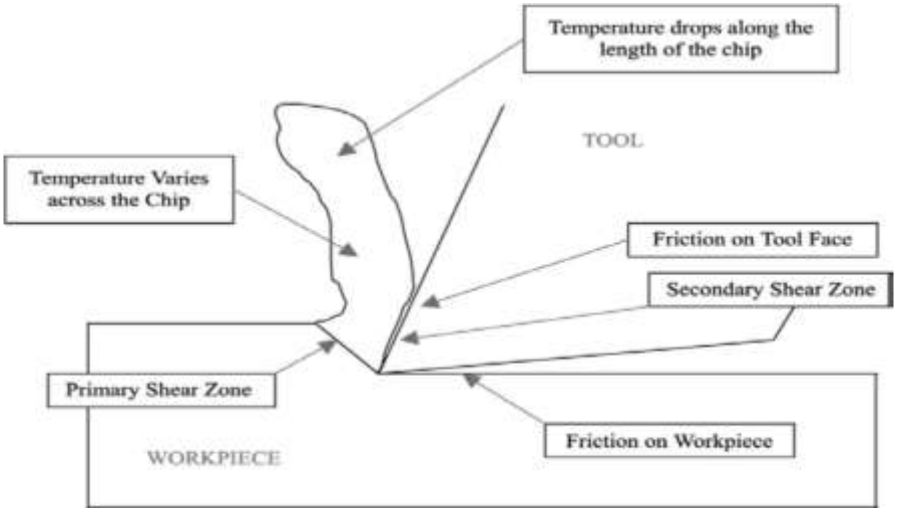



**Fig: Schematic of chip formation**

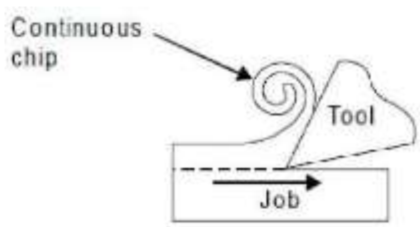
**TYPES OF CHIPS PRODUCED IN METAL CUTTING**

1. **Continuous**
2. **Built-up Edge**
3. **Serrated or Segmented**
4. **Discontinuous**



**Continuous**

- The lower boundary is below the machined surface, subjecting the machined surface to distortion, as depicted by the distorted vertical lines.
- This situation occurs particularly in machining soft metals at low speeds and low rake angles.
- It can produce poor surface finish and induce residual surface stresses.
- Although they generally produce good surface finish, CCs are not always desirable.

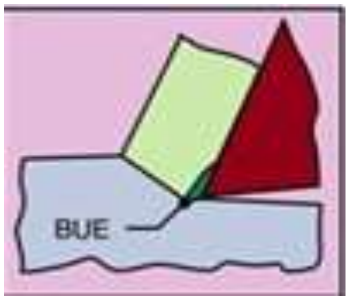



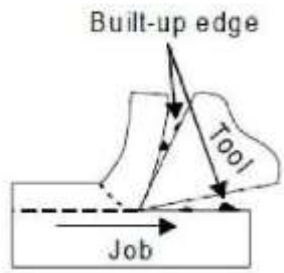

**Built-up Edge, BUE**

- BUE, consisting of layers of material from the workpiece that are gradually deposited on the tool, may form at the tip of the tool during cutting.
- As it becomes larger, BUE becomes unstable and eventually breads up.
- Part of BUE material is carried away by the tool side of the chip; the rest is deposited randomly on the workpiece surface.
- The process of BUE formation and destruction is repeated continuously during the cutting operation, unless measures are taken to eliminate it.
- Because of work hardening and deposition of successive layers of material. BUE hardness increases

significantly.

- BUE is generally undesirable.
- A thin, stable BUE is sometimes desirable because it reduces wear by protecting the rake face of the tool.
- As cutting speed increases the size of BUE decreases.



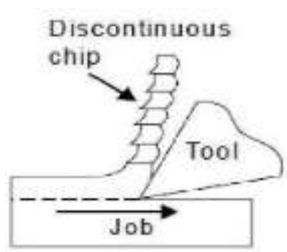

**Serrated chips**

- Serrated chips: semi-continuous chips with zones of low and high shear strain Metals with low thermal conductivity and strength that decreases sharply with temperature, such as titanium, exhibit this behavior.
- The chips have a saw-tooth-like appearance.




**Discontinuous, DCs**

- DCs consist of segments that may be firmly or loosely attached to each other
- DCs usually form under the following conditions:
    1. Brittle workpiece materials
    2. Workpiece materials that contain hard inclusions and impurities, or have structures such as the graphite flakes in gray cast iron.
    3. Very low or very high cutting speeds.
    4. Large depths of cut.
    5. Low rake angles.
    6. Lack of an effective cutting fluid.



