6-WI-43

CONCRETE BLOCK LINED CHUTE

DESCRIPTION

The concrete block lined chute is a structure with its flow area lined with precast concrete building blocks or modular concrete pavers placed on geotextile. The earth subgrade is shaped to the lines and grade of the structure and covered with geotextile on which the concrete blocks are placed. The openings in the blocks are filled with loose, friable soil and seeded to a sod-forming grass.

MATERIALS

The inlet, outlet, bottom and side slopes of the chute are lined with modular pavers or concrete building blocks made of precast concrete. Concrete building blocks shall be the standard heavy weight eight inch by sixteen inch (8" x 16") masonry units. Modular pavers have openings or cells that extend the depth of the unit. They are sold as modular pavers under a number of product names as shown in Table 3. Concrete building blocks and "Monoslabs" are the basis of this procedure. Other brands of pavers may be used by adjusting the structure dimensions. Geotextile lines the inlet, outlet, bottom and side slopes of the chute under the concrete blocks or modular pavers.

Cutoff walls may be cast-in-place concrete; precast concrete panels; sixteen (16) gage galvanized, smooth or corrugated steel sheets; or sheet plastic with a minimum of twenty (20) mil thickness.

FUNCTIONAL USE

The concrete block chute may be used to control over falls or abrupt changes in grade of a natural or constructed watercourse; prevent erosion at the outlets of waterways; lower water over ditch banks; and conduct water from an adjacent flat area to the bottom of a ditch.

ADAPTABILITY

The concrete block lined chute is adapted to small watersheds and sites where dense sod can be developed and maintained. The watercourse downstream of the chute SHALL be stable.

ADVANTAGES

The chute is easy to construct. It can be installed by inexperienced labor and the cost is relatively low.

LIMITATIONS

This structure is limited to sites that are well drained and do not have long, sustained flows. IT SHALL NOT BE USED AS A WATER IMPOUNDING STRUCTURE. Its life expectancy is not as long as other permanent structures. Particular care must be taken in the design, layout, construction and maintenance of these structures. A detailed Operations and Maintenance (O&M) plan SHALL be prepared at the time of the design and approval. Items which should be included are checking the chute after storm events for evidence of piping of material beneath blocks and any apparent movement of the blocks. Spring frost heave may also be a concern which should be checked.

DESIGN

The maximum drop through the structure is limited to ten (10) feet with the maximum design flow limited to two hundred (200) cubic feet per second (cfs).

Two design tables are presented which are based on the type of precast unit used, the site conditions and designers' preference.

Table 1 gives chute dimensions based on various bottom dimensions, chute channel slope and desired design velocities ranging from six to ten (6 to 10) feet per second. Bottom widths range from eight to eighty (8 to 80) feet and may be constructed with any type of modular paver in Table 3 and concrete building blocks.

Table 2 may be used when concrete building block units are used and design velocities range from twelve to fifteen (12 to 15) feet per second. Bottom widths range from four to thirty eight (4 to 38) feet.

See Table 1 or Table 2 on pages 6-WI-47 and 6-WI-48 for chute dimensions.

Chute widths will normally be less than the upstream watercourse width. Upstream from the chute inlet section, fifty (50) feet or less of the watercourse may be used for a transition section to change the bottom width and/or side slopes of the waterway to match the chute inlet dimensions. This upstream section shall be straight. Dikes may be required to ensure that

the design flow is directed to the structure. The height of the dike and/or sides of the inlet section of the chute should provide one (1) foot of freeboard above the depth of flow in the watercourse.

Aprons at the inlet and outlet should have a minimum length of eight (8) feet. Apron lengths on the standard drawing should be given in feet to correspond to the number of rows of blocks used. (The number of rows can also be shown in parentheses.)

For stability and ease of construction, chute side slopes should be no steeper than two horizontal to one vertical (2:1). A minimum of one (1) row of blocks should be used. The blocks should protect the slope for at least the design depth of flow plus six (6) inches of freeboard. Side slopes should be shaped to two horizontal to one vertical (2:1) or flatter above the last row of blocks to facilitate the establishment of grass cover.

