Step 1: Application Data

- **(W)** Weight = 2,000 lbs.
- **(H)** Height = 8 in.
- **(α)** Angle of incline = 30˚
- **(C)** Cycles/Hr = 60

Step 2: Calculate kinetic energy

$$E_k = W \times H$$

$$E_k = 2,000 \times 8$$

$$E_k = 16,000 \text{ in-lbs.}$$

Assume Model HD 1.5 x 2 is adequate (Page 13).

Step 3: Calculate work energy

$$E_W = W \times \sin \alpha$$

$$E_W = 2,000 \times 0.5$$

$$E_W = 1,000 \text{ lbs.}$$

Step 4: Calculate total energy per cycle

$$E_T = E_k + E_W$$

$$E_T = 16,000 + 1,000$$

$$E_T = 17,000 \text{ in-lbs./c}$$

Step 5: Calculate total energy per hour

$$E_{TC} = E_T \times C$$

$$E_{TC} = 17,000 \times 60$$

$$E_{TC} = 1,020,000 \text{ in-lbs./hr}$$

Step 6: Calculate impact velocity and confirm selection

$$V = \sqrt{\frac{2 \times E_T}{C}}$$

$$V = \sqrt{17,000 \times 60}$$

$$V = 124 \text{ in./sec.}$$

Model HD 1.5 x 2 is adequate.
Shock Absorber Sizing Examples

Overview

- **STEP 1**: Application Data
  - (W) Weight = 20,000 lbs.
  - (V) Velocity = 20 in./sec.
  - (C) Cycles/Hr = 4

- **STEP 2**: Calculate kinetic energy
  \[ E_K = \frac{W \times V^2}{772} \]
  \[ E_K = \frac{20,000 \times 20^2}{772} \]
  \[ E_K = 10,364 \text{ in-lbs.} \]

  Assume Model HD 1.5 x 2 is adequate (Page 13).

  If there is no additional drive force, proceed to step 4 and \( E_w = 0 \). If the application is driven by a cylinder, proceed to step 3a. If the application is driven by a motor proceed to step 3b.

- **STEP 3a**: Calculate work energy:
  - (d) Cylinder bore diameter = 6 in.
  - (P) Cylinder pressure = 80 psi
  \[ F_D = 0.7854 \times d^2 \times P \]
  \[ F_D = 0.7854 \times 6^2 \times 80 \text{ psi} \]
  \[ F_D = 2,262 \text{ lbs.} \]
  \[ E_w = F_D \times S \]
  \[ E_w = 2,262 \times 2 \]
  \[ E_w = 4,524 \text{ in-lbs.} \]

- **STEP 3b**: Calculate work energy:
  - (Hp) Motor Horsepower = 5 Hp
  \[ F_D = 19,800 \times \frac{\text{Hp}}{20} \]
  \[ F_D = 19,800 \times 5 \]
  \[ F_D = 4,950 \text{ in-lbs.} \]
  \[ E_w = F_D \times S \]
  \[ E_w = 4,950 \times 2 \]
  \[ E_w = 9,900 \text{ in-lbs.} \]

- **STEP 4**: Calculate total energy per cycle
  \[ E_T = E_K + E_w \]
  \[ E_T = 10,364 + 4,524 \]
  \[ E_T = 14,888 \text{ in-lbs.} \]

- **STEP 5**: Calculate total energy per hour
  \[ E_T \times C = E_T \times C \]
  \[ E_T \times C = 14,888 \times 4 \]
  \[ E_T \times C = 59,552 \text{ in-lbs. /hr} \]

Model HD 1.5 x 2 is adequate.

