CHECK-RAS Tutorial

Developed October 2000

CHECK-RAS Learning Objectives

Upon completing this tutorial you will...

- Have an overall understanding of the functions of the CHECK-RAS program.
- Understand how CHECK-RAS is different from HEC-RAS internal checks.
- Know the basic steps for setting up CHECK-RAS.
- Be familiar with the CHECK-RAS interface.
- Know how to generate a HEC-RAS report for CHECK-RAS.
- Understand the basic principles behind each of the five types of CHECK-RAS checks.
- Know how to run a CHECK-RAS check.
- Know how to read a CHECK-RAS report.
- Know how to use CHECK-RAS help screens.

Introduction

This tutorial will discuss the basic concepts of CHECK-RAS (River Analysis System) and demonstrate how to use the program. The tutorial consists of three sections - 'Overview', 'Setup and Navigation', and 'Checks and Examples'.

Prior to running CHECK-RAS for the first time, users should:

- Have a good understanding of stream hydraulics.
- Be familiar with the U.S. Army Corps of Engineers HEC-RAS program.
- Have a basic understanding of Microsoft Windows.

CHECK-RAS

The CHECK-RAS program uses a series of checking routines to check the reasonableness of data from HEC-RAS files. HEC-RAS is the U.S. Army Corps of Engineers Hydrologic Engineering Center River Analysis System program.

CHECK-RAS uses data from the HEC-RAS geometric, steady flow, and output files to verify that:

- The hydraulic estimates and assumptions made in the model appear to be justified.
- The data is in accordance with applicable Federal Emergency Management Agency (FEMA) requirements
- The data is compatible with the assumptions and limitations of the HEC-RAS program.

HEC-RAS Overview

The HEC-RAS software allows a user to perform one-dimensional steady flow hydraulics. HEC-RAS can perform these hydraulic calculations for a full network of natural and constructed channels.

The major hydraulic capability of HEC-RAS is Steady Flow Water Surface Profiles analysis.

CHECK-RAS Background

CHECK-RAS Version 1.1 was released in August 2000.

FEMA has made CHECK-RAS available in the public domain through the FEMA web site for use by study contractors, revision requesters, state and local agencies, regional offices and FMPCCs.

CHECK-RAS is an enhanced and improved version of the CHECK-2 program and is intended to replace that program. It significantly differs from CHECK-2 by requiring the user to create a CHECK-RAS report file. Although the overall features are similar to CHECK-2, the interface and checking procedures are more advanced in CHECK-RAS.

More CHECK-RAS Background

CHECK-RAS allows users to examine a variety of parameters from HEC-RAS data files, as well as generate, view, and print reports. These reports include tables and warning messages about possible inconsistencies in the HEC-RAS input and output.

CHECK-RAS checking routines cover the following five areas which will be discussed later in this tutorial:
NT Check
Cross-Section Check
Floodway Check
Structure Check
Profile Check

Differences between HEC-RAS checks and CHECK-RAS checks

Although HEC-RAS provides some warning messages, CHECK-RAS differs from HEC-RAS in that it does the following:
-Categorizes floodplain modeling into five distinct areas of checks.
-Provides a summary table and warning messages for each checked area.
-Assesses the suitability of roughness coefficients and transition loss coefficients.
-Assesses the suitability of starting water-surface elevations.
-Assesses bridge and culvert modeling
-Provides a detailed floodway analysis.
-Compares important parameters among multiple profiles.
-Proposes solutions through the use of Help screens.

CHECK-RAS Overview Summary

Congratulations, you have completed the 'Overview' section of this tutorial. Let's summarize what we have learned so far.

•The CHECK-RAS program uses a series of routines to check the reasonableness of data from HEC-RAS files.
•The HEC-RAS program allows a user to perform one-dimensional steady flow hydraulics.
•CHECK-RAS is an enhanced version of the CHECK-2 program for use with HEC-RAS.
•CHECK-RAS allows users to examine a variety of parameters from HEC-RAS data files, as well as generate, view, and print reports.
•CHECK-RAS checking routines cover 5 checks - NT, Cross Section, Structure, Floodways, Profiles
•CHECK-RAS checks differ from HEC-RAS checks in several ways.

