Describing Bivariate Relationships

Chapter 3 Summary

YMS3e

AP Stats at LSHS

Mr. Molesky

Bivariate Relationships

- When exploring/describing a bivariate (x,y) relationship:
  - ☑ Determine the Explanatory and Response variables
  - ☑ Plot the data in a scatterplot
  - ☑ Note the Strength, Direction, and Form
  - ☑ Note the mean and standard deviation of x and the mean and standard deviation of y
  - ☑ Calculate and Interpret the Correlation, r
  - ☑ Calculate and Interpret the Least Squares Regression Line in context.
  - ☑ Assess the appropriateness of the LSRL by constructing a Residual Plot.

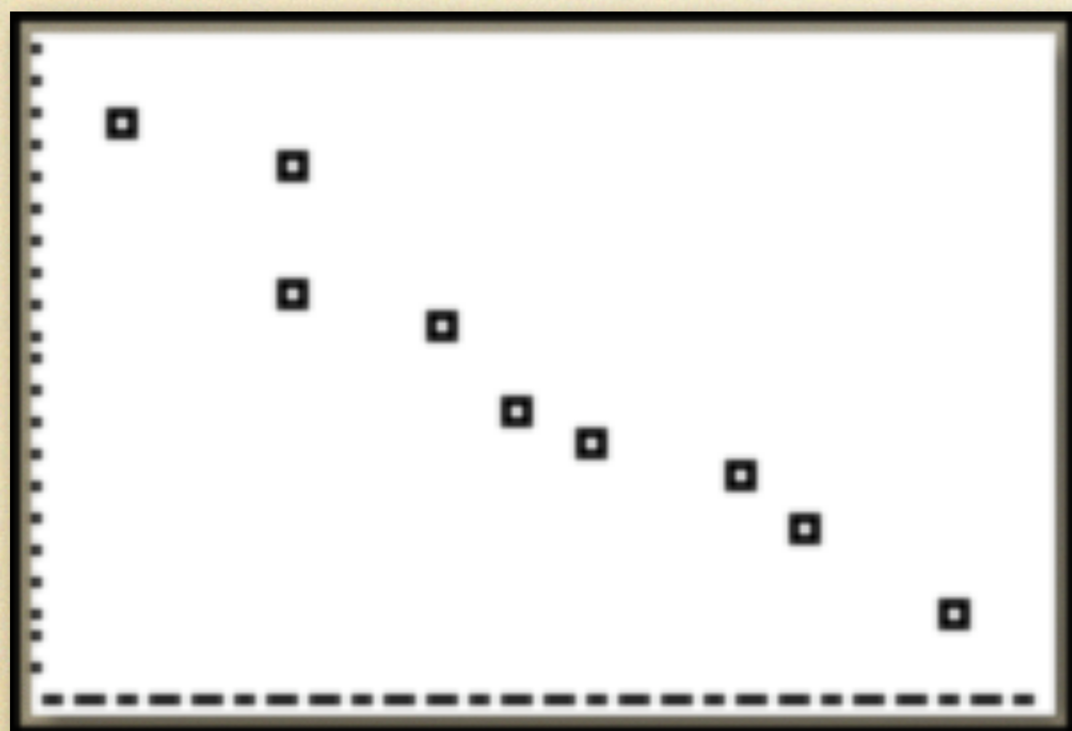
Corrosion and Strength

- Consider the following data from the article, "The Carbonation of Concrete Structures in the Tropical Environment of Singapore" (*Magazine of Concrete Research* (1996):293-300):
    - x= carbonation depth in concrete (mm)
    - y= strength of concrete (Mpa)

x	8	20	20	30	35	40	50	55	65
y	22.8	17.1	21.5	16.1	13.4	12.4	11.4	9.7	6.8

- Define the Explanatory and Response Variables.
- Plot the data and describe the relationship.

