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APPENDIX

CURVE FITTING SOLUTION

1. Equation used in curve fitting

1.1 Linear regression (Lin.)

$$y = a + bx$$

1.2 Exponential curve fit (exp.)

$$y = ae^{bx}$$

1.3 Logaithmic curve fit (Log.)

$$y = a + b\ln X$$

1.4 Power curve fit (Pwr.)

$$y = aX^{b}$$

in which,

a and b are regression coefficients and can be computed by the formula as shown in Table A-1.

X and y are variables.

2. Curve fitting to the predicted and the measured UC strength.

Data from Table 4.7 were tabulated as follows,

$\frac{1}{W/LL}$, (x)	1.0	1.0	1.1	1.1	1.1	1.3	1.3	1.3	1.4	1.4	1.4
$\frac{UC}{UC_{(w)}}$, (y_1)	0.4	0.4	0.5	0.5	0.4	0.9	0.6	0.6	1.2	1.0	0.7
$\frac{UC}{UC_{(s)}}$, (y_2)	0.6	1.0	0.7	1.3	0.8	1.2	1.1	0.9	1.7	1.6	0.9

TABLE A-1 Formula To Compute a,b and r^2

Curve Type	a	b	Correlation, r^2
Lin.	$\left[\frac{\Sigma y_i}{n} - b\frac{\Sigma x_i}{n}\right]$	$\dfrac{\Sigma x_i y_i - \frac{\Sigma x_i \Sigma y_i}{n}}{\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}}$	$\dfrac{\left[\Sigma x_i y_i - \frac{\Sigma x_i \Sigma y_i}{n}\right]^2}{\left[\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}\right]\left[\Sigma y_i^2 - \frac{(\Sigma y_i)^2}{n}\right]}$
Exp.	$\exp\left[\frac{\Sigma \ln y_i}{n} - b\frac{\Sigma x_i}{n}\right]$	$\dfrac{\Sigma x_i \ln y_i - \frac{1}{n}(\Sigma x_i)(\Sigma \ln y_i)}{\Sigma x_i^2 - \frac{1}{n}(\Sigma x_i)^2}$	$\dfrac{\left[\Sigma x_i \ln y_i - \frac{1}{n}\Sigma x_i \Sigma \ln y_i\right]^2}{\left[\Sigma x_i - \frac{(\Sigma x_i)^2}{n}\right]\left[\Sigma(\ln y_i)^2 - \frac{(\Sigma \ln y_i)^2}{n}\right]}$
Log.	$\frac{1}{n}(\Sigma y_i - b\Sigma \ln x_i)$	$\dfrac{\Sigma y_i \ln x_i - \frac{1}{n}\Sigma \ln x_i \Sigma y_i}{\Sigma(\ln x_i)^2 - \frac{1}{n}(\Sigma \ln x_i)^2}$	$\dfrac{\left[\Sigma y_i \ln x_i - \frac{1}{n}\Sigma \ln x_i \Sigma y_i\right]^2}{\left[\Sigma(\ln x_i)^2 - \frac{1}{n}(\Sigma \ln x_i)^2\right]\left[\Sigma y_i^2 - \frac{1}{n}(\Sigma y_i)^2\right]}$
Pwr.	$\exp\left[\frac{\Sigma \ln y_i}{n} - b\frac{\Sigma \ln x_i}{n}\right]$	$\dfrac{\Sigma(\ln x_i)(\ln y_i) - \frac{(\Sigma \ln x_i)(\Sigma \ln y_i)}{n}}{\Sigma(\ln x_i)^2 - \frac{(\Sigma \ln x_i)^2}{n}}$	$\dfrac{\left[\Sigma(\ln x_i)(\ln y_i) - \frac{(\Sigma \ln x_i)(\ln y_i)}{n}\right]^2}{\left[\Sigma(\ln x_i)^2 - \frac{(\Sigma \ln x_i)^2}{n}\right]\left[\Sigma(\ln y_i)^2 - \frac{(\Sigma \ln y_i)^2}{n}\right]}$

2.1 Computation of regression coefficients for X and y_1.

2.1.1 Linear regression fitting (Lin.)

From Table A-1, $a = \frac{\Sigma y_i}{n} - b\frac{\Sigma x_i}{n}$

$$b = \frac{\Sigma x_i y_i - \frac{\Sigma x_i \; y_i}{n}}{\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}}$$

Correlation, $$r^2 = \frac{\left(\Sigma x_i y_i - \frac{\Sigma x_i \; y_i}{n}\right)^2}{\left[\Sigma x_i^2 - \frac{(\Sigma x_i^2)}{n}\right]\left[\Sigma y_i^2 - \frac{(\Sigma y_i^2)}{m}\right]}$$

$n = 11$, $\Sigma x_i = 13.40$, $\Sigma y_i = 7.20$

$\Sigma x_i y_i = 9.13$

$\Sigma x_i \; y_i = 96.48$

$\Sigma x_i^2 = 16.58$

$(\Sigma x_i)^2 = 179.56$

then, $$b = \frac{9.13 \; \frac{96.48}{11}}{16.58 - \frac{179.56}{11}}$$

$b = 1.4$

$$a = \frac{7.20}{11} - \frac{1.40 \times 13.40}{11}$$

$a = -1.1$

and $r^2 = 0.69$

2.1.2 Exp., Log. and Pwr. curve fit.

The variables x and y_1 were put in the calculator program of HP 67 type to compute the regression coefficients a, b and r^2 and found to be,

For exp. curve fit,

$$r^2 = 0.34$$

$$a = 0.1$$

$$b = 1.6$$

For log. curve fit,

$$r^2 = 0.68$$

$$a = 0.3$$

$$b = 1.7$$

For pwr. curve fit

$$r^2 = 0.78$$

$$a = 0.4$$

$$b = 2.5$$

The maximum correlation r^2 will be selected, then the pwr. curve suit the condition,

$$y_1 = ax^b$$

or,

$$\frac{UC}{UC_{(w)}} = 0.4 \left(\frac{1}{w/LL}\right)^{2.5}$$

$$UC = UC_{(w)} \times 0.4 \left(\frac{1}{w/LL}\right)^{2.5}$$

or,

$$UC_{(aw)} \equiv \frac{q_c}{19} \times 0.4 \left(\frac{1}{w/LL}\right)^{2.5}$$

$$= 0.02\, q_c \left(\frac{1}{w/LL}\right)^{2.5}$$

2.2 Computation of regression coefficients for x and y_2.

The variables x and y_2 were put in the calculator program of HP 67 type to compute the regression coefficients a, b and r^2 and found to be;

For lin. curve fit,

$$r^2 = 0.37$$

$$a = -0.6$$

$$b = 1.3$$

For exp. curve fit,

$$r^2 = 0.39$$

$$a = 0.2$$

$$b = 1.3$$

For log. curve fit

$$r^1 = 0.37$$

$$a = 0.8$$

$$b = 1.6$$

For pwr. curve fit

$$r^2 = 0.40$$

$$a = 0.8$$

$$b = 1.5$$

Then the pwr. curve suit the condition,

$$y_2 = ax^b$$

or, $$\frac{UC}{UC_{(s)}} = 0.8 \left(\frac{1}{w/LL}\right)^{1.5} = UC_{(s)} \times 0.8 \left(\frac{1}{w/LL}\right)^{1.5}$$

or, $$UC_{(as)} = 0.04 \, (q_c - \gamma_t z) \times \left(\frac{1}{w/LL}\right)^{1.5}$$

3. Curve fitting to the predicted and measured FV strength.

Data from Table 4.9 were tabulated and they were computed in the same manner. FV and $FV_{(w)}$ will be represented by the variables y and x respectively.

For lin. curve fit,

$$r^2 = 0.99$$
$$a = 1.5$$
$$b = 0.5$$

For exp. curve fit,

$$r^2 = 0.98$$
$$a = 1.7$$
$$b = 0.2$$

For log. curve fit,

$$r^2 = 0.98$$
$$a = 1.7$$
$$b = 1.2$$

For exp. curve fit,

$$r^2 = 0.98$$
$$a = 1.9$$
$$b = 0.4$$

The linear curve fit suit the condition,

$$y = a + bx$$
$$FV = 1.5 + 0.5\ FV_{(w)}$$

or, $$FV_{(a)} = 1.5 + 0.5 \times \frac{q_c}{16}$$
$$= 1.5 + 0.03\ q_c$$

4. <u>Curve fitting to the predicted and the measured UU strength</u>

Data from Table 4.11 were tabulated in the same manner. UU and $UU_{(w)}$ will be represented by the variables y and x respectively.

For lin. curve fit,

$$r^2 = 0.06$$

$$a = 1.1$$

$$b = 0.04$$

For exp. curve fit,

$$r^2 = 0.06$$

$$a = 1.1$$

$$b = 0.03$$

For log. curve fit,

$$r^2 = 0.03$$

$$a = 1.2$$

$$b = 0.05$$

For pwr. curve fit,

$$r^2 = 0.52$$

$$a = 1.1$$

$$b = 0.1$$

The pwr. curve fit suit the condition,

$$y = ax^b$$

$$UU = 1.1\ (UU_{(w)})^{0.1}$$

$$= 1.1 \times (\frac{q_c}{17})^{0.1}$$

or, $$UU_{(aw)} = 0.83\ (q_c)^{0.1}$$

All formulae are empirical formulae and unit of all streses are in t/m^2.

VITA

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