CHECK-RAS Interface

CHECK-RAS is a Windows-based program, allowing for mouse navigation, function keys, icons, and a help menu.

To take a quick tour of the CHECK-RAS interface click the show me button below.

CHECK-RAS Setup

CHECK-RAS can only run if the HEC-RAS program is installed on the same computer. If you are using CHECK-RAS for the first time you will need to configure your CHECK-RAS program so that it can find your HEC-RAS program.

CHECK-RAS First Time User

The following procedures must be followed when running CHECK-RAS for the first time.

Click the show me button below to walk through the HEC-RAS setup procedure.

Generating a Report in HEC-RAS for CHECK-RAS

For CHECK-RAS to process a HEC-RAS project it must extract data from that project's HEC-RAS report. The instructions below show you how to generate a HEC-RAS report.

First open the CHECK-RAS program and open the project file that you wish to run. Click the show me button to see what steps you must next take to generate the HEC-RAS report.

Extracting Data and Selecting a Profile

- Extracting HEC-RAS Data
- 100-year Profile
- Floodway Profile
- Multiple Profiles

Running a Check and Viewing

After you have extracted the HEC-RAS data for your project and selected a profile type, you can run a check and view the resulting report. To do this, click on the icon button for the check that you would like to run and then click the 'Report' button to view the report. To run another check and view its report simply repeat this process.

Help Messages in Reports

A series of Help messages may be accessed and displayed from each report by highlighting a complete Message ID with your mouse. Available help messages are displayed in Help Message dialog boxes for each individual Message ID. Additional Message IDs may be referenced in these Help Message dialog boxes. The same highlighting procedure may be used to get additional information about these Message IDs from the dialog boxes. Help messages may be printed by selecting the 'Print' option from the 'File' pull-down menu provided in the Help Message dialog box.

CHECK-RAS Setup and Navigation Summary

Congratulations, you have completed the 'Setup and Navigation' section of this tutorial. Let's summarize what we have learned in this section.

- The CHECK-RAS interface.
- Basic CHECK-RAS setup.
- First time user setup.
- Generating a report in HEC-RAS for CHECK-RAS.
- Extracting data and selecting a profile.
- Running a check and viewing a report.
- Using Help Messages

Navigation Screen

Allow users to choose which checks they want to learn about.
NT-CHECK
Cross-Section Check
Floodway Check
Structures Check
- Bridges
- Culverts
- In-line Weirs
- Other Structures (Gate Weir (Dams) / Multiple Opening Weir)
- Profile Check

NT Check

The NT Check evaluates roughness (Manning's "n") and transition loss coefficients. The NT Check command will invoke CHECK-RAS to perform the following tasks:

· Generate Summary Table
· Generate Summary of Statistics Table
· Check Roughness Coefficients at Cross Sections
· Check Transition Coefficients
· Check Roughness Coefficients at Structures

NT Check Summary Table

A Summary Table for all cross sections is created by the NT Check Program consisting of 7 columns, as follows:

· River Station
· Type of Structure
· Left Overbank "n" Value
· Channel "n" Value
· Right Overbank "n" Value
· Contraction Loss Coefficient
· Expansion Loss Coefficient

When the horizontal variation in the "n" values option is used and the left overbank, right overbank, and channel "n" values are specified by more than one value, each individual "n" value is shown on a separate line in the table to clearly show that multiple "n" values are used at that section.

Summary of Statistics Table

This table, which is also generated by the NT CHECK Program, includes the maximum and minimum left and right overbank and channel roughness coefficient values for all cross sections in the input file. It also shows the maximum and minimum values of contraction and expansion loss.

Roughness Coefficients at Cross Sections

The following checks evaluate roughness coefficient values used at cross sections that are not at structures. A detailed explanation of these checks can be found under the 'Help' menu in CHECK-RAS.