Corrosion and Strength

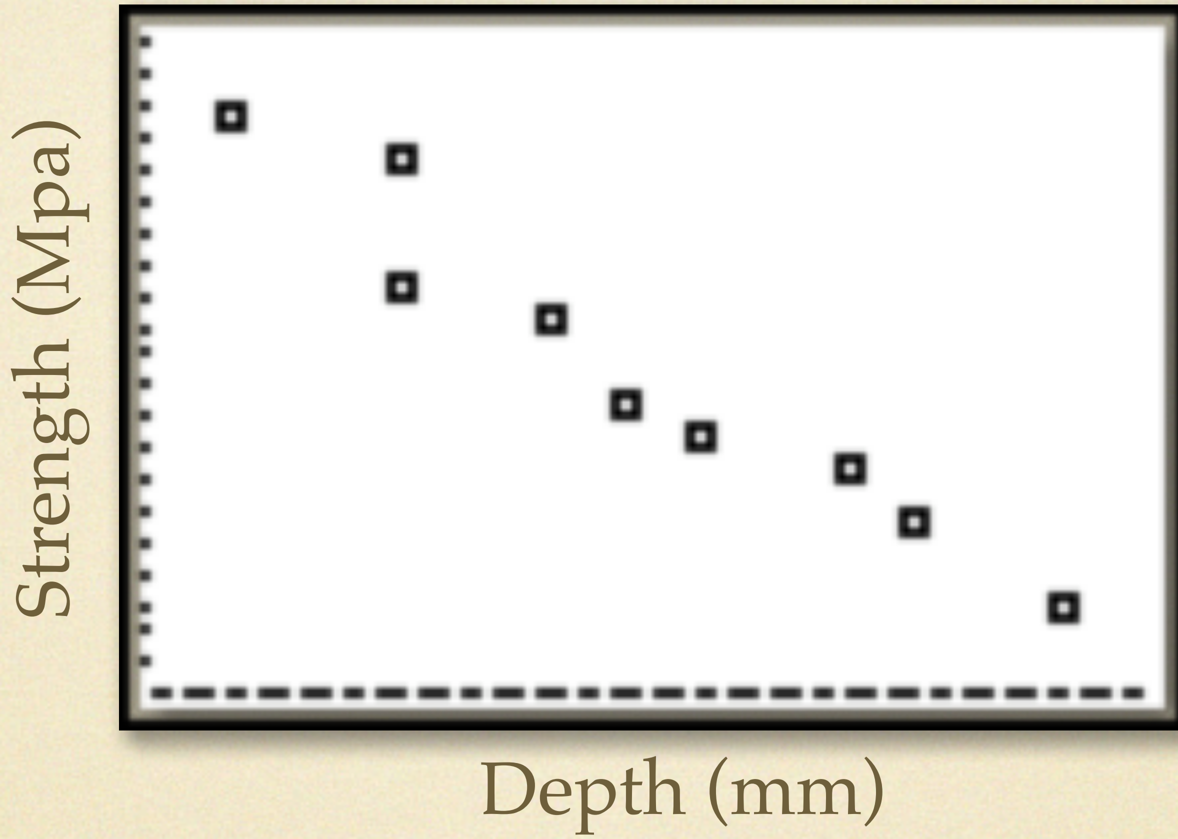


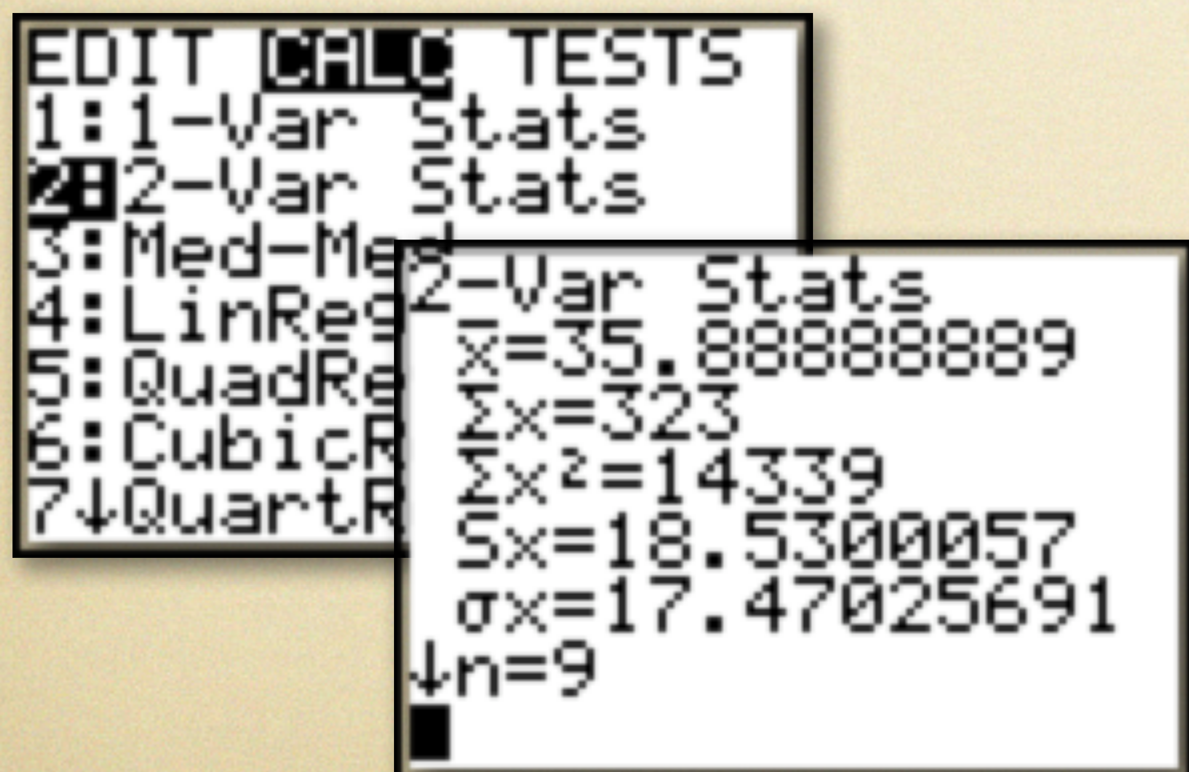
Strength (Mpa)