Cutoff walls shall be placed both upstream and downstream. The upstream cutoff helps prevent water from flowing under the blocks and the downstream cutoff helps to prevent sliding of the blocks, or erosion at the outlet. The cutoff wall shall extend a minimum of two (2) feet below the subgrade of the chute.

Cast-in-place cutoff walls shall have a minimum thickness of six (6) inches. Ready mixed, air-entrained concrete purchased from commercial mixing plants is acceptable. Precast concrete panels shall have minimum dimensions of two feet by two feet by two inches thick (2' x 2' x 2").

Sheet plastic cutoffs should be placed with the top flush with the chute subgrade. Other types of cutoffs should be placed with the top flush with the upper face of the adjacent blocks.

Subgrade beneath the concrete blocks shall be completely covered with geotextile. Subgrade material which is added to level the foundation for the construction of the chute shall be compatible with the base material and the geotextile used. Use Wisconsin Construction Specification 13, Geotextiles for non woven Class III geotextile. No material shall be placed between the geotextile and the concrete blocks.

Type of soils, volume of runoff, and chute flow velocity must be considered when designing a chute. Chute slopes of three and four horizontal to one vertical (3:1 and 4:1) are acceptable in cohesive soils and the chute is located all in cut (excavation of the existing ground) and flows are low. Slopes of six horizontal to one vertical (6:1) or flatter should be used on noncohesive soils and sites where the chute is placed partially or entirely on compacted earthfill. Velocities should be

limited to fifteen (15) feet per second for cohesive soils when concrete building blocks are used. If modular pavers are used, the velocity shall be limited to ten (10) feet per second for cohesive soils.

The grade downstream of the structure must be stable. Excessive scour can occur immediately downstream from the chute if sufficient tailwater is not provided. Tailwater depth should equal or exceed the depth of flow in the waterway. The outlet apron should be placed below channel grade, if necessary, to provide additional tailwater depth. The outlet section shall be level.

CONSTRUCTION

Excavation begins at the downstream cutoff and apron, proceeds up the chute slope, and ends at the inlet apron and cutoff. Subgrade alignment and grade are referenced to offset stakes.

If subgrade material is added to level the base for the installation of the chute, it shall be compatible with the base material and the geotextile used. This compatibility is important so a piping potential is not created (i.e. soil particles being able to move through the geotextile).

Once excavation is completed, geotextile is placed over the subgrade and down into the cutoff trenches where it is anchored. The cutoffs are then installed and backfilled with compacted earthfill. The geotextile shall have a minimum overlap of one (1) foot where the two (2) pieces are joined. It is important that cutoff and geotextile extend to the full width of the blocks laid.

No material shall be placed between the geotextile and the concrete blocks.

All areas of the structure will then be covered with concrete blocks placed tightly together with the holes up. Monoslabs will be placed with the long axis perpendicular to the direction of flow. Concrete building blocks will be placed with the long axis parallel to the direction of flow except on the side slopes where they are placed perpendicular to the flow.

The triangular void areas at the joints between the inlet apron, chute slope, outlet apron, and side slopes SHALL be grouted using a mixture of three (3) parts sand to one (1) part cement. Bagged mortar mix may also be used.

Holes in the concrete blocks shall be filled with loose, friable soil suitable for a seedbed. The entire disturbed area shall be seeded.

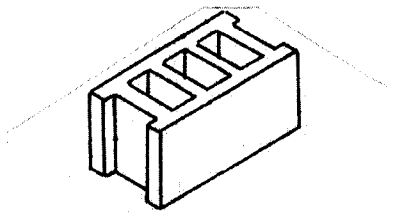
The following table is based on a Manning's "n" value of 0.040 and two horizontal to one vertical (2:1) side slopes. It may be used to determine the chute dimensions. This table may be used with either modular pavers or concrete building blocks.