**TOOL LIFE: WEAR & FAILURE**

Gradual wear occurs at three principal location on a cutting tool. Accordingly, three main types of tool wear can be distinguished,

- crater wear
- flank wear
- corner wear

***Crater wear***: consists of a concave section on the tool face formed by the action of the chip sliding on the surface. Crater wear affects the mechanics of the process increasing the actual rake angle of the cutting tool and consequently, making cutting easier. At the same time, the crater wear weakens the tool wedge and increases the possibility for tool breakage. In general, crater wear is of a relatively small concern.

***Flank wear*****:** occurs on the tool flank as a result of friction between the machined surface of the workpiece and the tool flank. Flank wear appears in the form of so-called *wear land* and is measured by the width of this wear land

***Corner wear*****:** occurs on the tool corner. Can be considered as a part of the wear land and respectively flank wear since there is no distinguished boundary between the corner wear and flank wear land. We consider corner wear as a separate wear type because of its importance for the precision of machining. Corner wear actually shortens the cutting tool thus increasing gradually the dimension of machined surface and introducing a significant dimensional error in machining, which can reach values of about 0.03~0.05 mm.

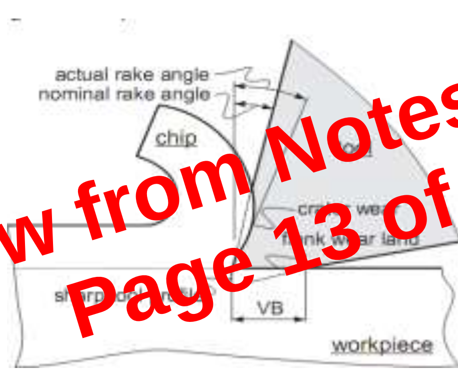


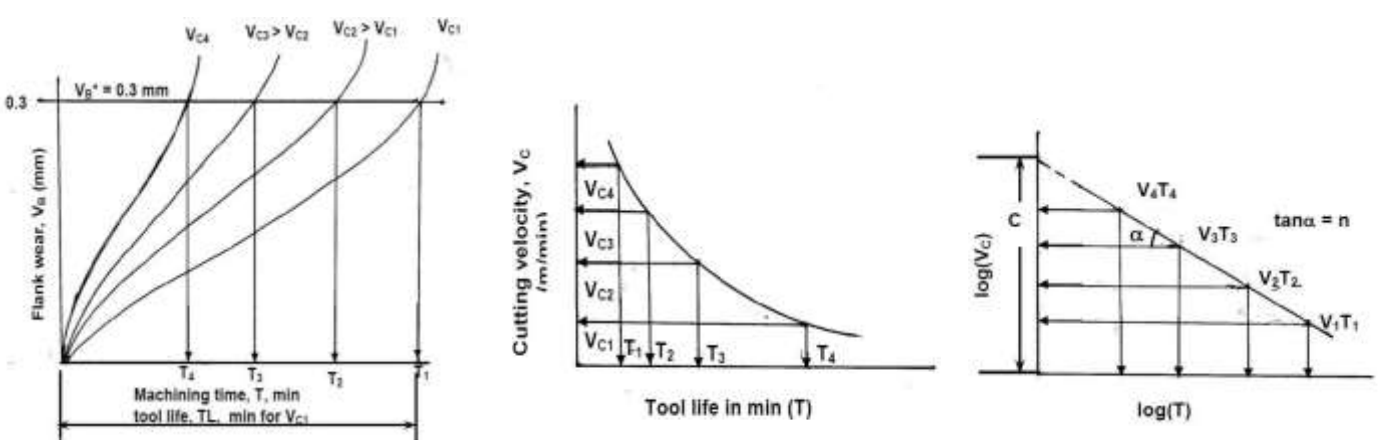



**Fig. Cross-section perpendicular to the major cutting edge of a worn cutting tool showing the effect of crater wear on the tool rake angle and the flank wear land**

**TOOL LIFE**

Tool life is generally defined by the span of actual uninterrupted machining time through which the tool or tool-tip renders desired service and satisfactory performance and after which that tool needs replacement.

**Taylor's tool life equation**



<u>**Forces in Metal Cutting**</u>

**Forces in the secondary deformation zone**:

1. **Friction force *F***:

The force between the tool and chip, which resisting the flow of the chip along the rake face of the tool.

2. **Normal force to friction *N***:

The force which is normal to the friction force.
Friction coefficient: μ = F/N
Friction angle: b
Resultant force: *R*

**Forces in the first deformation zone**:

3. **Shear force $F_s$**:

The force which causes shear deformation to occur in the shear plane.

4. **Normal force to shear $F_n$**:

The force which is normal to the shear force.

**Forces on the cutting tool**:

5. **Cutting force $F_c$**:

The force in the direction of cutting, the same direction as the cutting speed *v*.

6. **Thrust force $F_t$:**

The force which is perpendicular to the cutting force.