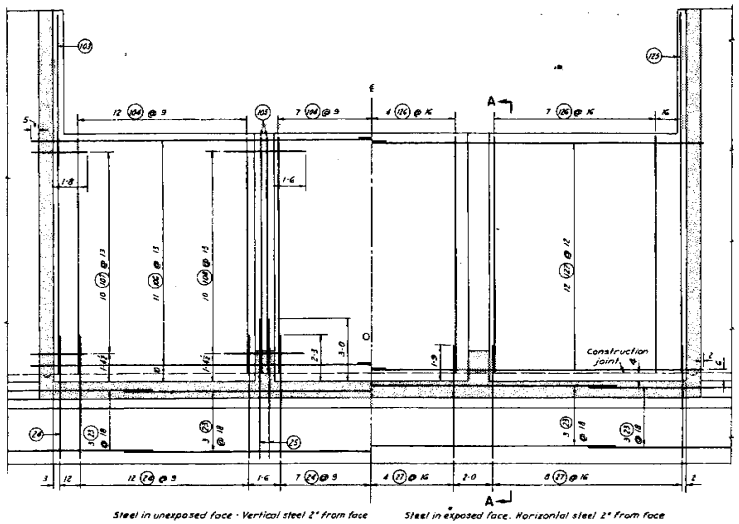
Class "B" Concrete
f_s = 20,000 lbs/sq.in.
f'_c = 3,000 "
f_c = 1,200 "

F = 10-0, h = 6-0, L = 30-0

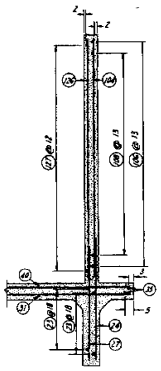
Note: Structure is symmetrical about ℄ except for 4" fibre pipe drain and outlet.
Chamfer all exposed edges ¾".

ENGINEERING STANDARDS UNIT
Engineering Approval: M. M. Culp
Cartographic Approval: [signature]
Designed by: C.A. Reese
Drawn by: R. Boyeson
Checked by: J. R. Brownell
Standard Dwg. No. ES-2108-30B
Date: 2-5-51
Sheet 1 of 3 Sheets

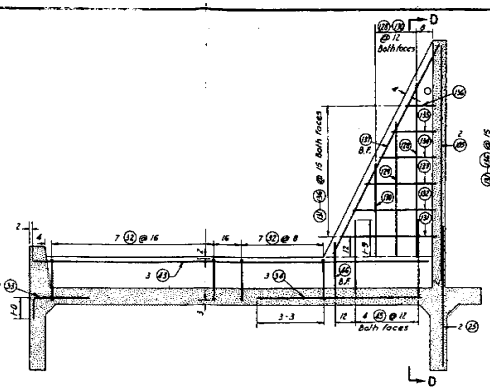
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Reference
Engineering Approval
Cartographic Approval
Adapted by
Drawn by
Checked by
Drawing No.
Date
Sheet of Sheets



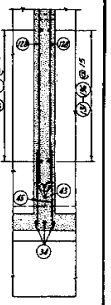
SECTIONAL ELEVATION OF HEADWALL



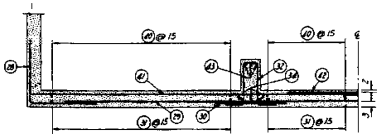
SECTION A-A



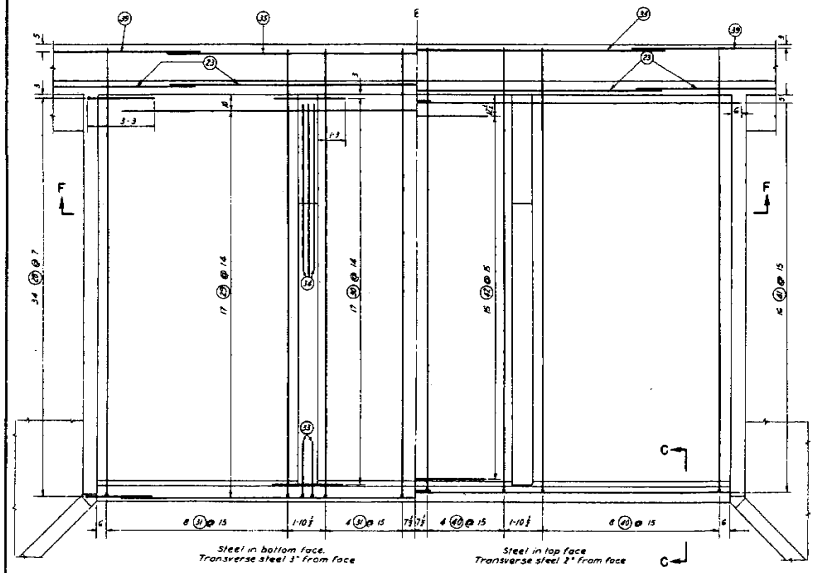
ELEVATION - LONGITUDINAL SILL AND BUTTRESS



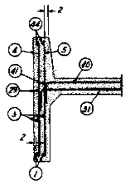
SEC. D-D



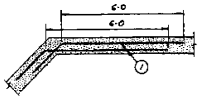
HALF - SECTION F-F



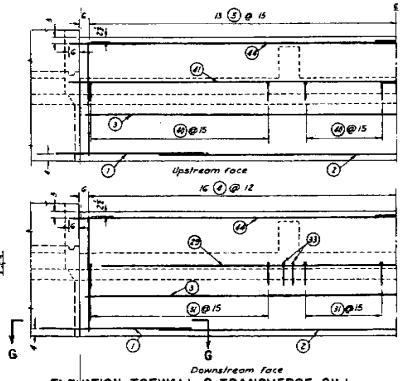
PLAN - APRON



SECTION C-C



SECTION G-G



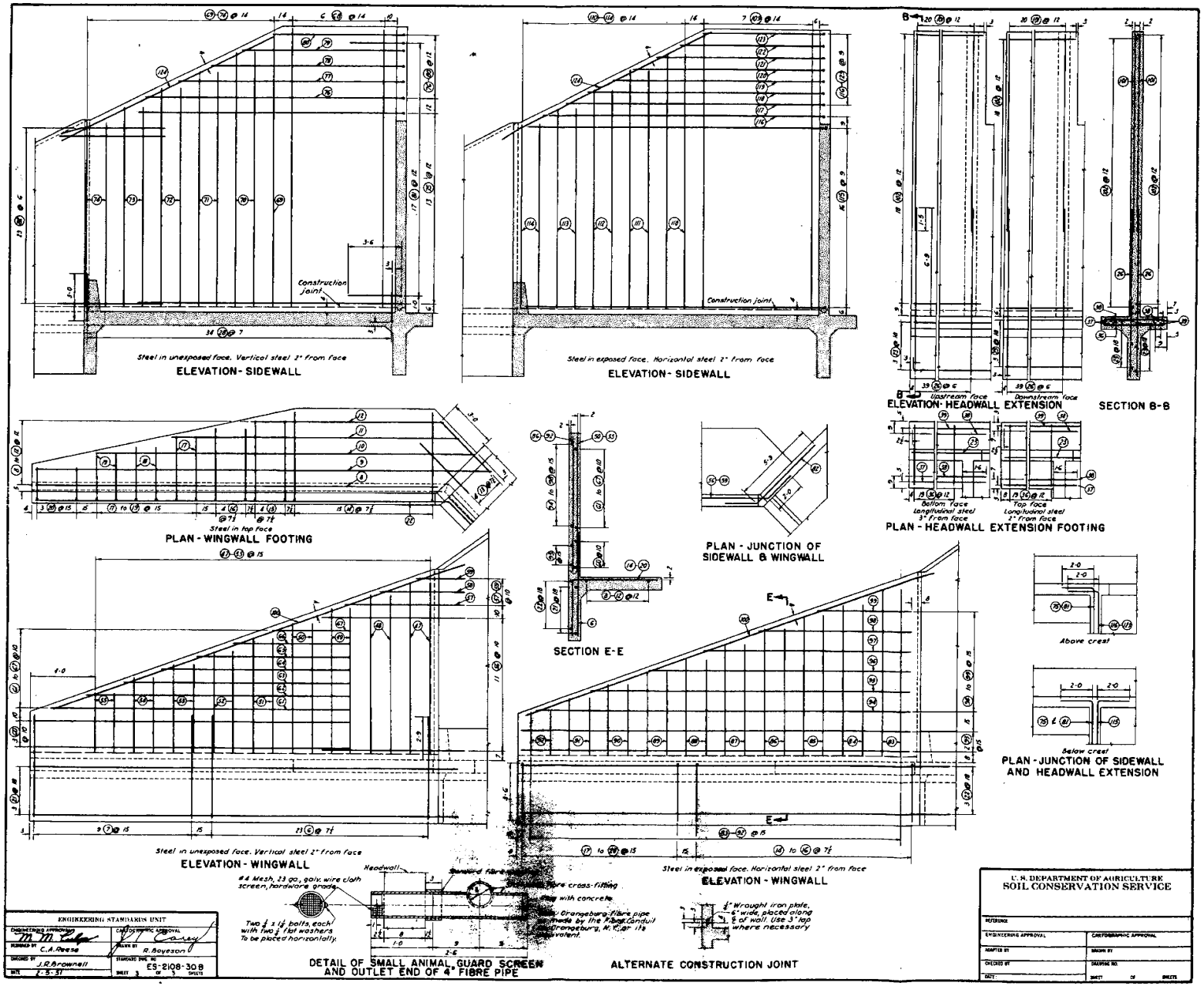
ELEVATION - TOEWALL & TRANSVERSE SILL

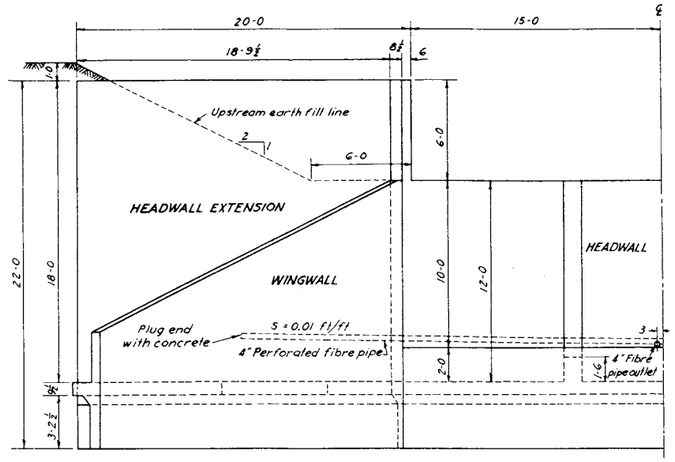
Note:
The longitudinal and transverse sills shall be poured monolithically with the apron and without use of a horizontal construction joint.
All dimensions showing distance from face of concrete to steel designate the clear distance.