TABLE 1 - MINIMUM CHUTE BOTTOM WIDTH - FEET

Q CFS	CHUTE SLOPE-PERCENT:	10.0			12.5			16.7		
	MAX VELOCITY-FPS	6	8	10	6	8	10	6	8	10
	MAX FLOW DEPTH-FEET:	0.4	0.6	0.9	0.3	0.5	0.8	0.3	0.4	0.6
10		8	8	8	8	8	8	8	8	8
15		8	8	8	8	8	8	10	8	8
20		8	8	8	10	8	8	14	8	8
25		10	8	8	14	8	8	16	8	8
30		14	8	8	18	8	8	20	10	8
35		16	8	8	20	8	8	24	12	8
40		18	8	8	22	20	8	26	12	8
45		20	10	8	26	12	8	30	14	8
50		22	10	8	28	12	8	34	16	8
60		26	12	8	34	14	8	40	18	10
70		32	14	8	40	18	8	46	22	12
80		36	16	8	44	20	10	54	26	14
90		40	18	10	50	22	12	60	28	16
100		46	20	10	56	26	12	66	32	18
120		54	26	12	68	30	16	80	38	22
140		64	30	14	78	36	18	---	46	24
160		72	34	18	---	42	22	---	52	28
180		---	38	20	---	46	26	---	58	32
200		---	42	22	---	42	28	---	64	36

TABLE 1 - MINIMUM CHUTE BOTTOM WIDTH - FEET (CONTIUED)

Q CFS	CHUTE SLOPE-PERCENT:	20.0			25.0			33.0		
	MAX VELOCITY-FPS	6	8	10	6	8	10	6	8	10
	MAX FLOW DEPTH-FEET:	0.2	0.4	0.5	0.2	0.3	0.4	0.2	0.2	0.3
10		8	8	8	10	8	8	12	8	8
20		16	8	8	18	8	8	22	20	8
30		24	10	8	28	14	8	34	16	10
40		30	14	8	36	18	10	46	22	12
50		38	18	10	46	22	12	56	28	16
60		46	22	12	54	26	14	68	32	18
70		54	26	14	64	30	18	80	38	22
80		62	30	16	72	36	20	---	44	24
90		70	34	18	---	40	22	---	50	28
100		76	38	20	---	44	24	---	54	32
120		---	44	24	---	54	30	---	66	38
140		---	52	28	---	62	34	---	76	44
160		---	60	34	---	70	40	---	---	50
180		---	66	38	---	80	44	---	---	56
200		---	74	42	---	---	50	---	---	62



The following table is based on a Manning's "n" value of 0.040 and two horizontal to one vertical (2:1) side slopes. It may be used to determine the chute dimensions. This table SHALL only be used with concrete building blocks.

TABLE 2 - MINIMUM CHUTE BOTTOM WIDTH - FEET
8" x 16" CONCRETE BUILDING BLOCK UNITS ONLY

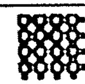
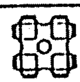
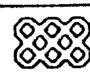
Q	CHUTE SLOPE-PERCENT:	10.0		12.5		16.7	
CFS	MAX VELOCITY-FPS	12	15	12	15	12	15
	MAX FLOW DEPTH-FEET:	1.2	1.6	0.9	1.8	0.7	1.2
10		4	4	4	4	4	4
15		4	4	4	4	4	4
20		4	4	4	4	4	4
25		4	4	4	4	4	4
30		4	4	4	4	4	4
35		4	4	4	4	4	4
40		4	4	4	4	4	4
45		4	4	4	4	4	4
50		4	4	4	4	6	4
60		4	4	4	4	6	4
70		4	4	6	4	8	4
80		4	4	6	4	8	4
90		4	4	8	4	10	4
100		6	4	8	4	12	4
120		6	4	10	4	14	6
140		8	4	12	4	16	6
160		10	4	14	4	18	8
180		10	6	16	4	20	8
200		12	6	18	4	24	10

TABLE 2 - MINIMUM CHUTE BOTTOM WIDTH - FEET
(CONTINUED)

Q	CHUTE SLOPE-PERCENT:	20.0		25.0		33.0	
CFS	MAX VELOCITY-FPS	12	15	12	15	12	15
	MAX FLOW DEPTH-FEET:	0.6	0.9	0.5	0.8	0.4	0.6
10		4	4	4	4	4	4
20		4	4	4	4	4	4
30		4	4	4	4	6	4
40		6	4	6	4	8	4
50		6	4	8	4	10	6
60		8	4	10	4	12	6
70		10	4	12	6	14	8
80		12	4	14	6	16	8
90		12	6	14	6	18	10
100		14	6	16	8	20	10
120		16	8	20	10	24	12
140		20	10	24	12	28	16
160		22	10	26	12	32	18
180		24	12	26	14	38	20
200				30	16	38	22