Depth (mm)

There is a strong, negative, linear relationship between depth of corrosion and concrete strength. As the depth increases, the strength decreases at a constant rate.

Corrosion and Strength

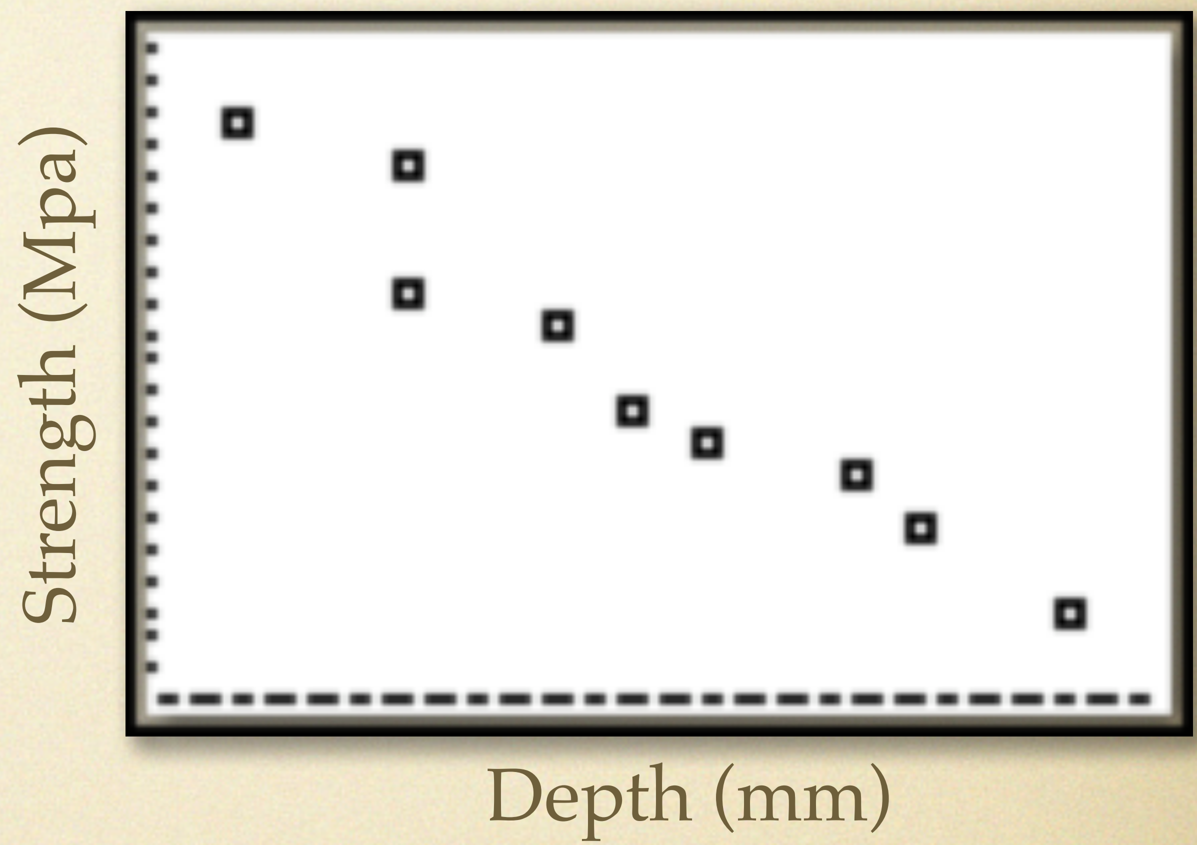


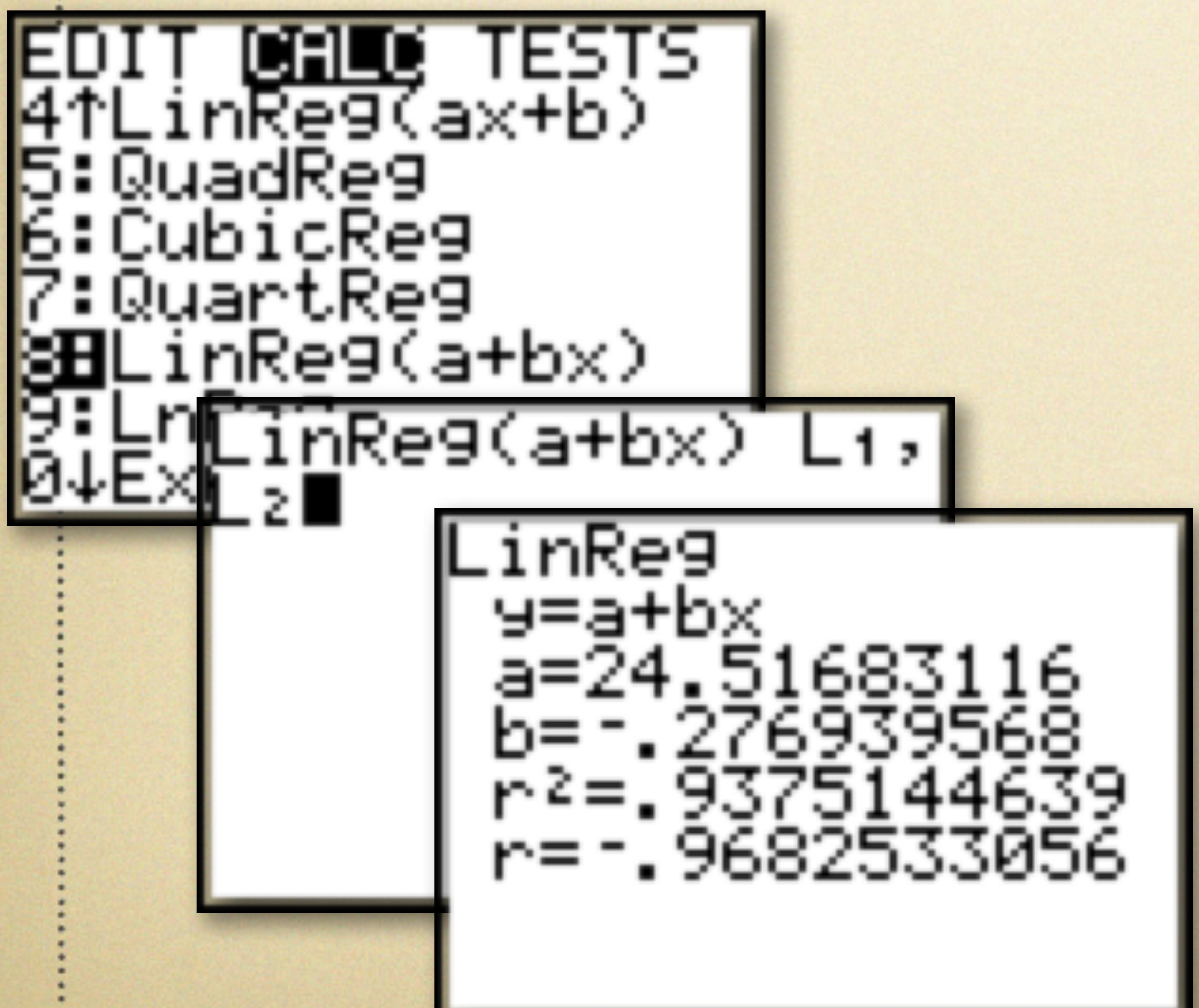


The mean depth of corrosion is 35.89mm with a standard deviation of 18.53mm.
The mean strength is 14.58 Mpa with a standard deviation of 5.29 Mpa.

Corrosion and Strength

Find the equation of the Least Squares Regression Line (LSRL) that models the relationship between corrosion and strength.



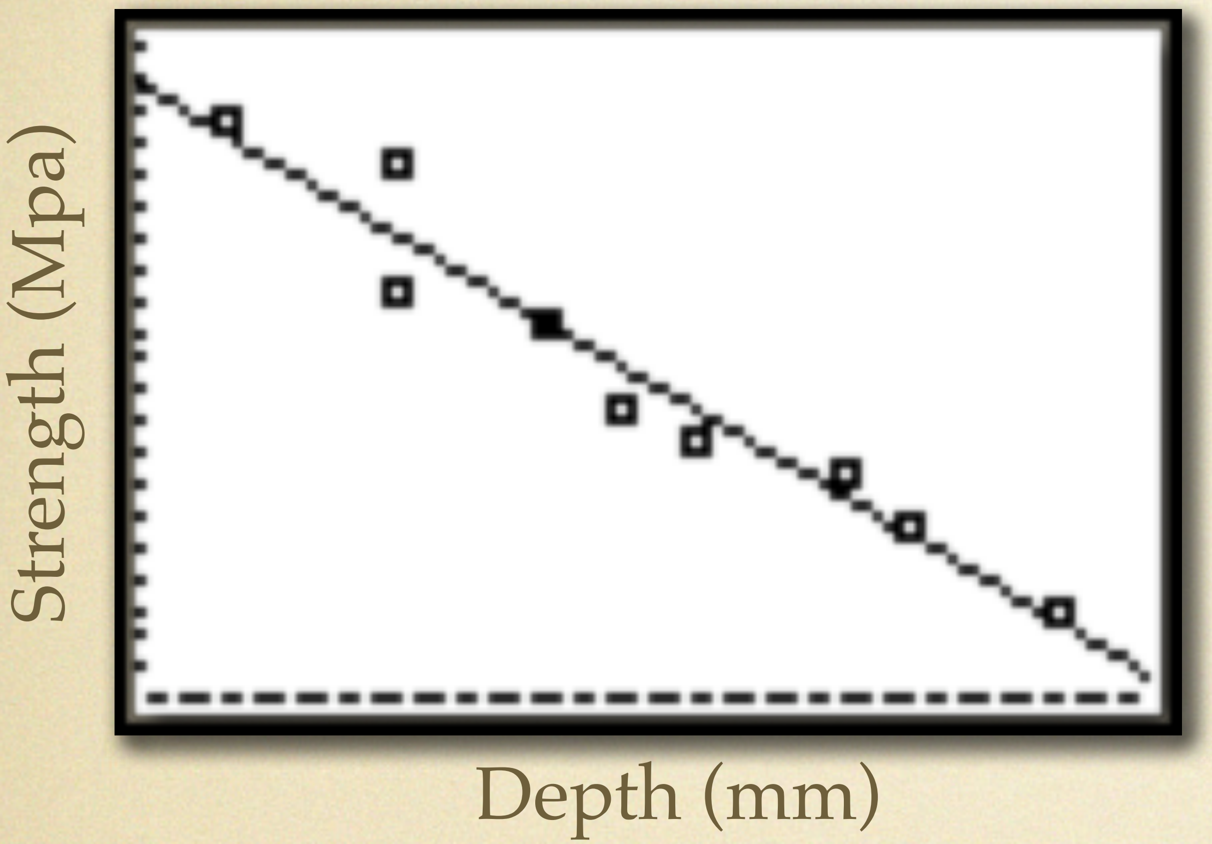


y=24.52+(-0.28)x

strength=24.52+(-0.28)depth

r=-0.96

Corrosion and Strength



y=24.52+(-0.28)x

strength=24.52+(-0.28)depth

r=-0.96

What does "r" tell us?

There is a Strong, Negative, LINEAR relationship between depth of corrosion and strength of concrete.

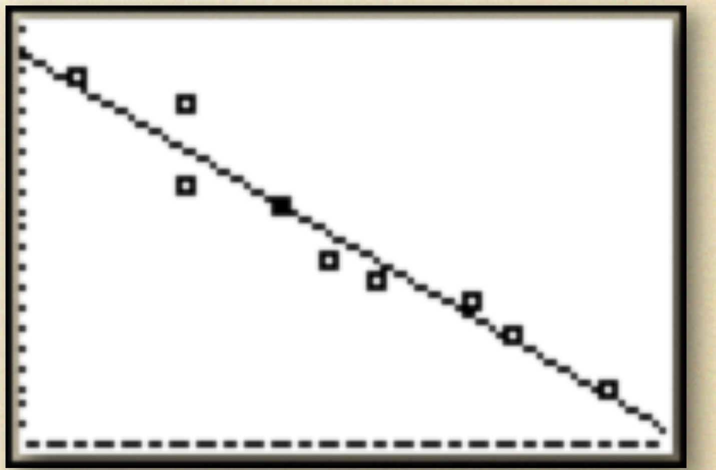
What does "b=-0.28" tell us?

For every increase of 1mm in depth of corrosion, we predict a 0.28 Mpa decrease in strength of the concrete.

Corrosion and Strength

- Use the prediction model (LSRL) to determine the following:

- What is the predicted strength of concrete with a corrosion depth of 25mm?
  - strength=24.52+(-0.28)depth
  - strength=24.52+(-0.28)(25)
  - strength=17.59 Mpa



- What is the predicted strength of concrete with a corrosion depth of 40mm?
  - strength=24.52+(-0.28)(40)
  - strength=13.44 Mpa
  - How does this prediction compare with the observed strength at a corrosion depth of 40mm?

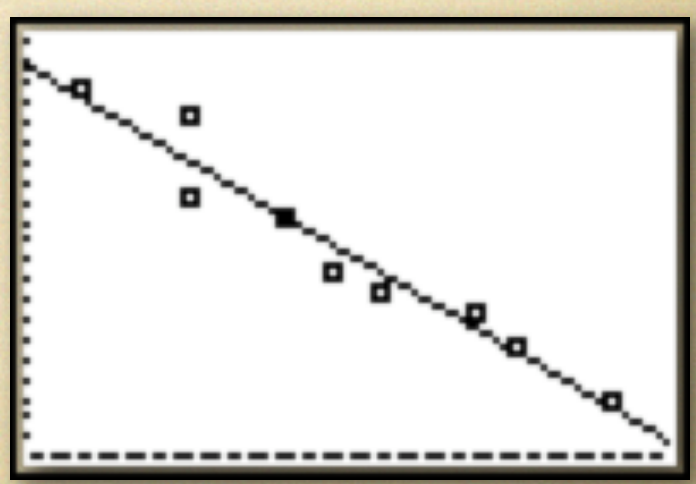
Residuals

- Note, the predicted strength when corrosion=40mm is:
    - predicted strength=13.44 Mpa
- The observed strength when corrosion=40mm is:
    - observed strength=12.4mm

- The prediction did not match the observation.
    - That is, there was an "error" or "residual" between our prediction and the actual observation.

- RESIDUAL = Observed y - Predicted y

- The residual when corrosion=40mm is:
    - residual = 12.4 - 13.44
    - residual = -1.04