ENGINEERING STANDARDS UNIT	
ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL J. J. Casey
DESIGNED BY C. A. Reese	DRAWN BY R. Bowson
CHECKED BY J. R. Brownell	STANDARD DWG. NO. ES-2108-308
DATE 2-3-51	SHEET 2 OF 3 SHEETS

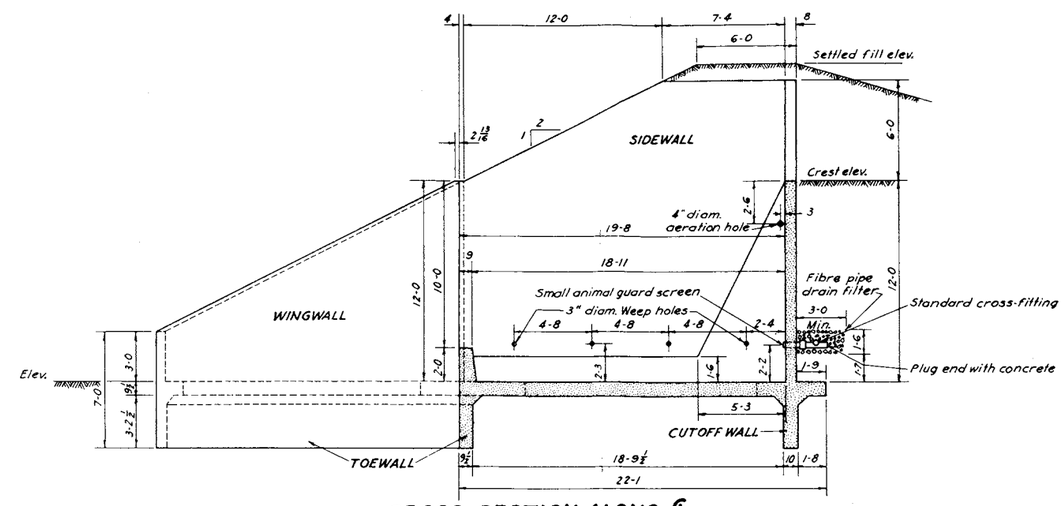
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

RESERVOIR	
ENGINEERING APPROVAL	CARTOGRAPHIC APPROVAL
ADAPTED BY	DRAWN BY
CHECKED BY	DRAWING NO.
DATE	SHEET OF SHEETS

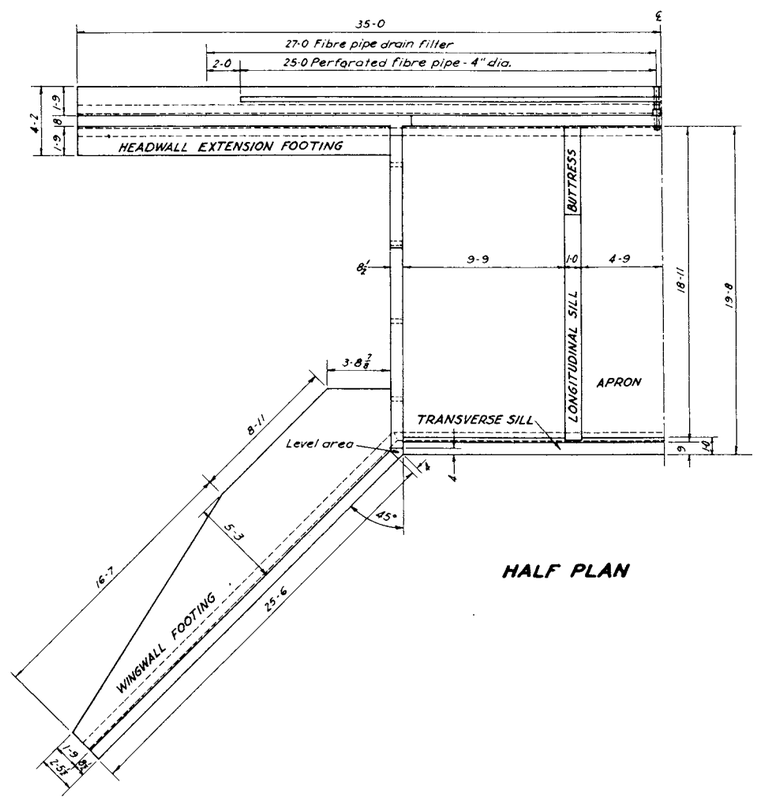

Steel in unexposed face. Vertical steel 2" from face
ELEVATION - SIDEWALL
Construction joint
Steel in exposed face. Horizontal steel 2" from face
ELEVATION - SIDEWALL
Construction joint
Upstream face
Downstream face
ELEVATION - HEADWALL EXTENSION
SECTION B-B
Steel in top face
PLAN - WINGWALL FOOTING
SECTION E-E
PLAN - JUNCTION OF SIDEWALL & WINGWALL
Bottom face
Longitudinal steel 3" from face
Top face
Longitudinal steel 2" from face
PLAN - HEADWALL EXTENSION FOOTING
Above crest
Below crest
PLAN - JUNCTION OF SIDEWALL AND HEADWALL EXTENSION
Steel in unexposed face. Vertical steel 2" from face
ELEVATION - WINGWALL
Steel in exposed face. Horizontal steel 2" from face
ELEVATION - WINGWALL
#4 Mesh, 23 ga., galv. wire cloth screen, hardware grade
Headwall
Two ½ x 1½ bolts each with two ½ flat washers To be placed horizontally.
DETAIL OF SMALL ANIMAL GUARD SCREEN AND OUTLET END OF 4" FIBRE PIPE
½" Wrought iron plate, 6" wide, placed along ½ of wall. Use 3" lap where necessary
ALTERNATE CONSTRUCTION JOINT
ENGINEERING STANDARDS UNIT
ENGINEERING APPROVAL
CARTOGRAPHIC APPROVAL
DRAWN BY R. Boyeson
CHECKED BY J.R. Brownell
DATE 2-5-51
STANDARD DWG. NO. ES-2108-308
SHEET 3 OF 3 SHEETS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
REVISIONS
ENGINEERING APPROVAL
CARTOGRAPHIC APPROVAL
ADAPTED BY
DRAWN BY
CHECKED BY
DRAWING NO.
DATE
SHEET OF SHEETS



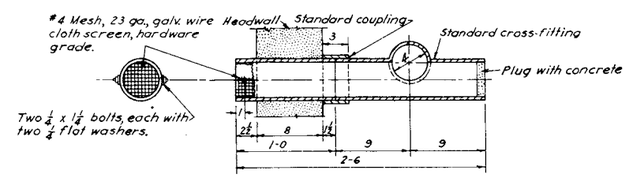
HALF DOWNSTREAM ELEVATION



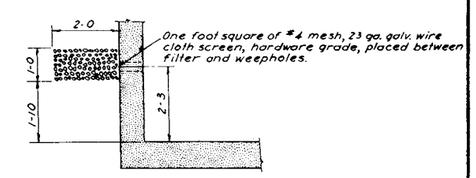
CROSS-SECTION ALONG ℄



HALF PLAN



DETAIL OF SMALL ANIMAL GUARD SCREEN AND OUTLET END OF 4" FIBRE PIPE



SECTION OF WEEP HOLE DRAIN FILTER

NOTES:

The structure is symmetrical about its centerline except the 4" fibre pipe and drain filter which are symmetrical about the outlet of the fibre pipe.

The fibre pipe shall be Orangeburg fibre pipe or equal.

The fibre pipe drain filter shall be a clean pit run sand and gravel mixture and shall be continuous along the pipe and extend 2'-0" beyond the ends of the pipe.

The weep hole drain filter shall be a clean pit-run sand and gravel mixture and shall extend the length of the sidewall.

Chamfer all exposed edges 3/4"

All fillets 6"

The longitudinal and transverse sills shall be poured monolithically with the apron and without the use of a horizontal construction joint.

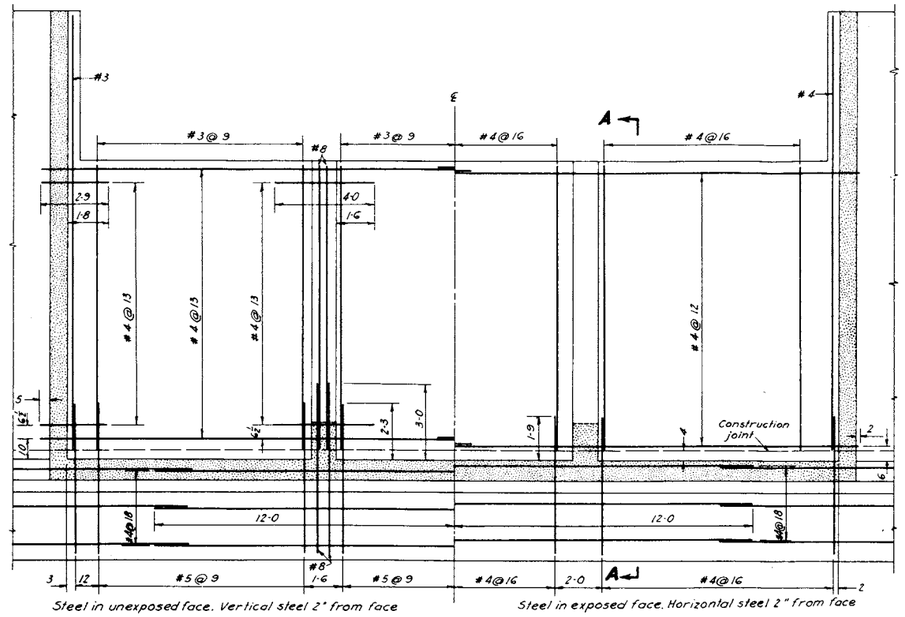
All reinforcing steel shall have at least 2" of concrete cover and in faces poured against earth, it shall have at least 3" of concrete cover.

All reinforcing bar lengths shall be in increments of 3"

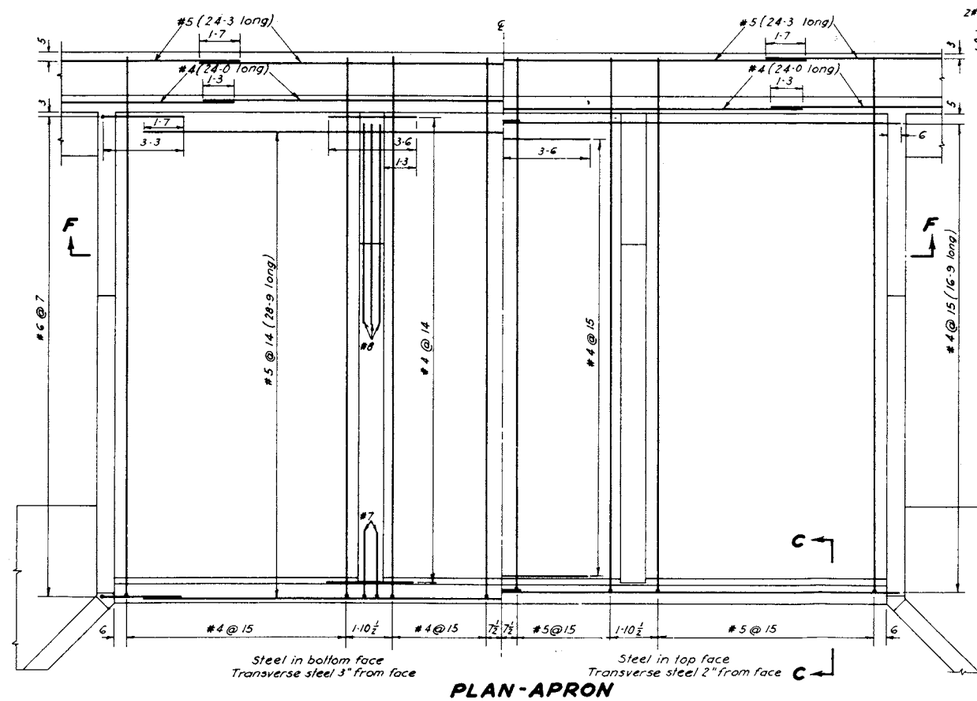
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING STANDARDS UNIT

REFERENCE	
ENGINEERING APPROVAL: W. M. Culp	CARTOGRAPHIC APPROVAL: V. Carey
DESIGNED BY: C.A. Reese	DRAWN BY: R. Boyeson
CHECKED BY: J.R. Brownell	STANDARD DWG. NO.: ES-2108-30 BE
DATE: 1-13-51	SHEET 1 OF 3 SHEETS

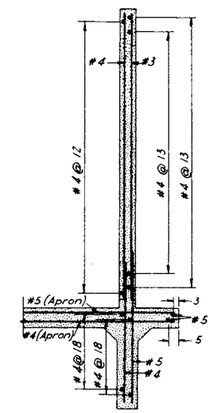
ENGINEERING DRAWING R/C Drop Spillway - F = 10'-0, h = 6'-0, L = 30'-0



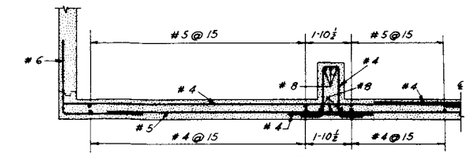
SECTIONAL ELEVATION OF HEADWALL



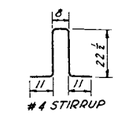
PLAN-APRON



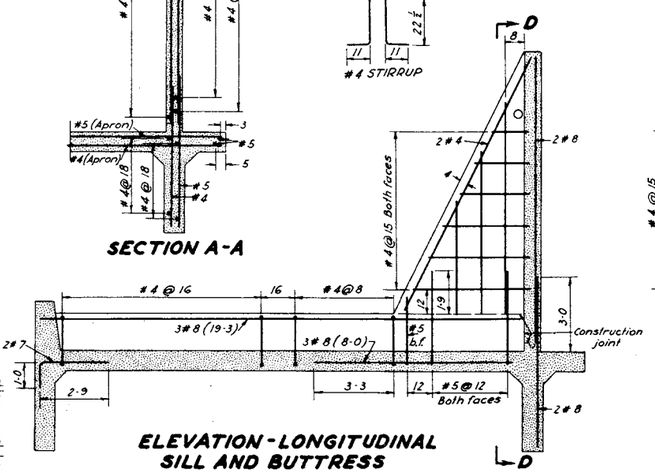
SECTION A-A



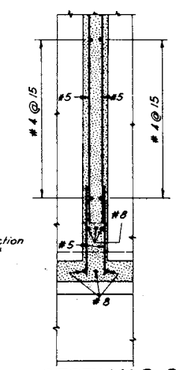
SECTION F-F



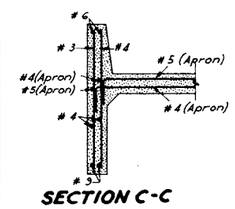
#4 STIRRUP



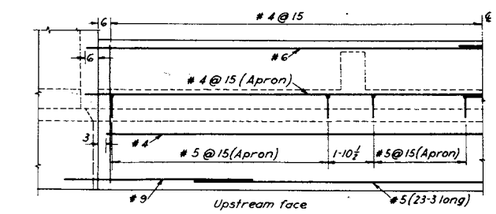
ELEVATION-LONGITUDINAL SILL AND BUTTRESS

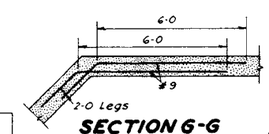


SECTION D-D

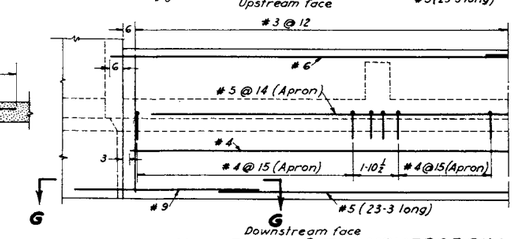


SECTION C-C

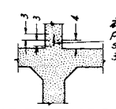




SECTION G-G



ELEVATION-TOEWALL & TRANSVERSE SILL



¼" Wrought iron plate, 6" wide, placed at ℄ of wall. Where splice is necessary, lap 3 inches.

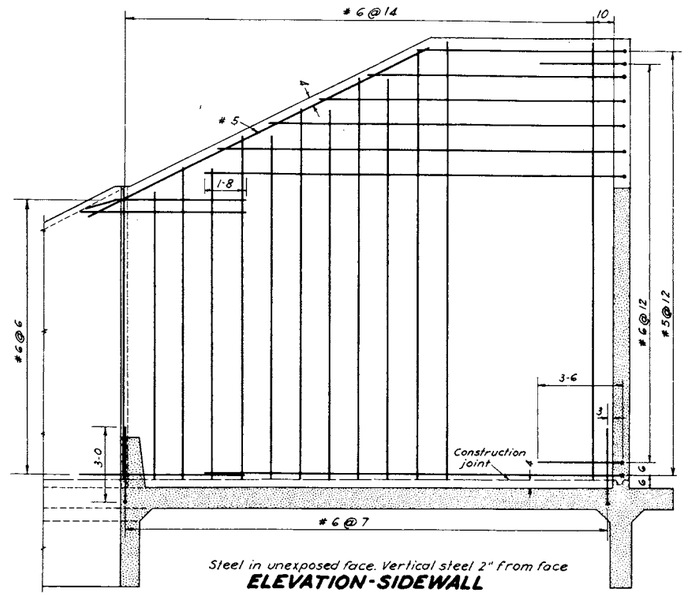
ALTERNATE CONSTRUCTION JOINT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

ENGINEERING STANDARDS UNIT

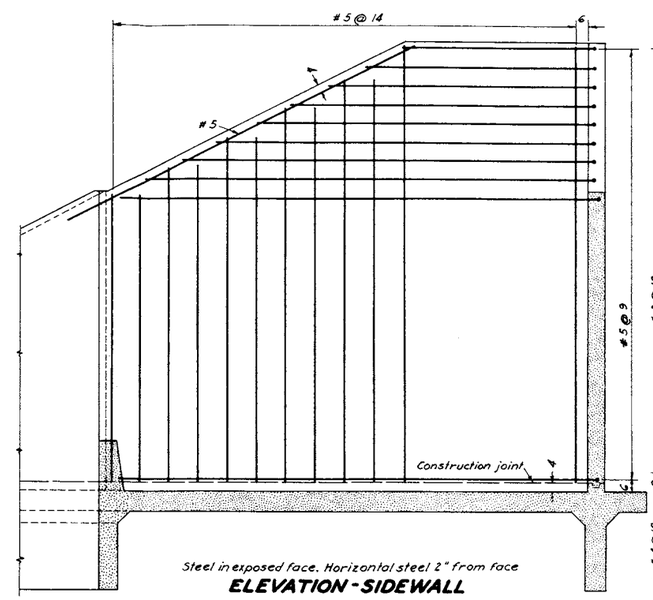
REFERENCE	
ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL F. T. Carey
DESIGNED BY C.A. Reese	DRAWN BY R. Boyeson
CHECKED BY J.R. Brownell	STANDARD DWG. NO. ES-2108-30 BE
DATE 1-13-51	SHEET 2 OF 3 SHEETS

ENGINEERING DRAWING R/C Drop Spillway - F=10·0, h=6·0, L=30·0



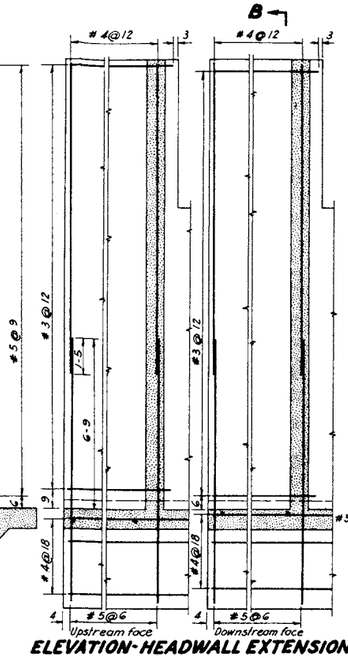
Steel in unexposed face. Vertical steel 2" from face

ELEVATION-SIDEWALL

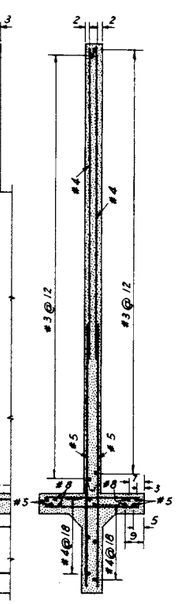


Steel in exposed face. Horizontal steel 2" from face

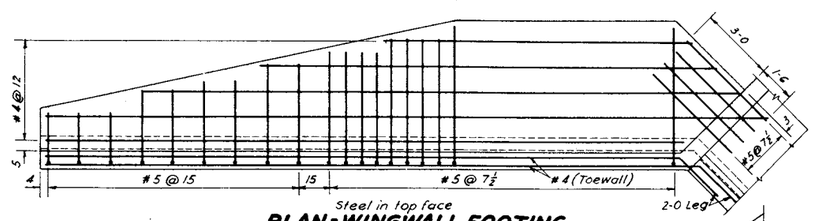
ELEVATION-SIDEWALL



ELEVATION-HEADWALL EXTENSION

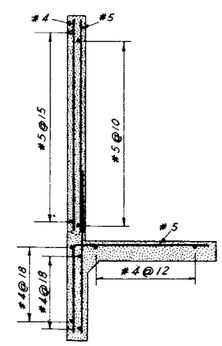


SEC. B-B

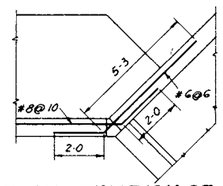


Steel in top face

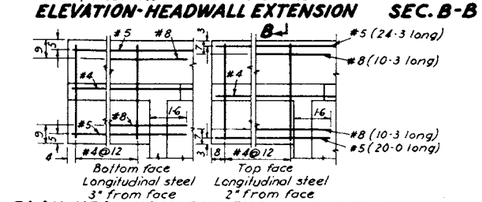
PLAN-WINGWALL FOOTING



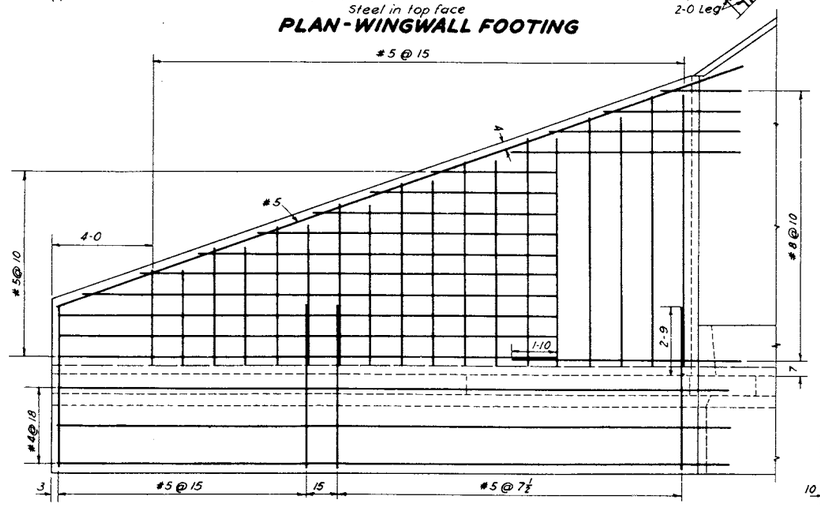
SECTION E-E



PLAN-JUNCTION OF SIDEWALL & WINGWALL

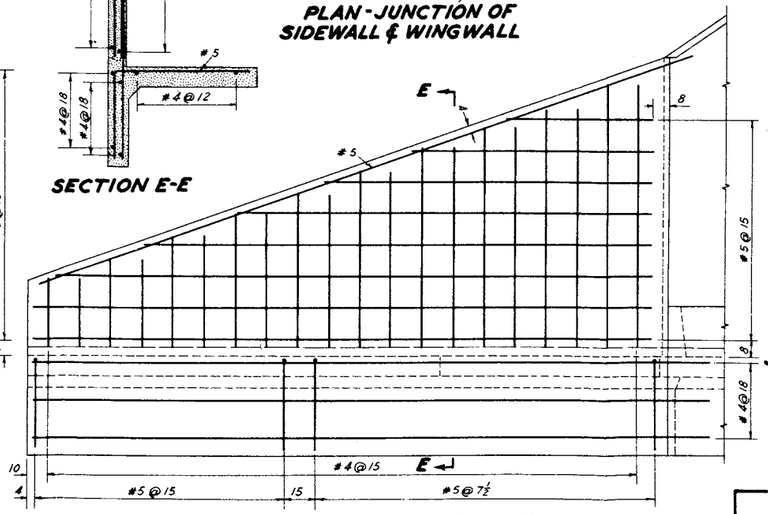


PLAN-HEADWALL EXTENSION FOOTING



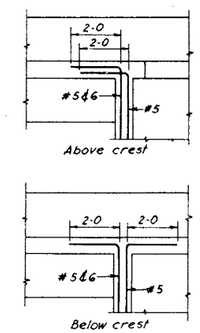
Steel in unexposed face - Vertical steel 2" from face