- Checks that the left and right overbank "n" values at each cross section are between 0.035 and 0.200.
- Checks that the channel "n" values at each cross section are between 0.025 and 0.100.

Transition Loss Coefficients

The following checks evaluate transition loss coefficient values used at all cross sections in the HEC-RAS input file. A detailed explanation for each of these checks can be found under the 'Help' menu in CHECK-RAS.

· Checks that the contraction loss coefficient is equal to 0.3 and the expansion loss coefficient is equal to 0.5 at Sections 2, 3, and 4 of the structure.
· Checks that the transition loss coefficients used are 0.1 and 0.3 at cross sections that are not sections 2, 3, and 4 of the structure.

Roughness Coefficient at Structures

The following checks evaluate roughness coefficient values used at structures. A detailed explanation of these checks can be found under the 'Help' menu in CHECK-RAS.

- Checks that the channel "n" values at Sections 2 and 3 of the structure are less than the channel "n" value of Sections 1 and 4, respectively, by 0.005.
- Checks that the channel "n" values downstream and upstream of an internal bridge opening section are equal to or larger than the channel "n" value of Sections 2 and 3, respectively.

NT RS 02 Example

For example files go to
http://www.fema.gov/fhm/dl_crrcr.shtm and download
the following files:

NTRS02.f01
NTRS02.g01
NTRS02.g02
NTRS02.p01
NTRS02.p02.
NTRS02.prj

Cross-Section Check

The XS Check evaluates distances, blocked obstructions, critical depth, ineffective flow areas, levees, divided flow, extended cross sections, known water-surface elevation, location of cross sections, placement of discharges, boundary conditions, and flow regimes. The XS Check command will invoke CHECK-RAS to perform the following tasks:

· Generate Summary Table
· Check distances between cross sections and junctions
· Check ineffective flow options
· Check location of cross section and discharges
· Check special conditions
· Check flow regime
· Check boundary conditions

XS Check Summary Table

A Summary Table for all cross sections is created by the XS Check function consisting of 6 columns, as follows:

· River Station
· Left Overbank Distance
· Right Overbank Distance
· Channel Distance
· Total Discharge
· Flow Codes

Cross Section Spacing

This XS function checks the following five variables for each cross section:

· Change in velocity head (HV) value exceeds 0.5
· Conveyance change (Kratio) is outside the range 0.7 and 1.4
· Water depth changes by a factor of 1.1
· Floodplain topwidth (TopWdthAct) varies by a factor of 2
· Distance between two cross sections is more than 500 feet

If all above conditions are satisfied, additional cross section(s) should be inserted between the cross sections.

Ineffective Flow

This XS function checks whether the following options are selected or used at a river station:

· Levee
· Normal Ineffective Flow
· Multiple (blocked) Ineffective Flow

Location

The function also checks whether the cross section upstream of a critical depth cross section is located at a distance no greater than the topwidth of the critical depth cross section.

Special Conditions

The XS function prints letters representing special conditions at river stations in the Summary Table.

· Letter "B" represents blocked obstruction
· Letter "C" represents critical depth
· Letter "D" represents divided flow
· Letter "E" represents an extended cross section where the computed water surface elevation exceeds the elevation of the starting and end stations specified of the ground data
· Letter "K" represents known or changing water surface or energy elevation Levee
· Normal Ineffective Flow
· Multiple (blocked) Ineffective Flow

Discharge

The following checks for Discharge are run as a part of the XS function: Discharges decrease in the downstream direction
· A constant discharge is used for the entire profile
· The same discharge is used at the downstream and upstream side of
  a structure
· A value of zero discharge shifts between the left and right
  overbanks between any two consecutive cross sections

Flow Regime

The XS function verifies whether the profiles are computed as:
· Super critical flow regime
· Mixed flow regime

Boundary Conditions

The XS function provides the following information regarding friction slope method and starting conditions at the downstream and upstream boundaries.

· A friction slope method other than the average conveyance method is used and there are channel lengths more than 500 feet within the model
· Known water-surface
· Energy slope
· Critical depth
· Elevation-discharge relationship

Structure Check

The Structure Check evaluates distances, type of flow, culvert coefficients, culvert solution criteria, bridge coefficients, bridge solution criteria, ineffective flow, deck/roadway and ground data, and floodway at the structure. The Structure Check command will invoke CHECK-RAS to perform the following tasks:

- Generate a Summary Table
- Check distance between the structure sections
- Check type of flow
- Check culvert coefficients
- Check culvert solution criteria
- Check bridge coefficients
- Check bridge solution criteria

Summary Table

A Summary Table is created by the Structure Check function consisting of 7 columns, as follows:

- River Station
- Maximum Low Cord Elevation
- Minimum Road Elevation
- Energy Gradient Elevation
- Water-Surface Elevation
- Minimum Channel Elevation
- Type of Structure

Distance

The Structure Check verifies whether the distance between Section 3 and the upstream face of the structure and the distance between the downstream face of the structure and Section 2 are less than the height of the opening.

Culvert Coefficients

The Structure Check function invokes the Culvert Coefficient Check, which verifies the following:

- Entrance loss coefficient is specified properly
- Exit loss coefficient is equal to 1.0
- Culvert “n” value is specified properly

Culvert Solution Criteria

The Structure Check function invokes the Culvert Solution Criteria Check, which verifies the following:

- “Highest U.S. EG” is selected as the criterion
- EG at Section 3 is lower than the specified MinWeirFlowEl and higher than the MnTpRd

Type of Flow

The Structure Check function invokes the Type of Flow Check, which verifies the following:

- The type of flow at the structure is either low flow, pressure flow, low and weir flow, or pressure and weir flow
- Criterion used for computing pressure flow is upstream energy grade line
- The pressure/weir method or energy method is used at a bridge when the type of flow is sluicegate pressure flow or sluicegate pressure and weir flow
- The sluicegate Cd value has been specified by the user
- The pressure/weir method or energy method is used at a bridge when the type of flow is submerged pressure flow or submerged pressure and weir flow
- A default submerged Cd value of 0.8 is used when the type of flow is submerged pressure flow

Ineffective Flow

The Structure Check function invokes the Ineffective Flow Check, which verifies the following:

- Multiple (blocked) ineffective flow areas option is used for single opening bridge, or a culvert group, or an inline weir
- Normal ineffective flow area option or Multiple (blocked) ineffective flow areas option is used at Sections 1 and 4 of the structure
- Ineffective flow elevations are higher than MnTpRd when weir flow occurs for Multiple (blocked) ineffective flow areas
- Ineffective flow area option is not considered at Sections 2 and 3 when pressure or low flow occurs at a structure
- Ineffective flow elevation is specified properly at Sections 2 and 3 of a structure
- Effective flow area is too narrow when pressure flow occurs at a structure
- Ineffective flow stations are within the abutments of a structure

Geometric Data

The Structure Check function invokes the Geometric Data Check, which verifies the following:

- Deck/Roadway data is aligned properly with the ground data
- Low cord line crosses the ground line at more than two locations for single opening bridge or within the stagnation limits of a bridge opening for multiple opening analysis
- Sections 2 and 3 are coded as narrowly as the bridge (culvert) opening
- Section 3 centerline station differs from that of Section 2 when weir flow is not computed although EG at Section 3 is higher than MnTpRd, or the combination of Qweir and CulvQ is larger than Qtotal by 1%
- The MnTpRdD is higher than MnTpRdU if the combination of Qweir and CulvQ is larger than Qtotal by 1%
- Centerline station of Section 3 differs from that of Section 2 if encroachment stations are not computed at the Culvert Section and Section 3
- “Cross Section Lid” option is used at Sections 1, 2, 3 and 4 of a structure

Floodway

The Structure Check function invokes the Floodway Check, which verifies the following:

- Encroachment method is specified at Section 3, Structure Section, and Section 2
- Encroachment Methods 2 and 3 are specified at Section 3, Structure Section, and Section 2
- Encroachment stations are within the abutment stations
- Encroachment stations are within the channel bank stations at Section 3, Bridge section, and Section 2
- Encroachment stations are computed at Section 3 when Encroachment Method 1 is specified at the Structure Section, and Encroachment Method 4 or 5 is specified at Section3
- Negative surcharge value at Section 3, Bridge-Up Section, Bridge-Dn Section, and Section 2, is less than -0.09.
- Surcharge value is more than the allowable surcharge value at Section 3, Bridge-Up Section, Bridge-Dn Section, and Section 2
- Encroachment stations are within the 1% annual chance floodplain
- Encroachment stations over the road for the culvert are the inline weir are within the weir stations of the natural profile.

Floodway Check

The Floodway Check evaluates the encroachment method, starting water-surface elevation, encroachment stations, surcharge values, and floodway discharge. The Floodway Check command will invoke CHECK-RAS to perform the following tasks:

- Generate a Summary Table
- Check encroachment method
- Check starting water-surface elevation of floodway profile
- Check encroachment stations
- Check surcharge values Check floodway discharges

Floodway Check Summary Table

A Summary Table is created by the Floodway Check function consisting of 7 columns, as follows:

- River Station
- Encroachment Method
- Surcharge Values
- Natural / Floodway Water-Surface Top Width
- Floodway Width
- Channel Width
- Type of Structure

Encroachment Method

The Floodway Check function invokes the Encroachment Method Check, which verifies the following:

- Encroachment method is specified at the river station
- Encroachment Methods 2 and 3 are used to compute the floodway encroachment stations
- A target surcharge value for water-surface is not specified for Encroachment Methods 4 or 5
- A surcharge target value greater than one foot or the maximum allowable surcharge value for the state where the stream is located is specified at any cross section

Starting Water-Surface Elevation

The following checks for starting water-surface elevation are run as a part of the Floodway Check function:

- Starting water-surface elevation of the floodway profile is equal to the computed water-surface elevation of the natural profile plus the specified surcharge value
- The difference in conveyance between the floodway profile and the natural profile is more than 1%

Floodway Width

The following checks for floodway width are verified as a part of the Floodway Check function:

- Encroachment stations are specified within the channel bank stations
- Encroachment stations are outside the 1% annual chance floodplain
- Channel bank stations are selected such that a relatively flat overbank exists outside of the channel bank stations

Surcharge Value

The following checks for surcharge value are run as a part of the Floodway Check function:

- Negative surcharge values exist in the floodway computations
- Computed surcharge value exceeds the maximum allowable surcharge value at any cross section
- "Change in WS or EG" option is used to specify the floodway water-surface elevation

Floodway Discharge

The Floodway check invokes a check to ensure that the total discharge in the natural and floodway profiles are the same at every cross section.

Multiple Profiles Check

The Multiple Profiles Check compares the starting water-surface elevation methods, crossing of water-surface elevations, discharges, and top-widths for two to four profiles. The Multiple Profiles Check command will invoke CHECK-RAS to perform the following tasks:

- Generate a Summary Table
- Check boundary conditions
- Check crossing of water-surface elevations between profiles
- Check discharges
- Check top widths

Multiple Profiles Summary Table

A Summary Table is created by the Multiple Profiles Check function consisting of 6 columns, as follows:

- River Station
- Water-Surface Elevation
- Total Discharge
- Top Width Actual
- Velocity Head
- Profile Number

Boundary Conditions

The Multiple Profiles Check function produces the starting water-surface method for the downstream and upstream boundary condition for each selected profile.

Discharge

The Multiple Profiles Check function verifies whether or not the discharges at a river station are in an increasing order.

Crossing of Water-Surface Elevations

The Multiple Profiles Check function checks whether the water-surface elevation of a lower discharge is higher than that of a higher discharge.

Top Width

The Multiple Profiles Check function checks that the top width of a higher discharge is the same as that of a lower discharge, and if so, the velocity head for the higher discharge is more than 0.5 feet.