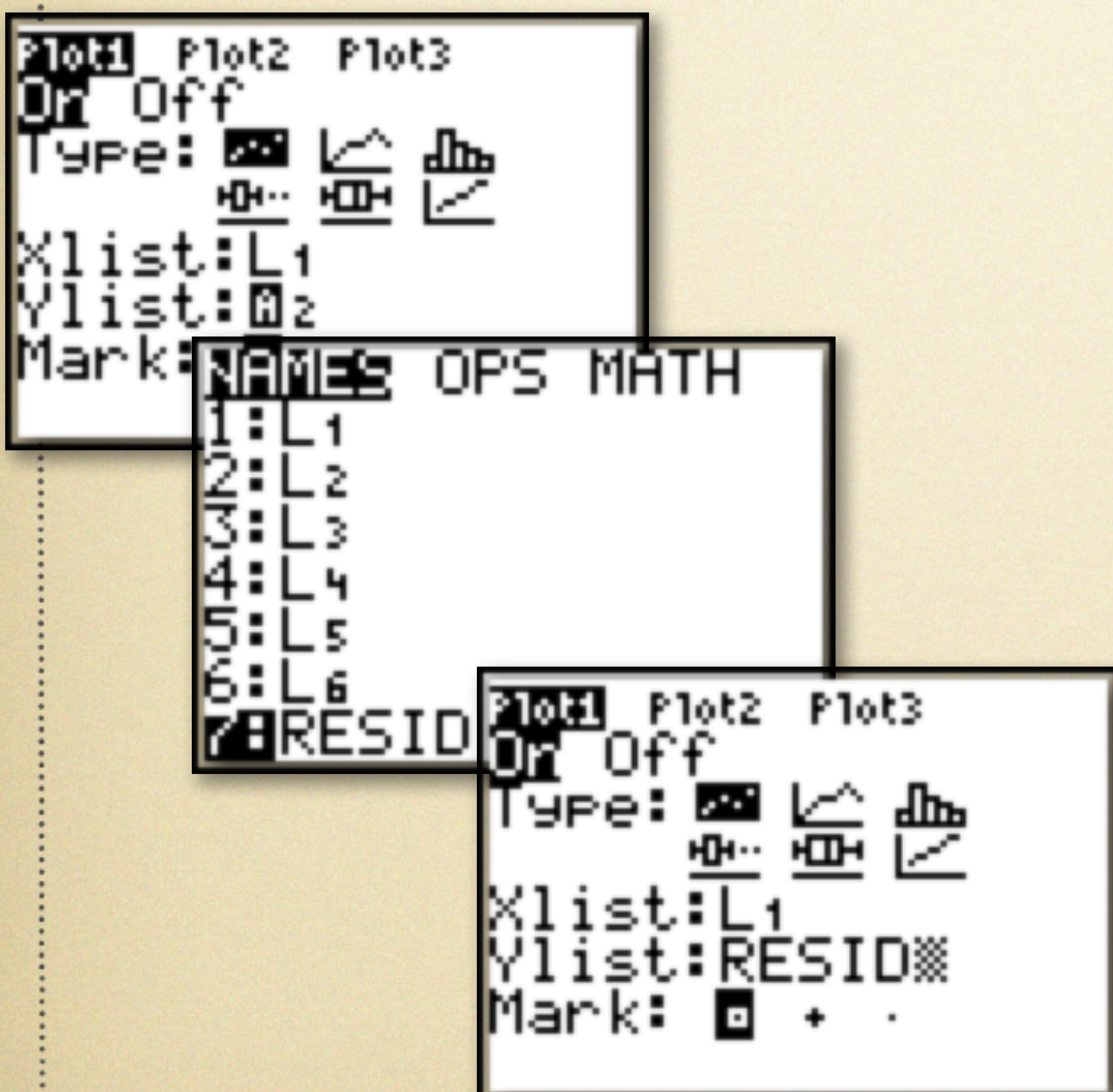


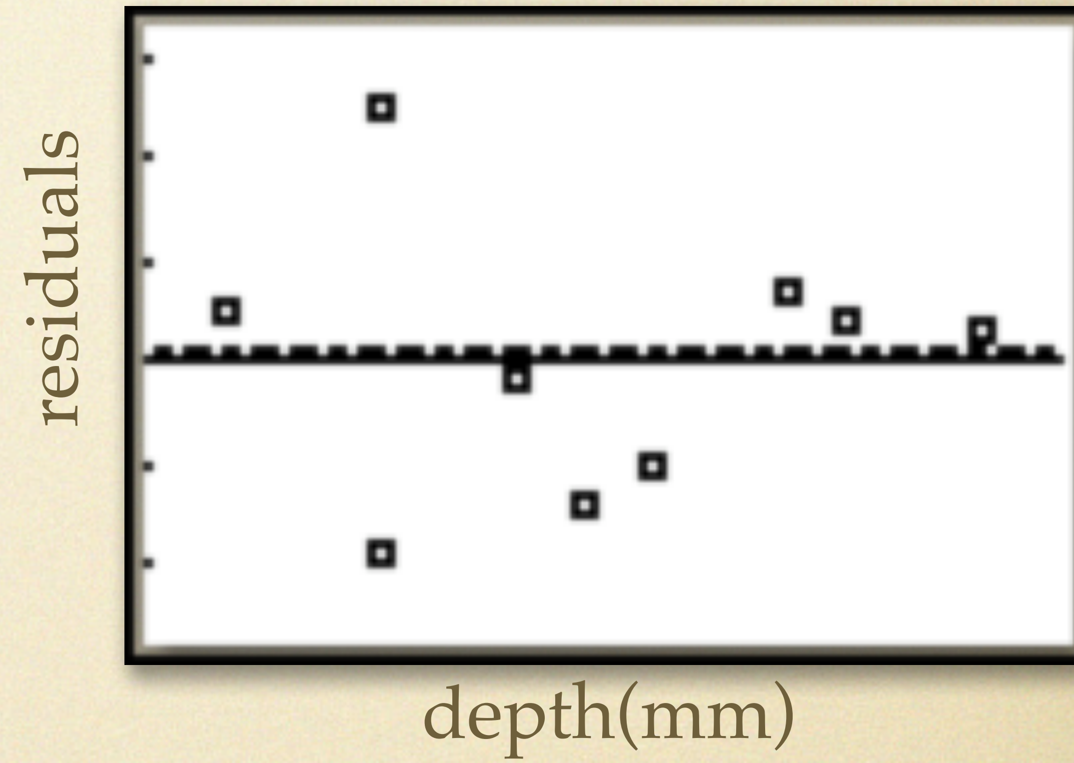
Assessing the Model

- Is the LSRL the most appropriate prediction model for strength? r suggests it will provide strong predictions...can we do better?
  - To determine this, we need to study the residuals generated by the LSRL.
    - Make a residual plot.
    - Look for a pattern.
      - If no pattern exists, the LSRL may be our best bet for predictions.
      - If a pattern exists, a better prediction model may exist...