**Example 3**: Horizontal Moving Load
**Overview**

Please note:

Unless instructed otherwise, Enidine will always calculate with:
- 100% velocity $v_A$ and
- 100% propelling force $F_D$

### Application 1

**Crane A against Solid Stop**

Velocity:

$$V_r = V_A$$

Impact weight per buffer:

$$W_I = \frac{W}{2}$$

### Application 2

**Crane A against Crane B**

Velocity:

$$V_r = V_A + V_B$$

Impact weight per buffer:

$$W_I = \frac{W_A + W_B}{2}$$

### Application 3

**Crane B against Crane C**

Velocity:

$$V_r = V_B + V_C$$

Impact weight per buffer:

$$W_I = \frac{W_B + W_C}{2}$$

### Application 4

**Crane C against Solid Stop with Buffer**

Velocity:

$$V_r = \frac{V_C}{2}$$

Impact weight per buffer:

$$W_I = W_C$$
### Shock Absorber Sizing Examples

**Typical Shock Absorber and Crane Applications**

Please note that this example is not based on any particular standard. The slung load can swing freely, and is therefore not taken into account in the calculation.

<table>
<thead>
<tr>
<th>Total Weight of Crane:</th>
<th>837,750 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Trolley:</td>
<td>99,200 lbs.</td>
</tr>
<tr>
<td>Span:</td>
<td>z = 3,940 in.</td>
</tr>
<tr>
<td>Trolley Impact Distance:</td>
<td>x = 3,540 in.</td>
</tr>
<tr>
<td>Crane Velocity:</td>
<td>V_{Crane} = 60 in./sec.</td>
</tr>
<tr>
<td>Required Stroke:</td>
<td>24 in.</td>
</tr>
<tr>
<td>Trolley Velocity:</td>
<td>V_{Trolley} = 160 in./sec.</td>
</tr>
<tr>
<td>Required Stroke:</td>
<td>40 in.</td>
</tr>
</tbody>
</table>

- **Bridge Weight per Rail** = Crane weight total - Trolley weight
  
  \[
  \text{Bridge Weight per Rail} = \frac{837,750 \text{ lbs.} - 99,200 \text{ lbs.}}{2} = \frac{369,275 \text{ lbs.}}{2}
  \]

- **WDmax** = Bridge Weight per Rail + Trolley Weight in Impact Position
  
  \[
  \text{WDmax} = \frac{369,275 \text{ lbs.} + (99,200 \text{ lbs.} \times 3,540 \text{ in.})}{3,940 \text{ in.}}
  \]

  \[
  \text{WDmax} = 458,404 \text{ lbs.}
  \]

- **EK** = WDmax \times \frac{V_r^2}{2}

  \[
  \text{EK} = 458,404 \text{ lbs.} \times \frac{(60 \text{ in./sec.})^2}{2}
  \]

  \[
  \text{EK} = 2,137,635 \text{ in-lbs.}
  \]

  Selecting for required 24-inch stroke:

  \[
  \text{HD} 5.0 \times 24, \text{ maximum shock force ca. 104,786 lbs} = F_s = \frac{\text{EK}}{\eta}
  \]

  \[
  \text{WD} = \text{Trolley Weight per Shock Absorber}
  \]

  \[
  \text{WD} = \frac{99,200 \text{ lbs.}}{2} = 49,600 \text{ lbs.}
  \]

  \[
  \text{E}_k = \frac{\text{WD}}{772} \times V_r^2
  \]

  \[
  \text{E}_k = 49,600 \text{ lbs.} \times \frac{(60 \text{ in./sec.})^2}{772}
  \]

  \[
  \text{E}_k = 2,137,635 \text{ in-lbs.}
  \]

  Selecting for required 40-inch stroke:

  \[
  \text{HD} 4.0 \times 40, \text{ maximum shock force ca. 48,376 lbs} = F_s = \frac{\text{EK}}{\eta}
  \]

  \[
  \text{WD} = \text{Trolley Weight per Shock Absorber}
  \]

  \[
  \text{WD} = \frac{99,200 \text{ lbs.}}{2} = 49,600 \text{ lbs.}
  \]

  \[
  \text{E}_k = \frac{\text{WD}}{772} \times V_r^2
  \]

  \[
  \text{E}_k = 49,600 \text{ lbs.} \times \frac{(160 \text{ in./sec.})^2}{772}
  \]

  \[
  \text{E}_k = 1,644,767 \text{ in-lbs.}
  \]

  Selecting for required 40-inch stroke: