**ERRATA TO TWRI SERIES (6.16.98)**

**TWRI BOOK 3A2 : slope-area measurements**

page 1, right column: Add, to definition of k on last line, k=0 for contracting reaches: k=0.5 for expanding reaches.

**TWRI BOOK 3A3 : culverts**

page viii, right column, for symbol n: Change ".. roughness of coefficient.." to "...roughness coefficient"

page 19*,* table 4: On second line, for d/D equal to 0.02, change values in column 1 to 0.027, column 2 to 0.043, and column 4 to 0.043. On sixth line, value of d/D should be 0.06.

page 10, per OSW tech memo no. 93.17, replace sections on corrugated metal, and multiplate sections to:

**Corrugated Metal**

Corrugated pipes and arches are made in riveted, helical (or spiral) and structural-plate styles. The riveted and spiral styles are used in small pipes of less than 9-foot diameter. Spiral corrugations have the same pitch and depth as that used in riveted construction, but the plates are wound to form' a continuous pipe. Because of its greater strength, structural-plate (also called multiplate) commonly is used for pipes that are more than 6 feet in diameter. Multiplate is made in sheets that are bolted together.

**Standard riveted sections**

The corrugated metal most commonly used in riveted pipes and arches has annular corrugations with a 2 2/3 inch pitch and a rise of 1/2 inch. This is frequently referred to as standard corrugated metal. According to laboratory tests, n values for full pipe flow vary for 0.0266 for a 1-foot diameter pipe to 0.0224 for an 8-foot diameter pipe for velocities normally encountered in culverts. The American Iron and Steel Institute recommends that a single value of 0.024 be used in design of both partly-full and full-pipe flow for any size of pipe. This value may be satisfactory for many computations of discharge. However, more precise values are given in the accompanying table, which shows values derived from tables and graphs published by the Federal Highway Administration for culvert design and that apply to both annular and spiral corrugations, as noted in the table. Values from this table should be used by U.S. Geological Survey offices in computation of discharge through culverts.

Riveted pipes are also made from corrugated metal with a 1-inch rise and 3-, 5-, and 6-inch pitch. Experimental data show a slight lowering of the n value as pitch increases. The n values for these three types of corrugation are also given in the table.

**Helical corrugated pipe**

Standard corrugated helical pipe is formed from a 24 inch wide strip of steel. Tests on helically corrugated pipe indicate a lower coefficient of roughness than for annularly corrugated steel pipe. Roughness values for helical corrugated pipe are listed in the accompanying table and are based on American Iron and Steel institute recommendations.

**Structural Plate (Multiplate)**

Structural-plate metal used in multiplate construction has much larger corrugations than does that used in riveted pipes. Multiplate construction is used with both steel and aluminum. The steel has a 6-inch pitch and a 2-inch rise; aluminum has a 9-inch pitch and a 2.5-inch rise. Tests show somewhat higher n values for this metal and type of construction than for riveted construction. Average n values range from 0.035 (steel) or 0.036 (aluminum) for 5-foot diameter pipes to 0.033 for pipes of 18 feet or greater diameter. The n values for various diameters of pipe are given in the following table:

|  |  |
| --- | --- |
| Pipe Diameter (feet) | Manning's roughness coefficient, n |
| Riveted | Structural-Plate |
| Corrugation, Pitch x Rise, inches |
|  | 2-2/3 x 1/2 | 3x 1 | 5x1 | 6x 1 | 6x2 | 9 x 2-1/2 |
| Annular Corrugations |
| *1*i | 0.027 |  |  |  |  |  |
| 2 | 0.025 |  |  |  |  |  |
| 3 | 0.024 | 0.028 |  | 0.025 |  |  |
| 4 | 0.024 | 0.028 | 0.026 | 0.024 |  |  |
|  5 | 0.024 | 0.028 | 0.026 | 0.024 | 0.035 | 0.036 |
| 6 | 0.023 | 0.028 | 0.026 | 0.024 | 0.035 | 0.035 |
| 7 | 0.023 | 0.028 | 0.026 | 0.023 | 0.035 | 0.034 |
| 8 | 0.023 | 0.028 | 0.025 | 0.023 | 0.034 | 0.034 |
| 9 | 0.023 | 0.028 | 0.025 | 0.023 | 0.034 | 0.034 |
| 10 | 0.022 | 0.027 | 0.025 | 0.023 | 0.034 | 0.034 |
| 11 | 0.022 | 0.027 | 0.025 | 0.022 | 0.034 | 0.033 |
| 12 |  | 0.027 | 0.024 | 0.022 | 0.033 | 0.033 |
| 16 |  | 0.026a | 0.023a | 0.021' |  |  |
| 18 |  |  |  |  |  | 0.033a |
| 21 |  |  |  |  | 0.033" |  |
|  | Helical (Spiral) Corrugations |
| 1 | 0.011 |  | Use values for annular corrugation sizes for all other corrugation sizes and pipe diameters. |
| 2 | 0.016 |  |
| 3 | 0.019 | 0.021 |
| 4 | 0.020 | 0.023 |
| 5 | 0.022 | 0.024 |
| 6 |  | 0.026 |
| Range of pipe diameters commonly encountered with indicated corrugation' sizes, in feet, |
|  | <9 | 3-13 | 5-13 | 3-13 | 5-25 | 5-25 |

extrapolated beyond Federal Highway Administration curves. See page 16 HDS-3 for extrapolation. Note: n values apply to pipes in good conditions. Severe deterioration of metal or pipe section misalignment may cause slightly higher values.

TWRI BOOK3A3 cont.

page 26, Figure 11, Vertical axis label: Denominator should contain Rc instead of R.

page 60, Selected References; Add the following: Normann, J.N., 1980, Hydraulic flow resistance factors for corrugated metal conduits: Federal Highway Administration Report No. FHWA-TS-80-216, 36p.

TWRI BOOK 3A4: contracted openings

page 4, add the following before the last paragraph in the "Friction Loss" section.

If the length of the approach reach, Lw*,* is greater than 1.25 times the bridge opening, b, a better approximation of the friction loss will be obtained from,

hf=(Lw-b)Q2/(K1)2+bQ2/(K1K2)+LQ2/(K3)2

page 9, left column, third line up: Replace ".. given in a previous section of the report.." to "..presented by Benson and Dalrymple (1967), .."

page 11, right column, line 6: Move all of the text beginning with "For example, if a certain bridge .." through the definition of k, ending with " .. for the influence of angularity," to the end of the first paragraph under "Adjustment factors" in the middle of this page.

page 12, right column, last line: Replace "equation 1" with "equation 7"

page 13, right column: replace lower case Greek phi to upper case Greek phi on line 4 of paragraph 1, and on line 7 of paragraph 2. (See, for example, second paragraph in left column of page 13.)

• page 15 left column: replace table of z/b versus kz with:

|  |  |
| --- | --- |
| z/b | kz |
| 0 | 1.00 |
| 0.01 | to 0.04 | 0.98 |
| 0.05 | 0.96 |

page 15, left column, line 12 up: Change lower case phi to upper case phi.

page 15, insert the following prior to "Computations" section":

**Approach section located >1.25b from bridge**

Field conditions sometimes prohibit measuring an approach section at one. bridge opening width, b, upstream of the bridge. For situations where the bridge opening width needs to be located greater than 1.25 b upstream, the friction loss term (L + Lw (K3/K1) in the denominator of the discharge equation 7 should be changed to:

$$(L+(bK\_{3})/K\_{1} +(L\_{w}-b)K\_{3}^{2}/K\_{1}^{2})$$

page 23, figure 13B: note next to sketch that these curves are for an angle  of 20°, and cross-reference the sketch to page 15, left column, line 10 up.

page 23, figure 13D: Add to sketch on right the definition of bd:

 |

 --------------------------| - |-

 | bd

 -|-

 .--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.

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 |

page 24, figure 14A: In "Standard conditions" legend, show w/b to have a range, 0.1 to 0.5

page *26,* figure 16B: In plot of kj versus j on left, the values of j should be 0, 0.02, 0.04, 0.06, 0.08, 0.10, etc.

page 33, right column: On line 3, add " and." after "..velocity of approach."

page 33, right column, item 2: Omit A1 and , from the parameters listed to be computed.

page 43, example problem. Replace the term ( 19.5 + 36(6560)/10840 ) in the denominator with (19.5 + 21(6560)/10840 + (36 - 21)(6560/10840)2 ). This replacement results in changes in the values computed in the subsequent calculations. The major changes are:

replace: $=\frac{0.92 x 622}{\sqrt{0.99}}=\frac{572}{0.995}=575 cfs$

with:$ =\frac{0.92 x 622}{\sqrt{0.956}}=\frac{572}{0.978}=585 cfs$

TWRI BOOK 3A4: contracted openings cont.

