INPUT DATA FOR BREACH EROSION MODEL (BRCH)
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Includes Modifications to the NWS Document
BREACH: AN EROSION MODEL FOR EARTHEN DAM FAILURES
By D.L. Fread[1]

This document contains Appendix A of the NWS BREACH Erosion Model documentation which includes a description of the input parameters and output variables. It contains corrections to the original documentation in addition to enhancements to the model (renamed BRCH to distinguish it from the NWS model). It is recommended that the BRCH GUI (BRCH-J) be used to create input files and to display the results.

Description of Input Parameters

The input data is written to a text file. The data is in fixed format, in fields of 10 characters (except the METRIC parameter which occupies 5 characters). A field may be left blank, and will be read in as a zero value. Each line of data (except lines 1 and 2) allows a maximum of 8 values (real numbers). Line 1 is a description of the file (up to 80 characters). Line 2 has 9 fields including the METRIC parameter which is an integer. Sample input files are included in the installation package. They can be displayed using a text editor.

Although the Metric option allows the input and output parameters to be displayed in Metric units, all computations within the BRCH model are done in English units. Unless noted, the English/Metric conversion units are as follows:

English/Metric Equivalents

Property	English Unit	Metric Unit	Conversion Factor (English to Metric)
Time	hr	hr	--
Elevation/depth/width	ft	m	1/3.281
Grass Length	in	cm	2.54
Flow	ft^3/sec	m^3/sec	1/35.32
Velocity	ft/sec	m/sec	1/3.281
Area	ft^2	m^2	1/10.765
Surface Area	acres	km^2	1/247.1
Weight	lb	N	4.448
Unit Weight	lb/ft^3	N/m^3	157.1
Shear Strength	lb/ft^2	N/m^2	47.88
Bottom Slope of channel	ft/mile	dimensionless	1/5280
Manning's n	English and Metric are same		
Note: Although the documentation refers to English units only (unless noted otherwise), the Metric option is fully functional. This table should be used to determine comparable units and to convert the recommended values to Metric units.			

Line
No. Data Description and Input Form

(1) MESSAGE - 20A4

MESSAGE Any message such as name of dam, MESSAGE must be < 80 characters long.

(2) HI, HU, HL, HPI, HSP, PI, CA, CB, METRIC - 5F10.2, 3F10.3, I5

HI Initial elevation (ft) of water surface in reservoir at time = 0.

HU Elevation (ft) of top of dam.

HL Elevation (ft) of bottom of dam (usually original stream-bed elevation).

HPI Elevation (ft) at which piping failure commences (if no piping failure is simulated, leave blank).

HSP Elevation (ft) of spillway crest (if no spillway, leave, blank).

PI Average plasticity index of clay for predominately clay dams.

CA Coefficient ($\tau_c = CA * PI^{CB}$) for clay critical shear stress, 0.004 < CA < 0.02.

CB Coefficient ($\tau_c = CA * PI^{CB}$) for clay critical shear stress, 0.58 < CB < 0.84.

METRIC Parameter indicating if input/output is in English (METRIC = 0) or Metric (METRIC = 1) units. All computations within BRCH are done in English units; only the input/output may be displayed in metric units. The METRIC value must be placed between columns 80 and 85.

(3) QIN(I) - 8F10.2

QIN(I) Inflow (cfs) to reservoir. I goes from 1 to a maximum 8. The inflow hydrograph is defined using 2 to 8 values. The first inflow value is associated with time = 0.

(4) TIN(I) - 8F10.2

TIN(I) Time (hrs) array associated with QIN(I), reservoir inflow hydrograph.

(5) RSA(I) - 8F10.2

RSA(I) Surface area (acres) of reservoir. I goes from 1 to a maximum of 8. Surface area is defined using 2 to 8 elevations, starting at the highest elevation and proceeding to the minimum reservoir elevation defined by HSA.

(6) HSA(I) - 8F10.2

HSA(I) Elevation (ft) associated with RSA(I), surface area values.

(7) HSTW(I) - 8F10.2

HSTW(I) Elevation (ft) associated with top widths of the tailwater cross-section. Elevations start at the channel invert. I goes from 1 to a maximum of 8 values.

(8) BSTW(I) - 8F10.2

BSTW(I) Top widths (ft) of tailwater cross-section.

Line
No. Data Description and Input Form

(9) CMTW(I) - 8F10.3

CMTW(I) Manning's n associated with each top width of the tailwater cross-section.

(10) ZU, ZD, ZC, GL, GS, VMP, SEDCON - 7F10.2

ZU Slope of upstream face of dam [1 (vertical) : ZU (horizontal)].

ZD Slope of downstream face of dam [1 (vertical) : ZD (horizontal)].

ZC Average slope of upstream and downstream faces of the inner core of the dam [1 (vertical) : ZC (horizontal)]. If no inner core, leave blank.

