1. Horizontal (x) and vertical (y) expansion were measured on 9 bridges in the area of Quebec City:

<table>
<thead>
<tr>
<th>Bridge 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>20</td>
<td>15</td>
<td>43</td>
<td>5</td>
<td>18</td>
<td>24</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>y</td>
<td>68</td>
<td>58</td>
<td>55</td>
<td>75</td>
<td>58</td>
<td>68</td>
<td>55</td>
<td>68</td>
</tr>
</tbody>
</table>

Summary statistics are:

\[ \bar{x} = 20.9 \quad \bar{y} = 60.9 \]

\[ S_{xx} = \sum (x - \bar{x})^2 = 1036.9 \]
\[ S_{yy} = \sum (y - \bar{y})^2 = 524.9 \]
\[ S_{xy} = \sum (x - \bar{x})(y - \bar{y}) = -515.1 \]

a. (5) The equation for the least squares line is \( \hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x = 71.4 - 0.50x \). Use the summary statistics to illustrate computation of \( \hat{\beta}_0 \) and \( \hat{\beta}_1 \):

\[
\hat{\beta}_1 = S_{xy} / S_{xx} = -515.1 / 1036.9 = -0.497 \quad \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 (\bar{x}) = 60.0 + 0.497(20.9) = 70.382
\]

b. (5) Complete the following analysis of variance (ANOVA) table:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>255.9</td>
<td>255.9</td>
</tr>
<tr>
<td>Error</td>
<td>7</td>
<td>269.0</td>
<td>38.43</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>524.9</td>
<td></td>
</tr>
</tbody>
</table>

c. (3) \( R^2 = .49 \). Use results in the ANOVA table to show how \( R^2 \) was computed:

\[ R^2 = 0.49 = \frac{255.9}{524.9} \]

d. (5) Construct a 95% confidence interval for \( \beta_1 \):

\[
\hat{\beta}_1 \pm t_{0.025,7} \sqrt{MSE / S_{xx}} = -0.497 \pm 2.36 \sqrt{38.43 / 1036.9} = -0.497 \pm 0.454
\]

e. (2) Compute the correlation coefficient between horizontal and vertical expansion:

\[
r = \frac{S_{xy}}{\sqrt{S_{xx} S_{yy}}} = \frac{-515.1}{\sqrt{(1036.9)(524.9)}} \quad \text{Also, } r = \text{negative square root of } R^2, \ -0.70
\]

f. (3) The method least squares is used to obtain parameter estimates, \( \hat{\beta}_0 \) and \( \hat{\beta}_1 \).

g. (2) The least squares estimates are obtained by minimizing

\[ \sum_i (y_i - (b_0 + b_1 x_i))^2 \]

with respect to \( b_0 \) and \( b_1 \).