

## Energy – Reduced Mass (CEES)

**Overview:** Computes the “Reduced Mass” of vehicles in collision and the maximum and actual Energy available for Damage and relative Translational Motion. It also computes the Crush Energy Equivalent Speed for the collision.

### Entry into Module:

This module of the program is normally entered by clicking on the **REC-TEC** block in the upper left of the **REC-TEC Window** causing the drop-down menu to appear. Place the cursor on the **Energy** block and click on **Reduced Mass (CEES)** on the sub-menu to initiate this module.

Under certain circumstances, the user may choose to use the **Files** block instead of the drop-down menu approach. Selecting any file with an **.ERM** extension in the **Dialog box** accessed from either the **Open Single File** or **Open Multiple Files** block opens this module.

Selecting **AutoLoad [ON]** from either the **Setup Menu** or the **AutoLoad Icon** on the upper right side (third line) of the **REC-TEC Window** automatically loads the two-vehicle scenario that was on the screen when the module was closed, either individually, or when the program was closed. With **AutoLoad [OFF]** on the main **REC-TEC Window**, modules will start without loading a file.

### Data Entry:

This module contains the following data entry blocks:

#### Test Collision Data (Used to compute A, B & G Stiffness Coefficients)

- **Velocity (C)** – Closing Velocity
- **Velocity (S)** – Separation Velocity
- **Weight (1)** – Weight of Unit 1 in Test Crash
- **Weight (2-B/I)** – Weight of Unit 2 (Barrier/Impactor) in Test Crash
- **Angle (Theta)** – The angle between the **PDOF** and a line Perpendicular to the Surface Struck

#### Converted Output

- **Velocity (C):** – Closing Velocity
- **Velocity (S):** – Separation Velocity
- **Mass 1:** – Mass of Unit 1 in Test Crash
- **Mass 2:** – Mass of Unit 2 (Barrier/Impactor) in Test Crash
- **C. Factor** – Correction Factor  $(1 + \tan(\theta)^2)$

**Additional Information:** The **IPTM** publication, *Anatomy of a Collision* by George M.

Bonnett contains an article entitled **Stiffness Coefficients – Energy and Damage**, detailing this process and is recommended for further reading. 1-904-620-4786 or <http://www.iptm.org>

## Graphs

- **CEES1** – Computed Speed if Unit 2 is Infinite-Mass Non-Deforming Barrier
- **CEES2** – Computed Speed if Unit 1 is Infinite-Mass Non-Deforming Barrier
- **Vc** – Closing Velocity
- **Vs** – Separation Velocity
- **W1** – Weight of Unit 1
- **W2** – Weight of Unit 2
- **Emax** – Maximum Energy for Damage (Includes Rotation)
- **Ertm** – Energy of Relative Translational Motion (Post-Impact)
- **Edmg** – Energy for Damage (Includes Rotation)

## Output

Display includes the formulae for computing the unknowns in this module. In addition to the basic formulae, the frame shows intermediate steps with the actual input data shown in the computation.

- **Emax** – Maximum Energy for Damage (Includes Rotation)
- **Ertm** – Energy of Relative Translational Motion (Post-Impact)
- **Edmg** – Energy for Damage (Includes Rotation)
- **Speed1(P)** – Crush Energy Equivalent Speed (Using Edm/C.Factor)
- **Speed1(S)** – Crush Energy Equivalent Speed (Using Edm/C.Factor)
- **Speed2(P)** – Crush Energy Equivalent Speed (Using Edm/C.Factor)
- **Speed2(S)** – Crush Energy Equivalent Speed (Using Edm/C.Factor)
- **rVelocity (Vs/Vc)** – Coefficient of Retained System Velocity

## Options:

Several **Command Buttons** appear in a frame located at the lower right corner of the module Window. The **Command Buttons** allow the user to engage options including the option to **Open** and **Save** the data required to generate the scenario shown on the screen at the time the file was saved.

- **Open .ERM File** – Calls up a **Dialog box**, which **Opens** any pre-existing **.ERM** file and displays the output results.
- **Save .ERM File** – Calls up a **Dialog box**, which **Saves** data on the screen to files with any user-selectable filenames. This is independent of the automatic saving as “**LastFile.ERM**” of the data at the close of this module or the close of the program.

- **N** – This button toggles a graphical number pad on the screen that can be used to enter data into the input boxes without using your keyboard number pad. This may be useful for presentations as data entry can be accomplished using a wired/wireless mouse.