ELEVATION-WINGWALL



Steel in exposed face - Horizontal steel 2" from face

ELEVATION-WINGWALL



JUNCTION OF SIDEWALL & HEADWALL EXTENSION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

ENGINEERING STANDARDS UNIT

REFERENCE

ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL V. J. Cusey
DESIGNED BY C.A. Reese	DRAWN BY R. Boyeson
CHECKED BY J.R. Brownell	STANDARD DWG. NO. ES-2108-30 BE
DATE 1-13-51	SHEET 3 OF 3 SHEETS

ENGINEERING DRAWING

R/C Drop Spillway F=10-0, h=6-0, L=30-0

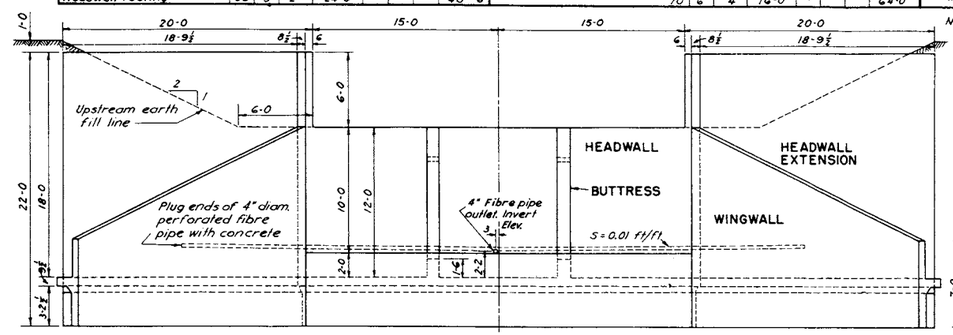
STEEL SCHEDULE

LOCATION	MARK	SIZE	QUAN.	LENGTH	TYPE	A	B	TOTAL FT.
Toewall	1	5	4	8'-0	16	2'-0	6'-0	32'-0
"	2	5	2	23'-3	51			46'-6
"	3	4	2	30'-6	"			61'-0
Toewall and transverse sill	4	3	31	5'-6	"			170'-6
" " " "	5	4	25	5'-6	"			137'-6
Toewall and wingwall	6	5	46	6'-6	"			299'-0
" " "	7	5	18	6'-6	"			117'-0
Wingwall footing	8	4	2	25'-6	"			51'-0
" "	9	4	2	29'-0	"			58'-0
" "	10	4	2	23'-9	"			47'-6
" "	11	4	2	18'-3	"			36'-6
" " " "	12	4	2	12'-3	"			24'-6
Wingwall footing and apron	13	5	8	4'-6	"			36'-0
Toewall and wingwall footing	14	5	30	9'-0	2	3'-6	5'-6	270'-0
" " " "	15	5	8	8'-6	"	3'-6	5'-0	68'-0
" " " "	16	5	8	8'-0	"	3'-6	4'-6	64'-0
" " " "	17	5	4	7'-6	"	3'-6	4'-0	30'-0
" " " "	18	5	4	6'-9	"	3'-6	3'-3	27'-0
" " " "	19	5	4	6'-6	"	3'-6	3'-0	26'-0
" " " "	20	5	6	5'-6	"	3'-6	2'-0	33'-0
Toewall under wingwall	21	4	6	27'-6	16	25'-6	2'-0	165'-0
" " "	22	4	6	28'-0	"	26'-0	2'-0	168'-0
Cutoff wall	23	4	18	24'-0	51			432'-0
Cutoff wall and headwall	24	5	39	6'-0	"			234'-0
" " " "	25	8	4	6'-9	"			27'-0
Cutoff wall and hdwl. ext.	26	5	156	10'-6	"			1638'-0
Cutoff wall and headwall	27	4	23	5'-6	"			126'-6
Apron and sidewall	28	6	68	6'-3	2	3'-3	3'-0	425'-0
Apron	29	5	17	28'-9	51			488'-9
"	30	4	34	3'-6	"			119'-0
Apron and toewall	31	4	24	22'-9	2	21'-9	1'-0	546'-0
Longitudinal sill	32	4	28	6'-3	54	See detail		175'-0
Longitudinal sill and toewall	33	7	4	3'-9	2	2'-9	1'-0	15'-0
Longitudinal sill	34	8	6	8'-0	51			48'-0
Headwall footing	35	5	2	24'-3	"			48'-6

LOCATION	MARK	SIZE	QUAN.	LENGTH	TYPE	A	B	TOTAL FT.
Headwall extension footing	36	4	76	3'-9	51			285'-0
" " "	37	5	4	20'-0	"			80'-0
" " "	38	8	8	10'-3	"			82'-0
" " "	39	5	4	24'-3	"			97'-0
Apron and toewall	40	5	24	22'-3	2	21'-3	1'-0	534'-0
Apron	41	4	32	16'-9	51			536'-0
"	42	4	15	7'-0	"			105'-0
Longitudinal sill	43	8	6	19'-3	"			115'-6
Transverse sill	44	6	4	17'-0	"			68'-0
Buttress	45	5	16	3'-9	"			60'-0
"	46	5	4	2'-9	"			11'-0
Wingwall	47	5	4	10'-9	"			43'-0
"	48	5	4	10'-0	"			40'-0
"	49	5	4	9'-0	"			36'-0
"	50	5	4	8'-3	"			33'-0
"	51	5	4	7'-3	"			29'-0
"	52	5	4	6'-6	"			26'-0
"	53	5	4	5'-6	"			22'-0
"	54	5	4	4'-9	"			19'-0
"	55	5	4	3'-9	"			15'-0
Wingwall and sidewall	56	8	22	9'-9	16	7'-9	2'-0	214'-6
" " "	57	8	2	8'-3	"	6'-3	2'-0	16'-6
" " "	58	8	2	6'-0	"	4'-0	2'-0	12'-0
" " "	59	8	2	3'-9	"	1'-9	2'-0	7'-6
Wingwall	60	5	6	20'-0	51			120'-0
"	61	5	2	19'-0	"			38'-0
"	62	5	2	16'-9	"			33'-6
"	63	5	2	14'-3	"			28'-6
"	64	5	2	12'-0	"			24'-0
"	65	5	2	9'-9	"			19'-6
"	66	5	2	7'-6	"			15'-0
"	67	5	2	5'-0	"			10'-0
Sidewall	68	6	12	17'-6	"			210'-0
"	69	6	2	17'-3	"			34'-6
"	70	6	4	16'-0	"			64'-0

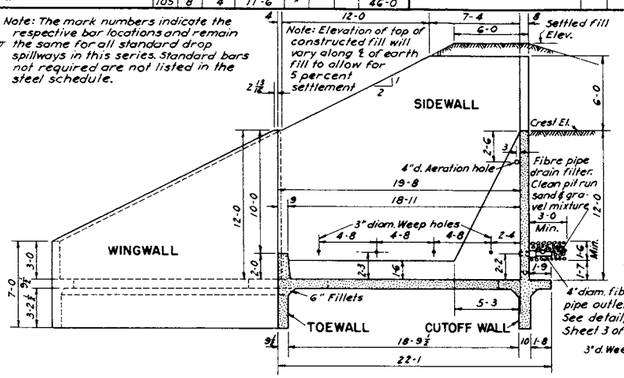
LOCATION	MARK	SIZE	QUAN.	LENGTH	TYPE	A	B	TOTAL FT.
Sidewall	71	6	4	14'-9	51			59'-0
"	72	6	4	13'-9	"			55'-0
"	73	6	4	12'-6	"			50'-0
"	74	6	4	11'-6	"			46'-0
Sidewall and headwall ext.	75	5	26	18'-9	2	16'-9	2'-0	487'-6
" " " "	76	5	2	18'-3	2	16'-3	2'-0	36'-6
" " " "	77	5	2	16'-3	2	14'-3	2'-0	32'-6
" " " "	78	5	2	14'-3	2	12'-3	2'-0	28'-6
" " " "	79	5	2	12'-3	2	10'-3	2'-0	24'-6
" " " "	80	5	2	10'-3	2	8'-3	2'-0	20'-6
" " " "	81	6	34	5'-6	2	3'-6	2'-0	187'-0
Sidewall and wingwall	82	6	46	7'-3	16	5'-3	2'-0	333'-6
Wingwall	83	4	4	10'-6	51			42'-0
"	84	4	4	9'-6	"			38'-0
"	85	4	4	8'-9	"			35'-0
"	86	4	4	8'-0	"			32'-0
"	87	4	4	7'-0	"			28'-0
"	88	4	4	6'-0	"			24'-0
"	89	4	4	5'-3	"			21'-0
"	90	4	4	4'-6	"			18'-0
"	91	4	4	3'-6	"			14'-0
"	92	4	4	2'-9	"			11'-0
"	93	5	4	25'-0	"			100'-0
"	94	5	2	24'-0	"			48'-0
"	95	5	2	20'-6	"			41'-0
"	96	5	2	16'-9	"			33'-6
"	97	5	2	13'-3	"			26'-6
"	98	5	2	9'-9	"			19'-6
"	99	5	2	6'-0	"			12'-0
Wingwall and sidewall	100	5	4	28'-3	16	26'-3	2'-0	113'-0
Headwall extension	101	4	80	12'-6	51			1000'-0
" "	102	3	72	19'-6	"			1404'-0
Headwall	103	3	2	17'-6	"			35'-0
"	104	3	37	11'-6	"			425'-6
"	105	8	4	11'-6	"			46'-0

LOCATION	MARK	SIZE	QUAN.	LENGTH	TYPE	A	B	TOTAL FT.
Headwall	106	4	22	17'-3	51			379'-6
"	107	4	20	2'-9	"			55'-0
"	108	4	20	4'-0	"			80'-0
Sidewall	109	5	14	17'-6	"			245'-0
"	110	5	4	16'-0	"			64'-0
"	111	5	4	15'-0	"			60'-0
"	112	5	4	13'-9	"			55'-0
"	113	5	4	12'-6	"			50'-0
"	114	5	4	11'-6	"			46'-0
Sidewall and headwall	115	5	32	21'-3	2	19'-3	2'-0	680'-0
Sidewall and headwall ext.	116	5	2	20'-0	2	18'-0	2'-0	40'-0
" " " "	117	5	2	18'-6	2	16'-6	2'-0	37'-0
" " " "	118	5	2	17'-3	2	15'-3	2'-0	34'-6
" " " "	119	5	2	15'-6	2	13'-6	2'-0	31'-0
" " " "	120	5	2	14'-3	2	12'-3	2'-0	28'-6
" " " "	121	5	2	12'-9	2	10'-9	2'-0	25'-6
" " " "	122	5	2	11'-3	2	9'-3	2'-0	22'-6
" " " "	123	5	2	9'-9	2	7'-9	2'-0	19'-6
Sidewall and wingwall	124	5	4	15'-6	16	13'-6	2'-0	62'-0
Headwall	125	4	2	17'-6	51			35'-0
"	126	4	21	11'-6	"			241'-6
"	127	4	24	17'-0	"			408'-0
Buttress	128	5	4	8'-6	"			34'-0
"	129	5	4	6'-6	"			26'-0
"	130	5	4	4'-6	"			18'-0
"	131	4	4	4'-9	"			19'-0
"	132	4	4	4'-0	"			16'-0
"	133	4	4	3'-6	"			14'-0
"	134	4	4	2'-9	"			11'-0
"	135	4	4	2'-3	"			9'-0
"	136	4	4	1'-6	"			6'-0
"	137	4	4	11'-3	"			45'-0

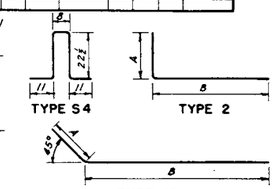


DOWNSTREAM ELEVATION

Note: The mark numbers indicate the respective bar locations and remain the same for all standard drop spillways in this series. Standard bars not required are not listed in the steel schedule.

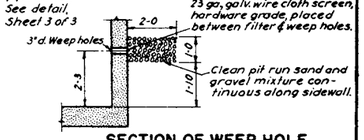


CROSS-SECTION ALONG ℄

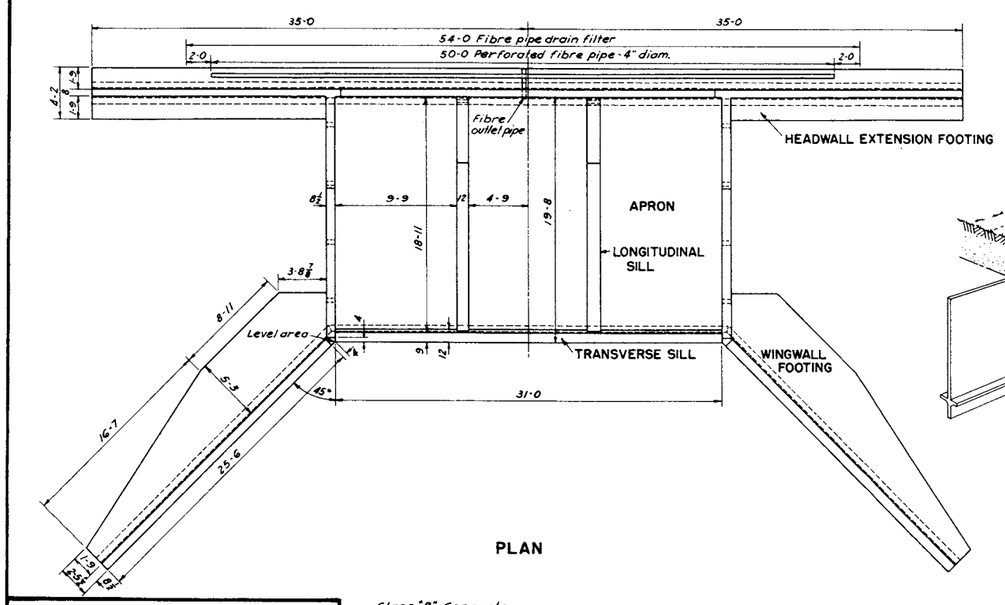


The bar schedule is listed in the approximate order of placement. Bars 1 through 46 are contained in the first pour. All reinforcing steel is round. "St" is an abbreviation for straight.

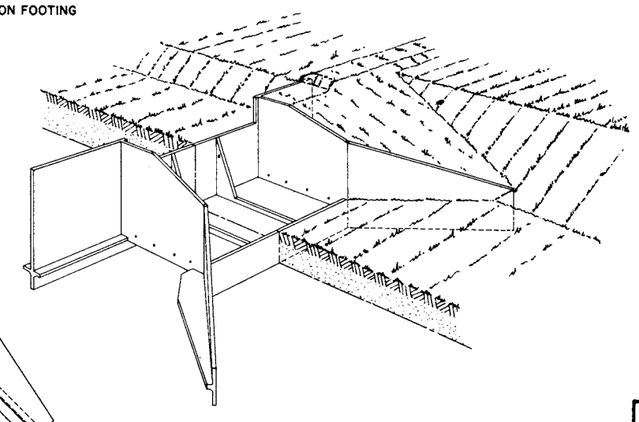
BAR TYPE DETAILS



SECTION OF WEEP HOLE AND DRAIN FILTER



PLAN



PERSPECTIVE VIEW

Not to scale

QUANTITIES

Reinforced concrete		108.45	Cu. yds.
Reinforcing steel			
# 3	2035.00 Ft.	765.16	Pounds
# 4	5655.50 "	3777.87	"
# 5	7361.25 "	7677.78	"
# 6	1532.00 "	2301.06	"
# 7	15.00 "	30.66	"
# 8	569.00 "	1519.23	"
# 9	32.00 "	108.80	"
Drainage - Perforated fibre pipe - 4" d.		52.5	L.F.
Drainage - Drain filter		11.9	Cu. yd.

Class "B" Concrete
f_s = 20,000 lbs/sq. in.
f'_c = 3,000 "
f_c = 1,200 "

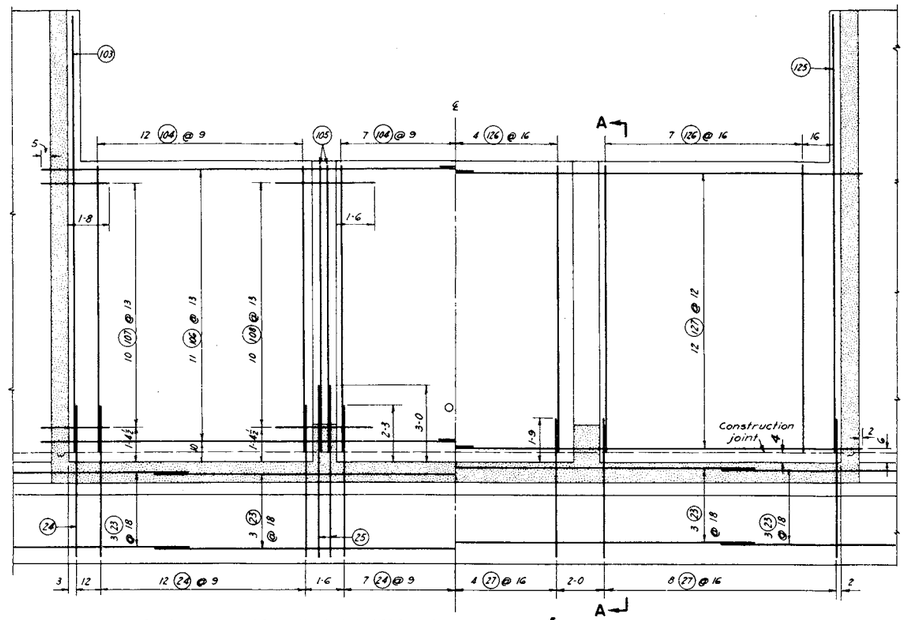
F = 10'-0, h = 6'-0, L = 30'-0

Note: Structure is symmetrical about ℄ except for 4" fibre pipe drain and outlet. Chamfer all exposed edges ¾"

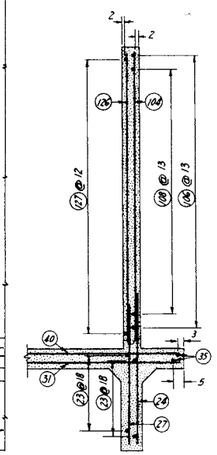
ENGINEERING STANDARDS UNIT	
ENGINEERING APPROVAL: M. M. Culp	CARTOGRAPHIC APPROVAL: Casey
DESIGNED BY: C.A. Reese	DRAWN BY: R. Boyeson
CHECKED BY: J.R. Brownell	STANDARD DWG. NO.: ES-2108-30B
DATE: 2-5-51	SHEET 1 OF 3 SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

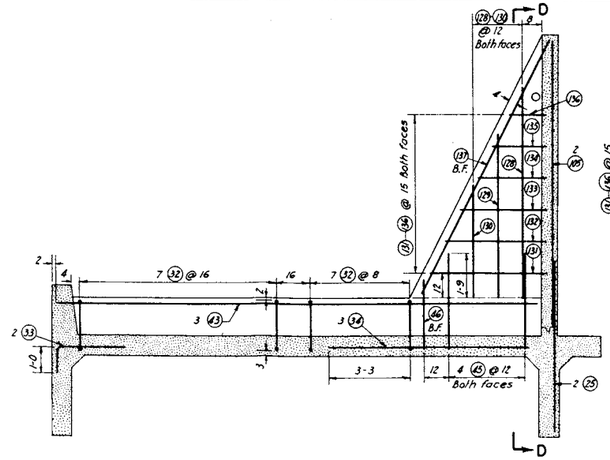
REFERENCE	
ENGINEERING APPROVAL	CARTOGRAPHIC APPROVAL
ADAPTED BY	DRAWN BY
CHECKED BY	DRAWING NO.
DATE	SHEET OF SHEETS



