PRESENTATION
ON
“GEAR FAILURE”

MACHINE DESIGN
(2171909)

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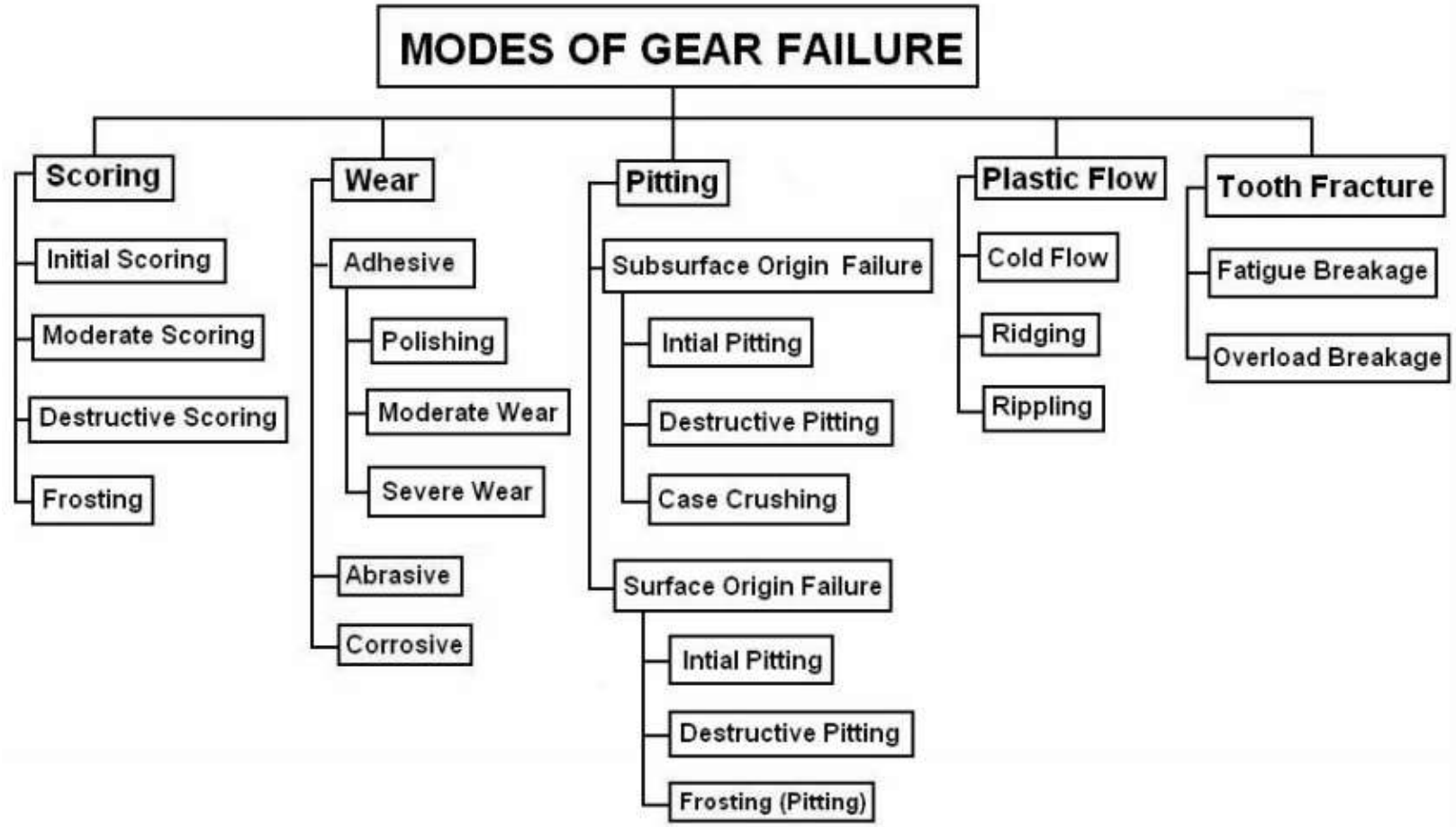
INTRODUCTION

- Gear failure can occur in various modes. If care is taken during the design stage itself to prevent each of these failure a sound gear design can be evolved.



SCORING

- Scoring is due to combination of two distinct activities:
- First, lubrication failure in the contact region and second, establishment of metal to metal contact.
- Later on, welding and tearing action resulting from metallic contact removes the metal rapidly and continuously so far the load, speed and oil temperature remain at the same level.
- The scoring is classified into initial, moderate and destructive.

➢ INITIAL SCORING:

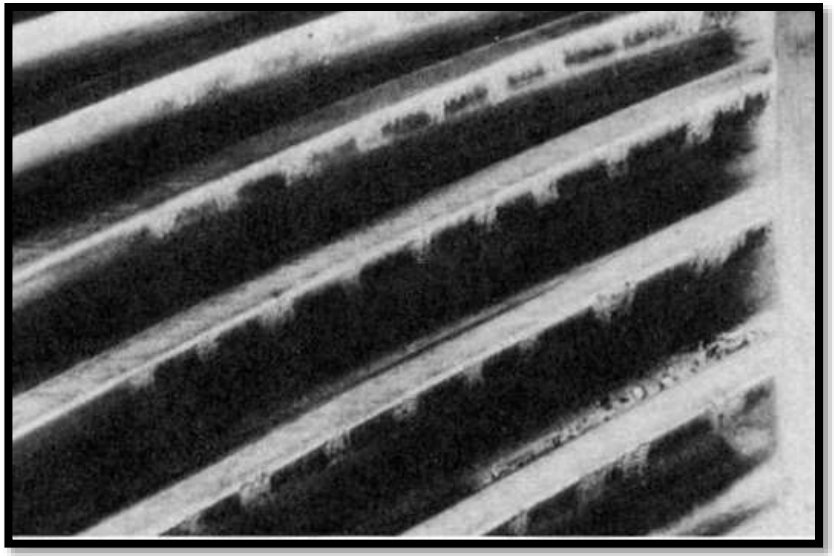
- Initial scoring occurs at the high spots left by previous machining. Lubrication failure at these spots leads to initial scoring or scuffing. Initial scoring is non progressive and has corrective action associated with it.

➢ MODERATE SCORING:

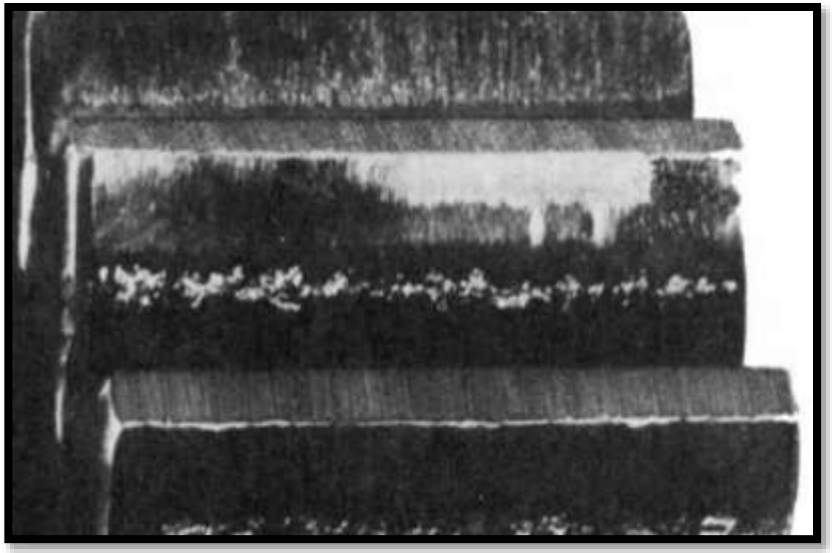
- After initial scoring if the load, speed or oil temperature increases, the scoring will spread over to a larger area. The Scoring progresses at tolerable rate. This is called moderate scoring.