replace V1= 3.88 with V1= 3.95

replace V3=6.67 with V3=6.79

replace F = 0.58 with F=0.59

add: Lw/b = 36/21 = 1.71 > 1.25

**TWRI BOOK 3A5: dams/weirs**

page 3, right column, 6 lines up: change ha equal to or less than 1.5hb to hbequal to or less than 1.5 ha

page 5, left column, paragraph 1: a) first sentence should read. "Side contractions reduce the effective length of the weir crest and the effective approach velocity"

b) fourth sentence should read "if the abutment corners are rounded, with radius r and r/b > 0.12, the correction factor is approximated as (1 + kc)/2 (obtain kc from figure 3).

page 6, figure2: Underline the words "full width" in the caption.

page 6, figure 3: a) the lowest curve on figure 3 should be labeled "b/B = 0.2 for square edges.

b) sketch in a new curve, to be labeled "b/B < 0.2 for rounded abutments" and plot with the following coordinate points:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| L | 0.99 | 0.90 | 0.85 | 0.825 |
| h/P | 0.0 | 1.2 | 2.0 | 2.8 |

1. Add to title of figure 3, ".. with square abutment corners."
2. Add marginal note: "For rounded abutments, if r/b > 0.12, compute coefficient to be ( 1 + kc. )/2 ,
where kc is from figure 3."

page 9, left column, line 3: Change "equation 2" to "equation 3."

page 10, left column, third sentence: If the abutment corners are square, the correction factor is approximated as

( 1 + kc )/2 (obtain kc. from figure 3).

page 19, right column, line 2: Replace sentence with following explanation: "E is the maximum value of y corresponding to the computed values of hs/P, For the computed value of hs/P, determine the maximum value of y/hs and multiply it by hs to obtain E (see figure 9, page 13, for definition of symbols)."

page 22, figure 15: Vertical axis should be labeled: Q/bho3/2 .

page 23, left column, paragraph 1, last sentence: Change to, "For all b/B ratios less than 1.0, C must be corrected by kc from figure 3 for square abutment comers, and by (1 + kc )/2 for round corners."

page 23, figure 16: Label the present curve, "ho/P = 0." Draw a new curve as a straight line between h/ho = 0, C/C0 = 0.65 and h/ho = 1.0, C/C0 = 1.00; label this curve “ho/P= 2." For other ho/Pvalues, the ordinates for h/ho= 0 will approximate:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ho/P | 0.0 | 0.5 | 1.0 | 1.5 |
| C/Co | 0.77 | 0.76 | 0.70 | 0.67 |

page 23, right column, line 8: Change "equation 1" to "equation 2."

page 23, right column, line 15 down: Change "H/H0" to "H/Hi" page 24, figure 19: change x axis label to "H/Hi”

page 25, left column, third sentence: It is further assumed that the correction factor is

( 1 + kc. )/2 if the abutment corners are rounded, and r/b is > 0.12.

page 26, immediately preceding subtitle, "Length of flow section", add sentence: "The-total head, H, should reflect the average head for nonhorizontal (variable depth) flow sections.

Page 26, right column, under “Discharge coefficients”, last sentence, first paragraph: Change “…function of the head, h, and the roughness of…” to “..function of the head, H. In both cases the coefficient is also a function of the roughness of…”

**TWRI 3A14: flume**

Page 2, correct equation 3 to: $d\_{c}=\left(^{q^{2}}/\_{q}\right)^{1/3}$

Page 8, table 1, replace “Converging wall length” column values with the following:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Throat widths, W (inches) | 0.5 | 10 | 12 | 15 | 20 | 25 | 30 | 40 | 50 |
| Converging wall length (feet) | 2.04 | 14.3 | 16.3 | 25.5 | 25.5 | 25.5 | 26.5 | 27.5 | 27.5 |

Page 8, table 1, tables notes defining the gage point location, Hc, should be changed to: “Hc located $\frac{2}{3}$C distance from crest for WT <1.0 foot, and $\frac{2}{3}\left(\frac{W\_{T}}{2}+4\right)$feet from crest for WT 1.0 foot.”