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USE OF SNAP SHEARS FOR SAMPLING COOLING BED PRODUCTS

Snap shears can be used effectively for cutting samples off the trailing ends of bars traveling to a cooling bed. The critical requirement in this operation is that the bar have at least as much kinetic energy as the work of shearing. Except for minor influences which are too small to be significant, the work of shearing can come from no other source.

For a round bar of diameter \(d\) inches and length \(L\) feet, traveling at \(V\) ft/sec., the relations are as follows:

\[
\text{area} = \frac{\pi}{4} d^2 \quad \text{weight} = \frac{\pi}{4} d^2 \times 12 \times 2835 \times L
\]

\[
\text{Shearing force} = S \times \frac{\pi}{4} d^2 \quad \text{where} \ S = \text{effective shearing stress}
\]

\[
\text{shearing work} = S \times \frac{\pi}{4} d^3
\]

\[
\text{kinetic energy} = \frac{\pi}{4} d^2 \times 3.4 \times L \times V^2
\]

\[
\text{for successful shearing,} \quad \frac{\pi}{4} d^2 \times \frac{3.4 \times L \times V^2}{2 \times 32.2} \geq \frac{S}{2} \frac{\pi}{4} d^3
\]

\[
\text{or} \quad \frac{3.4L}{64.4} V^2 \geq \frac{S}{2} d
\]

\[
\text{or} \quad \frac{LV^2}{d} \geq \frac{64.4S}{2 \times 3.4}
\]

In this case, the sudden effort to stop the bar as the shear knives engage it produces a tensile stress in the direction of the bar axis at the point of knife engagement. This stress aids the shearing action, in effect reducing the transverse stress which would otherwise be required for shearing. For normal shearing operations on cooling bed products, we would use:

- for low carbon steel
  
  Shearing Stress
  
  \[
  \frac{10,000 \text{ lbs/sq in}}{13,000}
  \]

- for common steel alloys

The reduction of shearing stress by the superimposed axial tension evidently will depend upon length, diameter and speed of the bar, but will be considerable for bars which are small, long and moving fast. To be conservative, and to focus attention principally on bars
11" and larger where this question is of greatest importance, let us assume a reduction of 25% to:

for low carbon steel 7500 lbs/sq in
for common steel alloys 9750 "

Then the criterion for successful shearing (approximate) is:

\[
\frac{LV^2}{d} \geq \frac{64.4 \times 7500}{6.8} \quad \text{for low carbon steel}
\]
\[
\frac{LV^2}{d} \geq \frac{64.4 \times 9750}{6.8} \quad \text{for common steel alloys}
\]

\[
\frac{LV^2}{d} \geq 70,900 \quad \text{for low carbon steel}
\]
\[
\frac{LV^2}{d} \geq 92,400 \quad \text{for common steel alloys}
\]

Example: 1" 200 ft. long 1200 FPM, low carbon

\[
\frac{LV^2}{d} = \frac{200 \times 400}{1} = 80,000
\]

This should be sheared successfully. If it were in a common steel alloy instead of low carbon successful shearing would be doubtful.

In at least one mill (Sheffield 12" KC) a snap shear has been used to arrest large bars and hold them while samples are burned off (without another bar following immediately behind).