TABLE 3 - MODULAR PAVING UNITS

MODULAR PAVING UNITS FOR EROSION CONTROL

PRODUCT NAMES (See notes below)	RECOMMENDED USES	MATERIAL	AVAILABLE FORMS	SHAPES & PATTERNS	OTHER COMPONENTS NEEDED FOR INSTALLATION	FOUNDATION REQUIREMENTS	UNIT DIMENSIONS	INSTALLATION METHOD	REMARKS
1. HASTINGS CHECKER BLOCKS ®	STABILIZATION ALONG STREAMS AND LAKE BANKS; ROAD SHOULDERS & SERVICE RDS.; SLOPES	PRECAST CONCRETE	OPEN CELLS; WAFFLE PATTERN		NONE	UNDISTURBED EARTH OR FILL COMPACTED TO 95% MAX. DRY DENSITY w/ TOPSOIL OR SAND IN A 2" COMPACTED LAYER	24"x24"x4"	HAND-PLACED	NOT SUITABLE FOR INTENSE WAVE ACTION; VOIDS CAN BE FILLED AND PLANTED
2. ARMORFLEX	COASTAL SHORELINES, LAKES, RIVERS, STREAMS, EMBANKMENTS, SLOPES	PRECAST CONCRETE BLOCKS INTERCONNECTED INTO MATS	OPEN CELLS; CLOSED CELLS; ALL CELLS INTERLOCK		CABLE & FITTINGS GEOSYNTHETIC FABRIC MAT ANCHORS	PREPARED SUBGRADE; GEOSYNTHETIC FABRIC AND/OR GRADED FILTER MATERIAL	13"x11.6"x4.75" to 17.4"x15.5"x9" (with intermed. dimensions)	CONVENTIONAL CONSTRUCTION EQUIPMENT & HAND PLACEMENT	CAN BE INSTALLED UNDERWATER; CABLE SYSTEMS INSURES ARTICULATION BETWEEN GRIDS; VOIDS CAN BE FILLED w/ INERT MATERIALS OR PLANTED
3. ARMORLOC	STABILIZATION ALONG STREAMS, LAKE BANKS & EMBANKMENTS	PRECAST CONCRETE	OPEN CELLS; CELLS INTERLOCK		MAY NEED GEOSYNTHETIC FABRIC	COMPACTED, PREPARED SUBGRADE	15.8"x11.9"x4"	HAND-PLACED	MINIMUM COMPRESSIVE STRENGTH-4000 psi; NO VISIBLE FREEZE/THAW EFFECT; 25% OPEN SPACE
4. GOBIBLOCK ®	STABILIZATION ALONG STREAMS & LAKE BANKS; STEEP SLOPES; EMBANKMENTS	PRECAST CONCRETE	OPEN CELLS; w/ COBBLED SURFACE		MAY NEED GEOSYNTHETIC FABRIC	PREPARED SUBGRADE; APPROX. 1" COMPACTED SAND FOR LIGHT LOADING	7.9"x7.9"x3.9"	HAND-PLACED	HIGHLY PERMEABLE; VOIDS CAN BE FILLED w/ INERT MATERIALS OR PLANTED w/ GRASS OR GROUND COVER
5. GRASSCRETE ®	STABILIZATION ALONG STREAMS & WATERWAYS; STEEP SLOPES; EMBANKMENTS	POURED-IN-PLACE CONCRETE	PROPRIETARY FORMERS w/ "X" VOIDS		REINFORCING STEEL	COMPACTED, PREPARED SUBGRADE & 3/4" SAND BED	N/A	REQUIRES LICENSED CONTRACTOR FOR PATENTED PROCESS	VOIDS ARE SMALL; WILL ACCOMODATE GRASSES BUT TOTAL PAVEMENT COVERAGE IS UNLIKELY; MORE COMPLEX INSTALLATION