Residual Plot

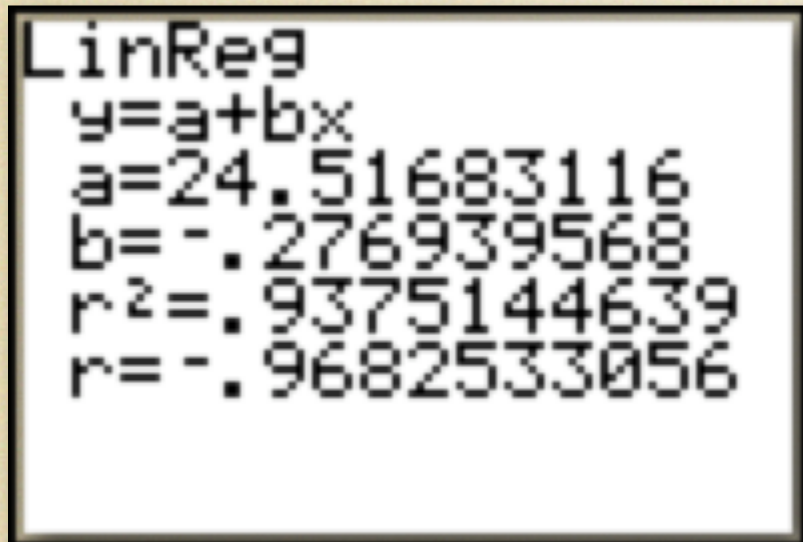
- ☑ **Construct a Residual Plot for the (depth,strength) LSRL.**





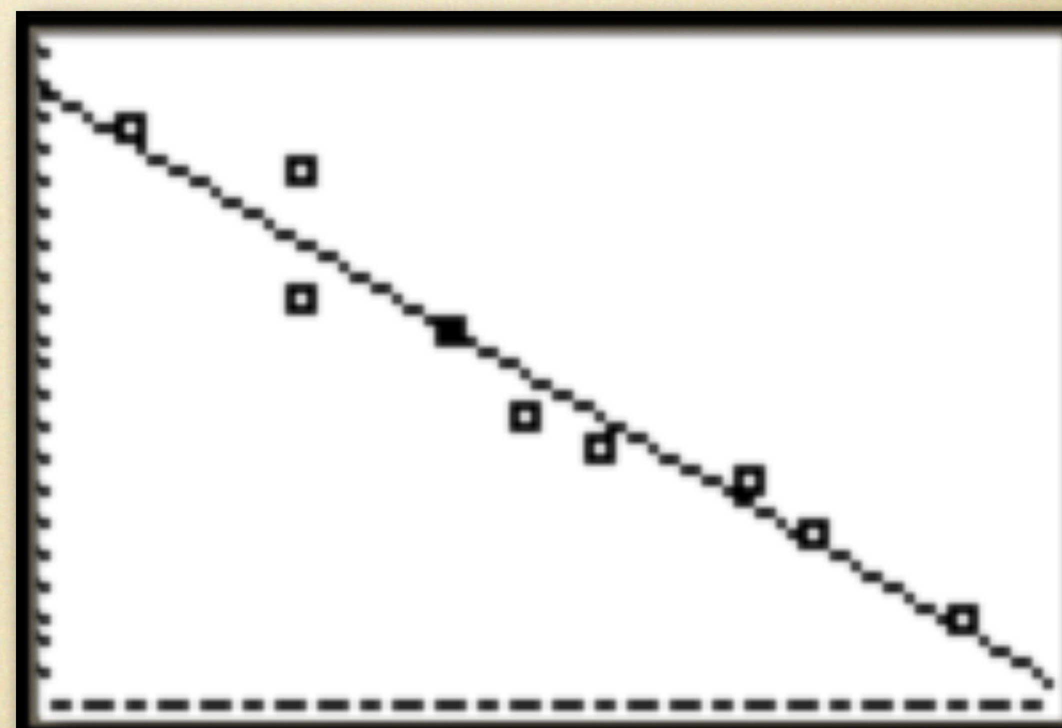
- ☑ **There appears to be no pattern to the residual plot...therefore, the LSRL may be our best prediction model.**

Coefficient of Determination



We know what "r" tells us about the relationship between depth and strength....what about r^2?

93.75% of the variability in predicted strength can be explained by the LSRL on depth.



Strength (Mpa)

Depth (mm)

Summary

- **When exploring a bivariate relationship:**
  - **Make and interpret a scatterplot:**
    - **Strength, Direction, Form**
  - **Describe x and y:**
    - **Mean and Standard Deviation in Context**
  - **Find the Least Squares Regression Line.**
    - **Write in context.**
  - **Construct and Interpret a Residual Plot.**
  - **Interpret r and r^2 in context.**
  - **Use the LSRL to make predictions...**