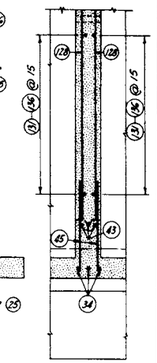
SECTIONAL ELEVATION OF HEADWALL



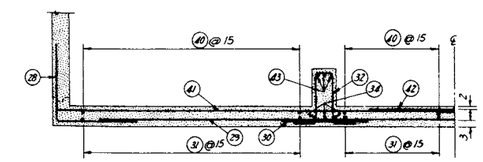
SECTION A-A



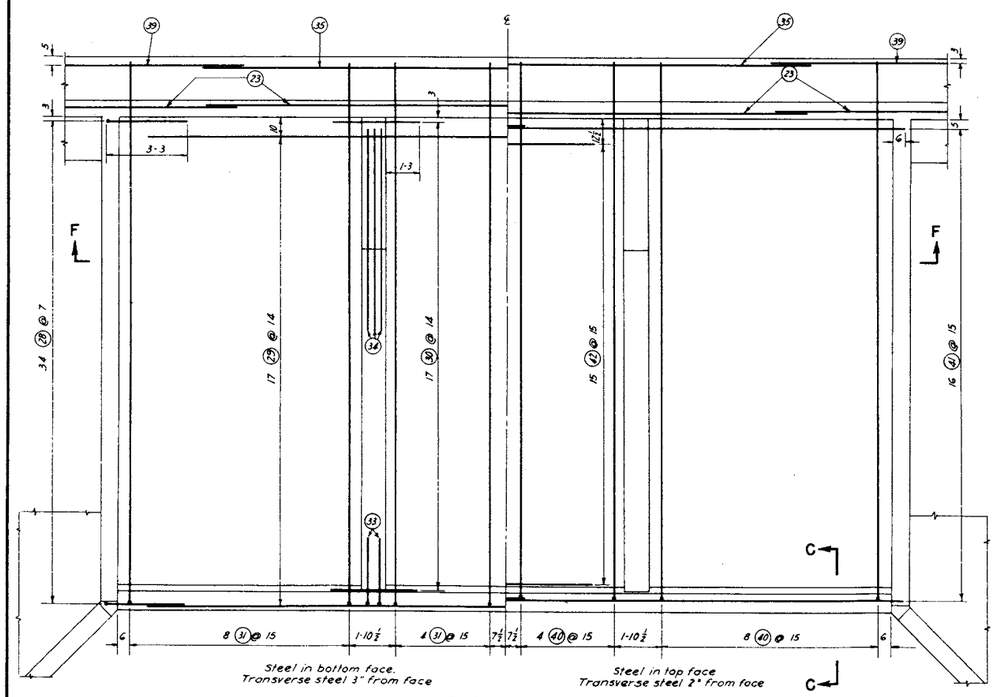
ELEVATION - LONGITUDINAL SILL AND BUTTRESS



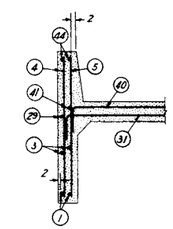
SEC. D-D



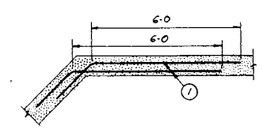
HALF-SECTION F-F



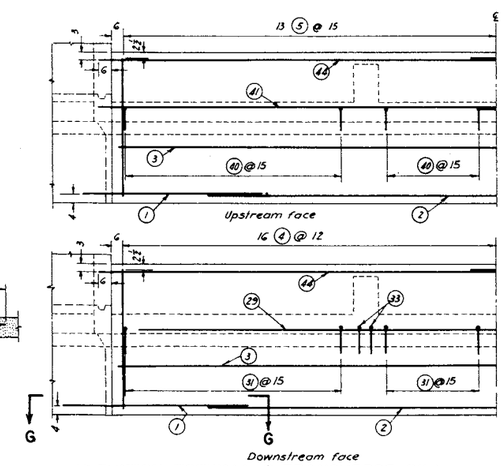
PLAN - APRON



SECTION C-C



SECTION G-G



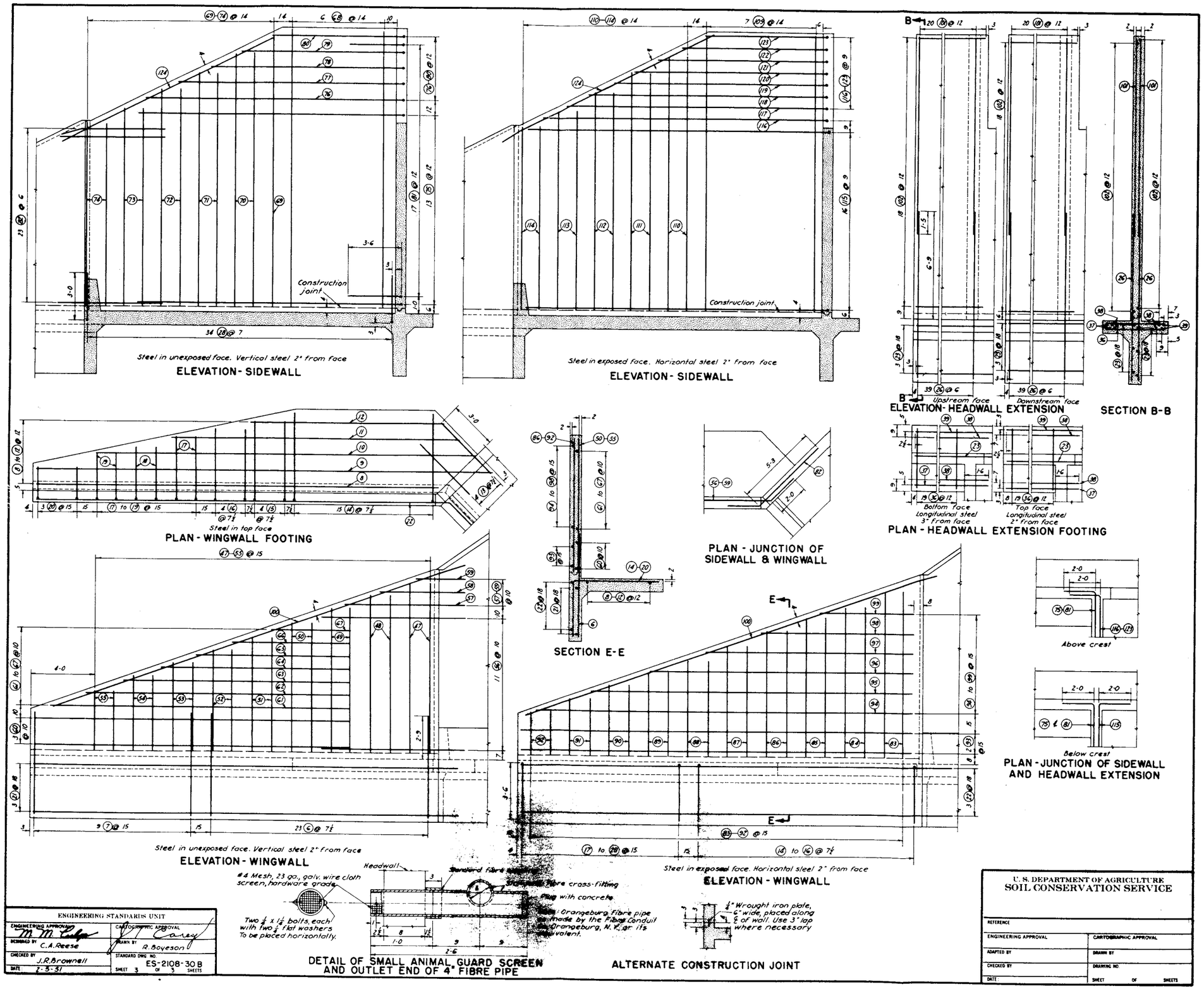
ELEVATION - TOEWALL & TRANSVERSE SILL

Note:
The longitudinal and transverse sills shall be poured monolithically with the apron and without use of a horizontal construction joint.
All dimensions showing distance from face of concrete to steel designate the clear distance.

ENGINEERING STANDARDS UNIT	
ENGINEERING APPROVAL M. M. Culp	CARTOGRAPHIC APPROVAL J. P. Casey
DESIGNED BY C. A. Reese	DRAWN BY R. Boveson
CHECKED BY J. R. Brownell	STANDARD DWG. NO ES-2108-30B
DATE 2-5-51	SHEET 2 OF 3 SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

REFERENCE	
ENGINEERING APPROVAL	CARTOGRAPHIC APPROVAL
ADAPTED BY	DRAWN BY
CHECKED BY	DRAWING NO
DATE	SHEET OF SHEETS


Construction joint
Steel in unexposed face. Vertical steel 2" from face
ELEVATION - SIDEWALL
Construction joint
Steel in exposed face. Horizontal steel 2" from face
ELEVATION - SIDEWALL
Upstream face
Downstream face
ELEVATION - HEADWALL EXTENSION
SECTION B-B
Steel in top face
PLAN - WINGWALL FOOTING
PLAN - JUNCTION OF SIDEWALL & WINGWALL
Bottom face Longitudinal steel 3" From face
Top face Longitudinal steel 2" From face
PLAN - HEADWALL EXTENSION FOOTING
SECTION E-E
Above crest
Below crest
PLAN - JUNCTION OF SIDEWALL AND HEADWALL EXTENSION
Steel in unexposed face. Vertical steel 2" from face
ELEVATION - WINGWALL
Steel in exposed face. Horizontal steel 2" from face
ELEVATION - WINGWALL
Headwall
#4 Mesh, 23 ga., galv. wire cloth screen, hardware grade
Two ¼ x 1½ bolts, each with two ¼ flat washers To be placed horizontally.
DETAIL OF SMALL ANIMAL GUARD SCREEN AND OUTLET END OF 4" FIBRE PIPE
¼" Wrought iron plate, 6" wide, placed along ℄ of wall. Use 3" lap where necessary
ALTERNATE CONSTRUCTION JOINT
ENGINEERING STANDARDS UNIT
ENGINEERING APPROVAL
DESIGNED BY C.A.Reese
CHECKED BY J.R.Brownell
DATE 2-5-51
CARTOGRAPHIC APPROVAL
DRAWN BY R.Boyeson
STANDARD DWG. NO. ES-2108-30 B
SHEET 3 OF 3 SHEETS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
REFERENCE
ENGINEERING APPROVAL
CARTOGRAPHIC APPROVAL
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CHECKED BY
DRAWING NO.
DATE
SHEET OF SHEETS

STRUCTURAL DESIGN: REINFORCED CONCRETE DESIGN. AREAS AND PERIMETERS OF BARS AT VARIOUS SPACINGS FOR 12 INCH WIDTH

Areas given in top figures in square inches
Perimeters given in bottom figures in inches