GL Average length of grass (inches). If no grass, leave blank.

GS Condition of stand of grass. If good, GS =1.0; if poor stand or no grass exists, GS = 0.0.

VMP Maximum permissible velocity (ft/sec) for grass-lined channel before the grass cover is eroded away. VMP can vary from 3 ft/sec to 6 ft/sec. If no grass, leave blank.

SEDCON Maximum sediment concentration (0.4 to 0.5) in breach flow. If left blank, a default value of 0.5 is used.

(11) D50C, PORC, UWC, CNC, AFRC, COHC, UNFCC - 3F10.2, F10.4, 3F10.2

D50C D_{50} (mm) grain size of the inner core material (50 percent finer). If no core, leave blank.

PORC Porosity ratio of the inner core material. If no core, leave blank.

UWC Unit weight (lb/ft^3) of the inner core material. If no core, leave blank.

CNC Manning's n of the inner core material. If left blank, CNC will be computed from the Strickler equation which is a function of the grain size of the core material. If a value greater than 0.99 is entered, CNC will be computed from the Moody diagram (Darcy f vs. D_{50} relationship). If no core, leave blank.

AFRC Internal friction angle (degree) of inner core material. If no core, leave blank.

COHC Cohesive strength (lb/ft^2) of inner core material. If no core, leave blank.

UNFCC Ratio of D_{90} to D_{30} grain sizes of inner core material. If no core, leave blank. If an inner core exists and UNFCC is left blank, the default value is 10.

(12) D50S, PORS, UWS, CNS, AFRS, COHS, UNFCS - 3F10.2, F10.4, 3F10.2

D50S D_{50} (mm) of the outer material of dam (50 percent finer).

PORS Porosity ratio of the outer material.

UWS Unit weight (lb/ft^3) of the outer material.

CNS Manning's n for the outer material. If left blank, CNS will be computed from the Strickler Equation which is a function of the grain size. If a value greater than 0.99 is entered, CNS will be computed from the Moody diagram (Darcy f vs. D_{50} relationship).

Line
No. Data Description and Input Form

AFRS Internal friction angle (degree) of the outer material.

COHS Cohesive strength (lb/ft^2) of the outer material.

UNFCS Ratio of D_{90} to D_{30} grain size of the outer material. If left blank, the default value is 10.

Note: If the dam material is homogenous (i.e., no inner core), use the outer layer to represent the entire homogenous dam material.

(13) BR, WC, CRL, SM, D50DF, UNFCDF, BMX, BTMX - 4F10.2, F10.4, 3F10.2

BR Ratio of breach width to flow depth for the initial rectangular-shaped breach. The range of values is $1 \leq \mathrm{BR} \leq 2$. Usually, use BR = 2.0 for overtopping failure, and BR = 1.0 for a piping failure. If left blank, BR = 2.0.

WC Width (ft) of dam crest (can be zero).

CRL Length (ft) of dam crest.

SM Bottom slope (ft/mile) of downstream river for the first few thousand feet below the dam.

D50DF D_{50} (mm) grain size of the material composing the top one-foot of the downstream face of the dam. If left blank, D50DF = D50S.

UNFCDF Ratio of D_{90} to D_{30} grain size of the material on the downstream face. If left blank, UNFCDF = 3.0 when D50DF > 0.0, or UNFCDF = UNFCS when D50F = 0.0.

BMX Maximum allowable width (ft) of the breach bottom as constrained by the valley cross-section. If left blank, BMX = CRL.

BTMX Maximum allowable width (ft) of the breach top as constrained by the valley cross-section. If left blank, BMX = CRL.

(14) DTH, DBG, H, TEH, ERR, FPT, TPR - 2F10.3, 5F10.2

DTH Basic time step size (hr). $0.001 \leq \mathrm{DTH} \leq 0.20$. The lower values are for man-made dams; the larger values are for large landslide dams. If left blank, DTH = 0.005.

DBG Output control parameter. If DBG = 0.0, only the outflow hydrograph and summary table are displayed; if DBG = 0.001, output at each time step is also displayed; if DBG = 0.002, output at each iteration of each time step is displayed along with the minimal output when DBG = 0.

H Initial depth (ft) of breach along the downstream face of dam for overtopping failure, or initial width of piping breach. Usually, $0.1 \leq \mathrm{H} \leq 1.0$. If left blank, H = 0.10. H must be sufficiently large to cause some degree of initial breach enlargement.

TEH Duration (hrs) of simulation.

ERR Error tolerance in iterative solution, expressed as a percentage ($0.1 \leq \mathrm{ERR} \leq 1.0$). If left blank, ERR = 0.5.

FPT Time step interval used to plot the outflow hydrograph ($1. \leq \mathrm{FPT} \leq 10.$). If left blank, FPT = 10.0.

Line
No. Data Description and Input Form

TPR Time (hrs) at which printing of the output begins. If $\mathrm{DBG} \geq 0.0001$, all debug information will be suppressed until time = TPR. TPR is useful in suppressing the base flow leading up to when significant failure begins. If left blank, output is printed for all time steps.

Note: Omit lines no. (15) and (16) if the spillway crest elevation, HSP (line no. 2), is blank or zero.

(15) SPQ(I) - 8F10.2

SPQ(I) Spillway flow (cfs). I goes from 1 to a maximum of 8. Spillway flow is defined using 2 to 8 head values starting at the spillway crest elevation and proceeding upwards until the maximum spillway discharge is specified.

(16) SPH(I) - 8F10.2

SPH(I) Head (ft) associated with SPQ(I), spillway flow.

Description of Output Parameters

The BRCH model has four levels of output based on the value of DBG (line no. 14).

1. Slump failure information (refer to the BREACH documentation for a description of the slumping process (Always printed)
2. A hydrograph of the total outflow (Always printed)
3. A summary of output parameters (Always printed)
4. Hydraulic information at each computational time step (DBG > 0)
5. Hydraulic information at each iteration of each time step (DBG > 0.001)
6. System level debug output which consists of the values of variables in the BRCH equations (DBG > 0.002)

The BRCH GUI (BRCH-J) will display the information generated when DBG = 0.001. A description of those table values follows.

Slump Failure Information

A mechanism controlling the breach width comes from the stability of the soil slopes. BRCH computes three critical collapse conditions as a function of critical depth and the critical collapse angle (Θ).

Name	Description of Variable
AFRA	Average internal friction angle (ϕ)
TH	Angle (Θ) of each of the three critical collapse conditions
H	Critical depth of each of the three collapse conditions
KSLUMP	Counter of slump failure
HCK	Depth of vertical cut when failure slump occurs
DELT	Time delay in erosion as slumped material is transported

DEL Total change in side angle due to slump failure

Output Summary Information

Name	Description of Variable
KTT	Maximum number of printed time steps
I	Total number of iterations
T	Total time period (hr)
QPB	Maximum outflow (cfs) through the breach
TP	Time (hr) at which the peak outflow occurs
QP	Maximum total outflow (cfs) occurring at time TP
TRS	Duration (hr) of the rising limb of the hydrograph (TP - TB)
TB	Time (hr) at which failure starts when the upstream face is eroding (KG=2) or during piping failure (KG=4)
BRD	Final depth (ft) of breach
BRW	Top width (ft) of breach at time TP
HU	Elevation (ft) of top of dam
HY	Final elevation (ft) of reservoir water surface
HC	Final elevation (ft) of bottom of breach
AGL	Acute angle that breach side makes with vertical at T = TP
QO	Outflow (cfs) at T = 0.0
Z	Side slope of breach (ft/ft) at time TP
TFH	Time of failure (hr) determined by the simplified dam-break (**SMPDBK**) equation
TFHI	Time of failure (hr) determined by the integration of the discharge hydrograph from TB to TP
BO	Bottom width (ft) of breach at time TP

Hydraulic Information at each Computational Time Step

Name	Description of Variable
I	Counter
T	Time (hr)
DTH	Time step (hr)

Name	Description of Variable
KG	Code for region of failure: -1 Reservoir filling 0 No erosion on grass 1 Erosion of downstream face 2 Erosion of upstream face 3 Draining of reservoir with breach size fixed at maximum dimensions 4 Piping mode 5 Collapse mode
KC	Collapse height (ft)
QTOT	Total outflow (cfs)
QTS	Spillway outflow (cfs)
QB	Breach outflow (cfs)
SUB	Submergence correction factor
BT	Top width of breach (ft)
HY	Elevation of reservoir water surface (ft)
HC	Elevation of bottom of breach (ft)
BO	Bottom width of breach (ft)
PPP	Depth (ft) of erosion perpendicular to the downstream face of the dam (KG $\leq$ 1) Length (ft) of breach along the downstream face of the dam (KG = 2) Breach width (ft) increase (KG = 3) Elevation (ft) of top of pipe (KG = 4)
HP	Horizontal distance (ft) eroded across top of dam (KREG $\leq$ 1) Vertical distance (ft) eroded at upstream face (KREG = 2) Depth (ft) of flow in breach (KREG = 3) Head (ft) on pipe (KREG = 4)
TWD	Tailwater depth (ft)
DH	Estimated erosion depth (ft) during the current time step
DHH	Computed erosion depth (ft) during the current time step
KIT	Iteration counter
AGL	Acute angle (degrees) that breach side makes with vertical

REFERENCE

[1]Fread, D.L. 1991, "BREACH, An Erosion Model for Earthen Dam Failures", Hydrology Laboratory, National Weather Service, Silver Spring, MD.