6. MONOSLABS ®	STABILIZING STEEP SLOPES; DIKES & EMBANK. (45° to WATERWAY BEDS & SLOPES; SHORELINES	PRECAST CONCRETE	OPEN CELLS; WAFFLE PATTERN		MAY NEED GEOSYNTHETIC FABRIC	LIGHT LOADS - PREP. SUBGRADE & 1" TAMPED SAND; HEAVY LOAD - SUBGRADE, 6" BALLAST COURSE & 1" TAMPED SAND	24"x16"x4.8"	HAND-PLACED	CAN BE LAID UNDERWATER; VOIDS CAN BE FILLED w/ INERT MATERIALS OR PLANTED w/ GRASS
7. GRASS PAVERS ®	TURF REINFORCER FOR ERODING ROADSIDES; PATHS; STABILIZATION ON MODERATE SLOPES	PRECAST CONCRETE	OPEN CELLS; CASTELLATED CHECKERBOARD		NONE	SAME AS FOR MONOSLABS®	23.5"x15.6"x4.6"	HAND-PLACED	SAME AS MONOSLABS® BUT USED FOR DIFFERENT PURPOSES
8. AMBIGRID™	STABILIZATION ALONG STREAMS, WATERWAYS; STEEP SLOPES; DIKES; EMBANK.	PRECAST CONCRETE	OPEN CELLS; CELLS INTERLOCK		MAY NEED GEOSYNTHETIC FABRIC	SAME AS FOR MONOSLABS®	17.3"x11.5"x5"	HAND-PLACED	HAS LARGE VOIDS, CAVITIES & BASE HOLES; PERMITS USE OF SOME SMALL SHRUBS; GOOD FLAT WALKING SURFACE FOR STABILIZATION AREAS USED AS PATHS
9. TURFSTONE ®	EROSION CONTROL ON EMBANKMENTS, EARTH BERMS, SWALES, STEEP SLOPES	PRECAST PORTLAND CEMENT	OPEN CELLS		GEOSYNTHETIC FILTER FABRIC	PREPARED SUBGRADE; 3"-16" OF 3/4" OR 3/8" CRUSHED ROCK; 2" OF UNCOMPACTED GRADED SAND	23.6"x15.6"x3.8"	HAND-PLACED	ON STEEP SLOPES TURFSTONE® SHOULD BE SECURED w/ A 2" STAKE; PERFORMS IN AREAS SUBJECT TO CONSTANT FLOWS OF <10 cfs; FROSTPROOF; LIGHT WEIGHT
10. PETRAFLEX™ (BLOCK H-512)	STABILIZATION OF SHORELINES, RIVERS, BEACHES, BOAT RAMPS, WATERCOURSE LINING, CULVERT DISCHARGE & RIVER CHANNEL	PRECAST CONCRETE	OPEN CELLS		CABLE & FITTINGS GEOSYNTHETIC FABRIC MAT ANCHORS	PREPARED SUBGRADE; GEOSYNTHETIC FILTER FABRIC (SPEC. ACCORD. TO SOIL TYPE)	11.9"x11.9"x5"	SPREADER BAR AND CRANE	ALSO AVAILABLE FROM PETRAFLEX: -BLOCK H-41224: 11.75"x23.75"x4.5" -BLOCK H-91824: 17.9"x23.75"x8" -BLOCKS FOR ARCTIC APPL. & HEAVY OCEAN WAVES
11. TRI-LOCK	REVETMENT FOR SHORE PROTECT., BEACHES, BOAT RAMPS, WATERCOURSE LININGS, CULVERT DISCHARGE & RIVER CHANNEL	PRECAST CONCRETE	TWO COMPONENTS: LOCK BLOCK & KEY BLOCK; OPEN CELLS		GEOSYNTHETIC OR CARRIER FABRIC	PREPARED SUBGRADE; GEOSYNTHETIC OR CARRIER FABRIC	16" MODULE 4"-6" THICK OR 32" MODULE 8"-12" THICK	HAND-PLACED AS BLOCKS OR USE CONVENTIONAL CONST. EQUIP. w/ SPREADER BAR FOR MATS	BLOCKS HAVE APPROX. 20% OPEN AREA; CONCRETE STRENGTH 3000 psi