Spacing	Bar Size									Spacing
	#3	#4	#5	#6	#7	#8	#9	#10	#11	
2	0.66 7.07	1.18 9.42	1.84 11.78	2.65 14.14						2
2 1/4	0.59 6.28	1.05 8.38	1.64 10.47	2.36 12.57	3.21 14.66					2 1/4
2 1/2	0.53 5.65	0.94 7.54	1.47 9.42	2.12 11.31	2.89 13.20	3.77 15.08				2 1/2
2 3/4	0.48 5.14	0.86 6.85	1.34 8.57	1.93 10.28	2.62 12.00	3.43 13.71				2 3/4
3	0.44 4.71	0.79 6.28	1.23 7.85	1.77 9.42	2.40 11.00	3.14 12.57	4.00 14.18			3
3 1/4	0.41 4.35	0.73 5.80	1.13 7.25	1.63 8.70	2.22 10.15	2.90 11.60	3.69 13.09			3 1/4
3 1/2	0.38 4.04	0.67 5.39	1.05 6.73	1.51 8.08	2.06 9.42	2.69 10.77	3.43 12.15	4.34 13.68		3 1/2
3 3/4	0.35 3.77	0.63 5.03	0.98 6.28	1.41 7.54	1.92 8.80	2.51 10.05	3.20 11.34	4.05 12.77	5.00 14.18	3 3/4
4	0.33 3.53	0.59 4.71	0.92 5.89	1.33 7.07	1.80 8.25	2.36 9.42	3.00 10.63	3.80 11.97	4.69 13.29	4
4 1/4	0.31 3.33	0.55 4.44	0.87 5.54	1.25 6.65	1.70 7.76	2.22 8.87	2.82 10.01	3.57 11.27	4.41 12.51	4 1/4
4 1/2	0.29 3.14	0.52 4.19	0.82 5.24	1.18 6.28	1.60 7.33	2.09 8.38	2.67 9.45	3.37 10.64	4.17 11.81	4 1/2
4 3/4	0.28 2.98	0.50 3.97	0.78 4.96	1.12 5.96	1.50 6.94	1.98 7.94	2.53 8.95	3.20 10.08	3.95 11.19	4 3/4
5	0.26 2.83	0.47 3.77	0.74 4.71	1.06 5.65	1.44 6.60	1.88 7.54	2.40 8.51	3.04 9.58	3.75 10.63	5
5 1/4	0.25 2.69	0.45 3.59	0.70 4.49	1.01 5.39	1.37 6.28	1.80 7.18	2.29 8.10	2.89 9.12	3.57 10.13	5 1/4
5 1/2	0.24 2.57	0.43 3.43	0.67 4.28	0.96 5.14	1.31 6.00	1.71 6.85	2.18 7.73	2.76 8.71	3.41 9.66	5 1/2
5 3/4	0.23 2.46	0.41 3.28	0.64 4.10	0.92 4.92	1.25 5.74	1.64 6.56	2.09 7.40	2.64 8.33	3.26 9.25	5 3/4
6	0.22 2.36	0.39 3.14	0.61 3.93	0.88 4.71	1.20 5.50	1.57 6.28	2.00 7.09	2.53 7.98	3.12 8.86	6
6 1/2	0.20 2.18	0.36 2.90	0.57 3.62	0.82 4.35	1.11 5.07	1.45 5.80	1.85 6.54	2.34 7.37	2.88 8.18	6 1/2
7	0.19 2.02	0.34 2.69	0.53 3.37	0.76 4.04	1.03 4.71	1.35 5.39	1.71 6.08	2.17 6.84	2.68 7.59	7
7 1/2	0.18 1.89	0.31 2.51	0.49 3.14	0.71 3.77	0.96 4.40	1.26 5.03	1.60 5.67	2.03 6.38	2.50 7.09	7 1/2
8	0.17 1.77	0.29 2.36	0.46 2.95	0.66 3.53	0.90 4.12	1.18 4.71	1.50 5.32	1.90 5.99	2.34 6.65	8
8 1/2	0.16 1.66	0.28 2.22	0.43 2.77	0.62 3.33	0.85 3.88	1.11 4.44	1.41 5.00	1.79 5.63	2.21 6.25	8 1/2
9	0.15 1.57	0.26 2.09	0.41 2.62	0.59 3.14	0.80 3.67	1.05 4.19	1.33 4.73	1.69 5.32	2.08 5.91	9
9 1/2	0.14 1.49	0.25 1.98	0.39 2.48	0.56 2.98	0.76 3.47	0.99 3.97	1.26 4.48	1.60 5.04	1.97 5.60	9 1/2
10	0.13 1.41	0.24 1.88	0.37 2.36	0.53 2.83	0.72 3.30	0.94 3.77	1.20 4.25	1.52 4.79	1.88 5.32	10
10 1/2	0.13 1.35	0.22 1.80	0.35 2.24	0.50 2.69	0.69 3.14	0.90 3.59	1.14 4.05	1.45 4.56	1.79 5.06	10 1/2
11	0.12 1.29	0.21 1.71	0.33 2.14	0.48 2.57	0.66 3.00	0.86 3.43	1.09 3.87	1.38 4.35	1.70 4.83	11
11 1/2	0.12 1.23	0.20 1.64	0.32 2.05	0.46 2.46	0.63 2.87	0.82 3.28	1.04 3.70	1.32 4.16	1.63 4.62	11 1/2
12	0.11 1.18	0.20 1.57	0.31 1.96	0.44 2.36	0.60 2.75	0.79 3.14	1.00 3.54	1.27 3.99	1.56 4.43	12
13	0.10 1.09	0.18 1.45	0.28 1.81	0.41 2.18	0.56 2.54	0.72 2.90	0.92 3.27	1.17 3.68	1.44 4.09	13
14	0.09 1.01	0.17 1.35	0.26 1.68	0.38 2.02	0.52 2.36	0.67 2.69	0.86 3.04	1.08 3.42	1.34 3.80	14
15	0.09 0.94	0.16 1.26	0.25 1.57	0.35 1.89	0.48 2.20	0.63 2.51	0.80 2.84	1.01 3.19	1.25 3.54	15
16	0.08 0.88	0.15 1.18	0.23 1.47	0.33 1.77	0.45 2.06	0.59 2.36	0.75 2.66	0.95 2.99	1.17 3.32	16
17	0.08 0.83	0.14 1.11	0.22 1.39	0.31 1.66	0.42 1.94	0.55 2.22	0.71 2.50	0.89 2.82	1.10 3.13	17
18	0.07 0.79	0.13 1.05	0.20 1.31	0.29 1.57	0.40 1.83	0.52 2.09	0.67 2.36	0.84 2.66	1.04 2.95	18
	#3	#4	#5	#6	#7	#8	#9	#10	#11	

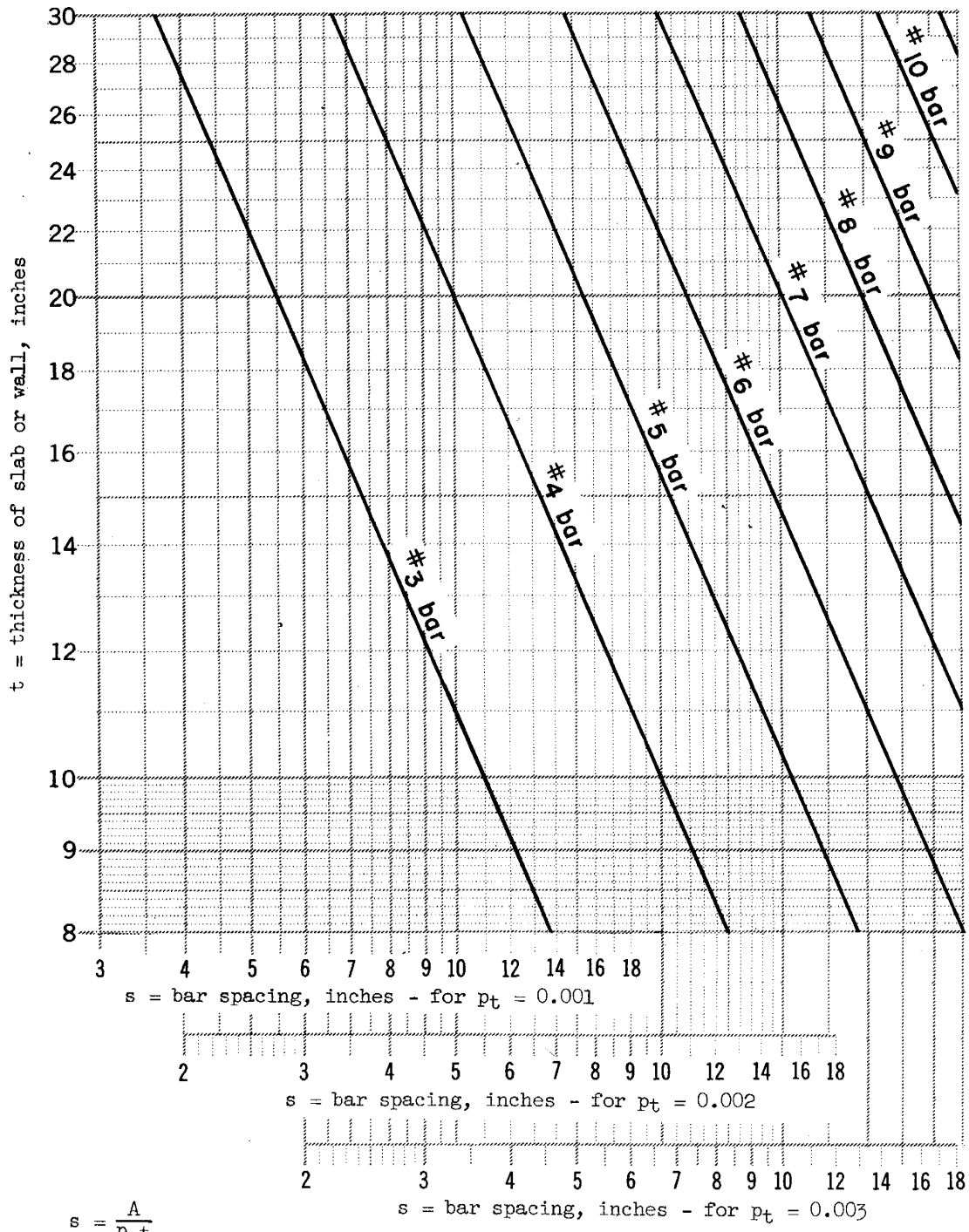
REFERENCE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING DIVISION - DESIGN SECTION

STANDARD DWG. NO.
ES – 46
SHEET 1 OF 1
DATE 12-14-50

REVISED 7-64

STRUCTURAL DESIGN: REINFORCED CONCRETE DESIGN
BAR SPACINGS FOR TEMPERATURE AND SHRINKAGE STEEL



$$s = \frac{A}{p_t t}$$

A = area of bar, sq in.

p_t = temperature and shrinkage steel ratio

REFERENCE	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION - DESIGN SECTION	STANDARD DWG. NO. ES- 47 SHEET 1 OF 1 DATE 12-8-50

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4.4 Detailing

4.4.1 General. Structural drawings should be simple, clear, complete, and accurate. They should not contain unnecessary lines, dimensions, symbols, or notes. They should contain, however, all the essential information supplemented by an adequate set of notes that are clearly stated. Such drawings save time and expense in the drafting room and on the job. Any engineering office that is doing an appreciable amount of reinforced concrete design and/or detailing should have a copy of the "Manual of Standard Practice for Detailing Reinforced Concrete Structures (ACI Standard 315-48)" published by the American Concrete Institute.

4.4.2 Drawing Standards. The standard drawing sizes and title blocks to be used by the Engineering Standards Unit are shown in drawing ES-16.

The recommended scales for detailing are: 1/4" = 1'-0", 3/8" = 1'-0", 1/2" = 1'-0", 3/4" = 1'-0", and 1" = 1'-0". The scale selected will depend on the proper layout of the drawing and the scale necessary to clearly show all details.

The use of symbols and abbreviations reduces the required drafting time and makes the drawing more clear and simple. The symbols and abbreviations should be clear in meaning and should above all be consistent. See drawings ES-2108-30BE and ES-2108-30B for the use of recommended symbols and abbreviations.

The recommended type and weight of line to accent the important features are as follows:

Concrete line	1/100"
Unexposed concrete line	1/100"
Reinforcement	1/50"
Center lines	1/100"
Dimension lines	1/150"

4.4.3 Engineering Drawing. The engineering drawing is prepared by the designer to convey all the necessary information to the draftsman so that he can prepare the detailed structure drawing. The engineering drawing should be simple, but should be clear and complete enough so that the draftsman will have no doubts as to the designer's intentions. See drawing ES-2108-30BE for a sample engineering drawing.

4.4.4 Detailed Structure Drawing. The detailed structure drawing is prepared by the draftsman and will be used by the steel fabricator, construction engineer, and the contractor. This drawing must be complete and accurate. It should contain the necessary information only. Superfluous material and notes add nothing to a drawing but confusion and higher

costs. The first sheet of this drawing will be the layout sheet which will show the over-all structure features and dimensions. It is usually advantageous to show a list of materials on the layout sheet. The following detail sheets will show the steel placement, but will not show the concrete dimensions except in special cases. The bar schedule may be shown on the layout sheet, all on one detail sheet, or may be divided on two or more of the detail sheets, whichever provides the better layout. The bars should be listed in the order that they will be placed, or as nearly so as possible. See drawing ES-2108-30B for a sample detailed structure drawing.

4.4.5 Reinforcement. Typical bar types that will be used are shown on drawing ES-18.

The required tension lap splices and required bar extensions for various size bars for the classes of concrete are shown in drawings ES-227 and ES-160 respectively.

The details of hook bars are shown in drawing ES-20. The recommended sizes for 180° hooks should be used wherever possible.

4.4.6 Notes to Designers and Detailers. The following notes are quoted, with permission, from the "Manual of Standard Practice for Detailing Reinforced Concrete Structures (ACI Standard 315-48)."

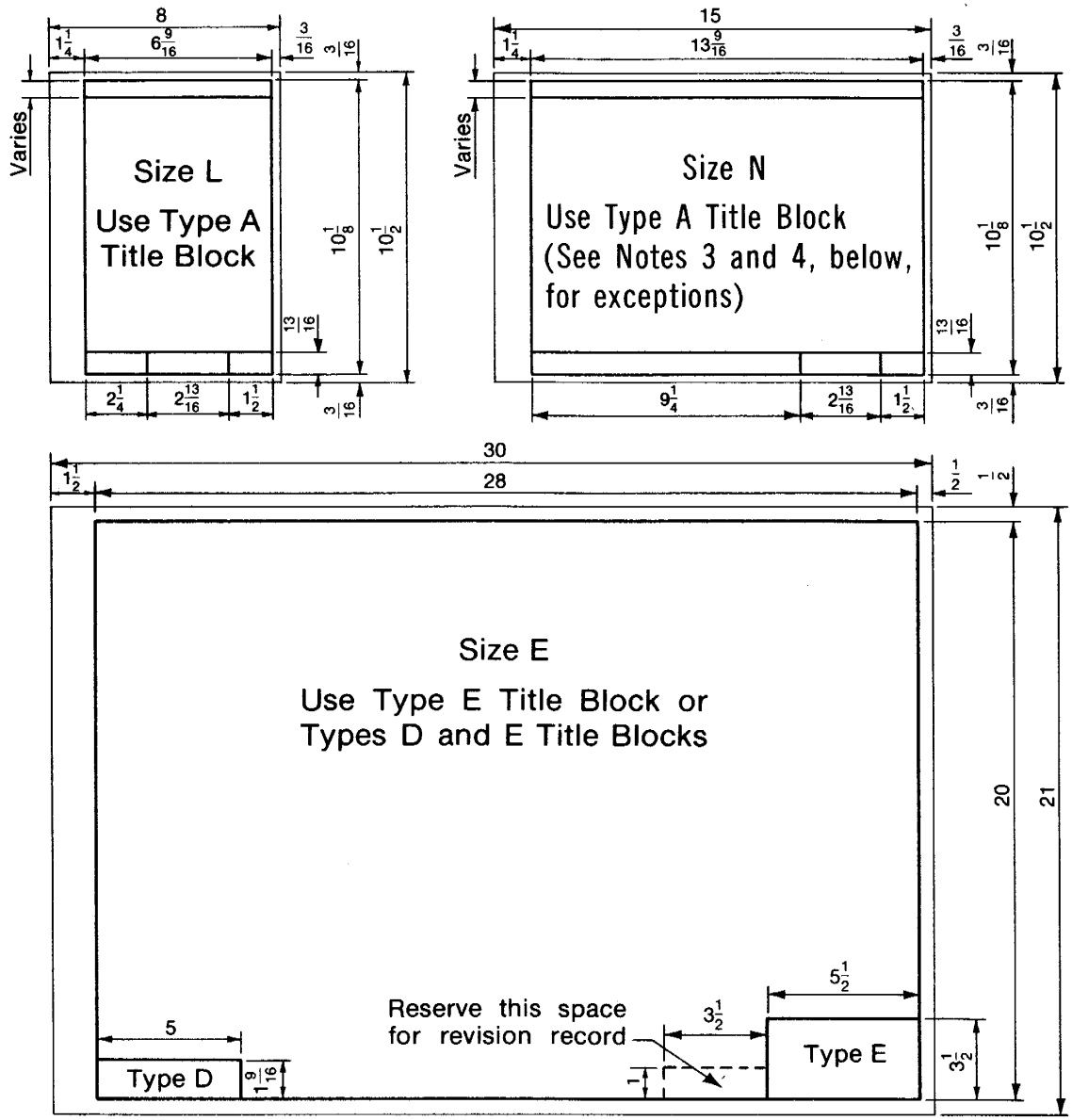
"109. Notes to Designers and Detailers. The designer must show plans which are complete and clear in every detail. The detailer should not be expected to do any designing or to guess at what the designer desires. The discussion in sections 105 and 106, together with the following notes, will assist in preparing satisfactory drawings.

"(a) Plan Study. The detailer should completely understand the engineer's design and the builder's method of construction before be begins detailing the structure. The preparation of placing drawings, bending details and bar lists for reinforcing steel requires careful study of the engineer's plans, thoughtful planning, patience, and above all, accuracy. This statement cannot be overemphasized.

"(b) Planning. The next step for the detailer in planning his work should be to determine the scale of the drawings he is to make, the size of his drawings, their arrangements with regard to plans, sections, details and schedules, and the number of sheets required. In his planning he should bear in mind the successive steps of construction so that all steel required for building any portion of the structure will be shown on the plan for that portion. If possible, the drawings should be so planned that the reinforcing steel setter will need but one print at a time. Where a structure is large and more than one drawing must be employed, the structure should be divided into sections in order to keep the drawings on a practical scale.

"(c) Checking. Placing drawings should be checked by the designing engineer before the reinforcing steel is fabricated.

STRUCTURAL DESIGN: STANDARD DRAWING SIZES AND TITLE BLOCKS



NOTES:

1. All drawings shall be one of the above sizes and shall have border and trim lines.
2. Standard size typewritten material placed on Size L and Size N drawings shall not have a linear reduction greater than 1 to 0.75 in the final form.
3. Size L and Size N drawings prepared for inclusion in National Engineering Technical Material shall use the Type A Title Block, except where a Size E drawing is reduced to a Size N. A Type A Title Block consists of two parts, one at the top of the sheet and the other at the bottom.
4. Size N drawings prepared for a purpose other than inclusion in National Engineering Technical Material may use the Type F Title Block.
5. All Size E drawings shall be prepared to accept a linear reduction of 1 to 0.5.
6. Type E Title Blocks shall be used on all Size E drawings.
7. Type D and E Title Blocks shall be used on all National Standard Detail Drawings that are to be incorporated into a set of construction plans. Type D shall be placed in the lower left-hand corner of the drawing and Type E in the lower right-hand corner. The Type D Title Block shall be completed by the office preparing the original standard drawing and the Type E by the office using the standard.
8. As shown above, all Size E drawings shall be prepared with a 3½ x 1 inch vacant space (without border lines) for recording drawing revisions..

REFERENCE	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION - DESIGN UNIT	STANDARD DWG. NO. ES- 16 SHEET 1 OF 2 DATE 4-7-50

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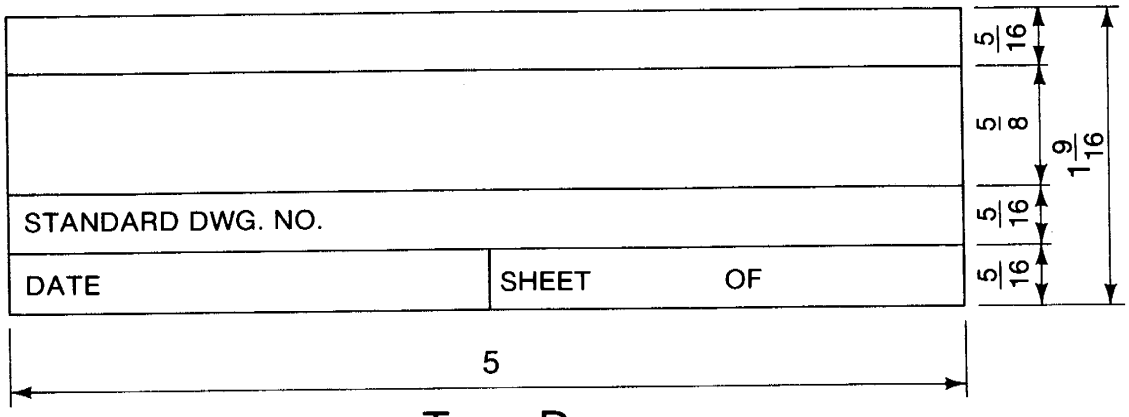
STRUCTURAL DESIGN: STANDARD DRAWING SIZES AND TITLE BLOCKS

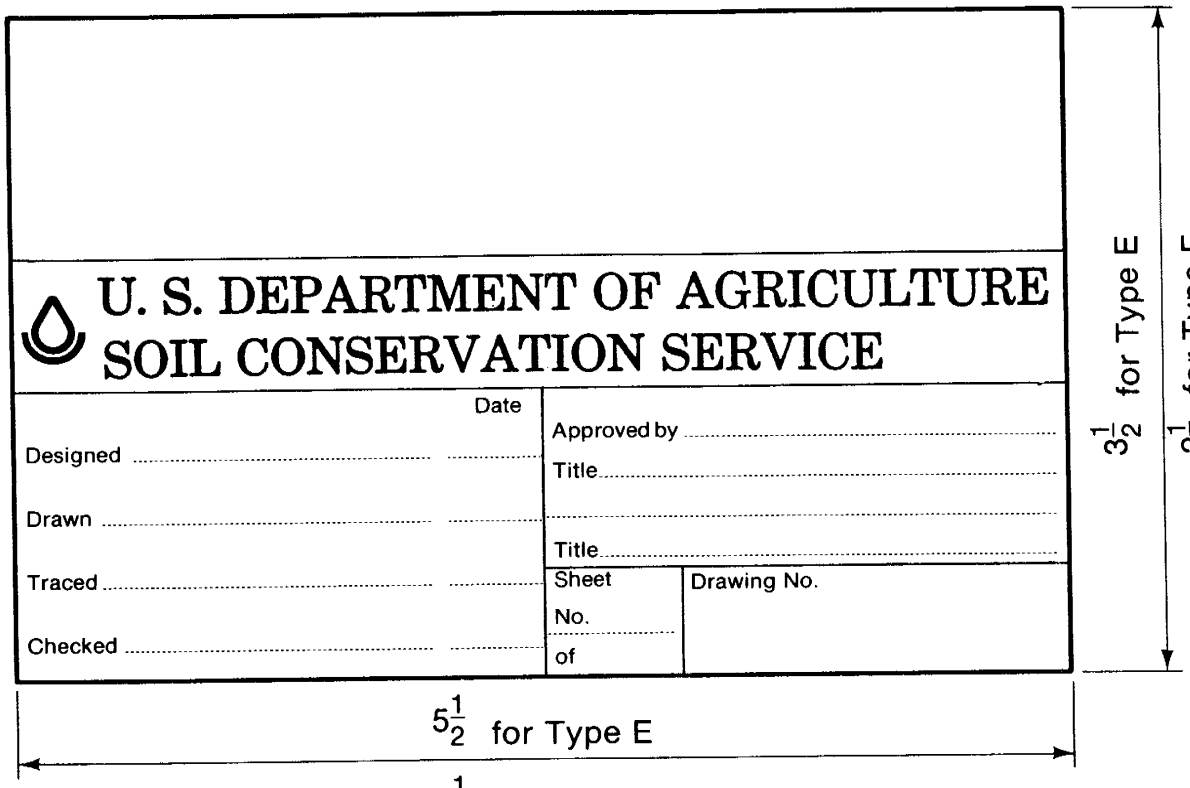
Type A

The title block used at the top and bottom of this sheet is Type A

For a Type A Title Block, enter name of office preparing the drawing in center block at bottom of page.



Type D



Type E and Type F

REFERENCE	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION - DESIGN UNIT	STANDARD DWG. NO. ES- 16 SHEET 2 OF 2 DATE 4-7-50

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