➢ DESTRUCTIVE SCORING:

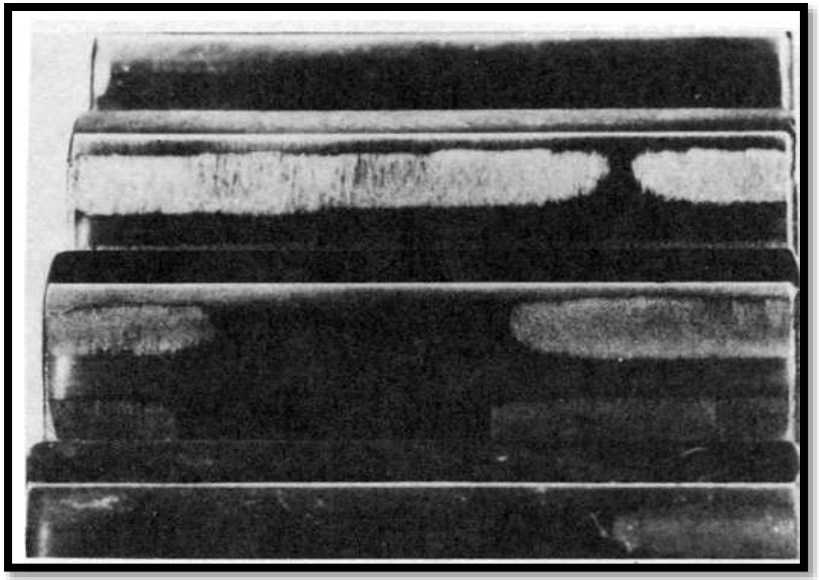
- After the initial scoring, if the load, speed or oil temperature increases appreciably, then severe scoring sets in with heavy metal torn regions spreading quickly throughout. Scoring is normally predominant over the pitch line region since elastohydrodynamic lubrication is the least at that region. In dry running surfaces may seize.



INITIAL SCORING



DESTRUCTIVE SCORING



MODERATE SCORING

WEAR

- The wear is a kind of tooth damage where in layers of metal are removed more or less uniformly from the surface.
- It is nothing but progressive removal of metal from the surface.
- Consequently tooth thins down and gets weakened.
- Three most common causes of gear tooth wear are:

➢ Metal-to-metal contact due to lack of oil film

➢ Ingress of abrasive particles in the oil

➢ Chemical wear due to the composition of oil and its additives

- Wear is classified as adhesive, abrasive and chemical wear.

➢ ADHESIVE WEAR:

- Adhesive wear is hard to detect. It occurs right from the start. Since the rate of wear is very low, it may take millions of cycles for noticeable wear. Prior to full load transmission, gears are run in at various fractions of full load for several cycles. The surface peaks are quashed over a long period of running and the surface gets polished appearance.

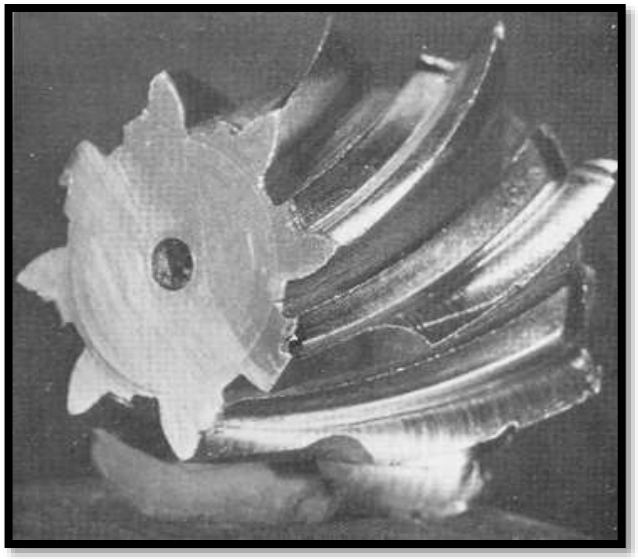
➢ ABRASIVE WEAR:

- Abrasive wear is the principal reason for the failure of open gearing and closed gearing of machinery operating in media polluted by abrasive materials. Examples are mining machinery; cement mills; road laying, building construction, agricultural and transportation machinery, and certain other machines. Abrasive wear is classified as mild and severe.

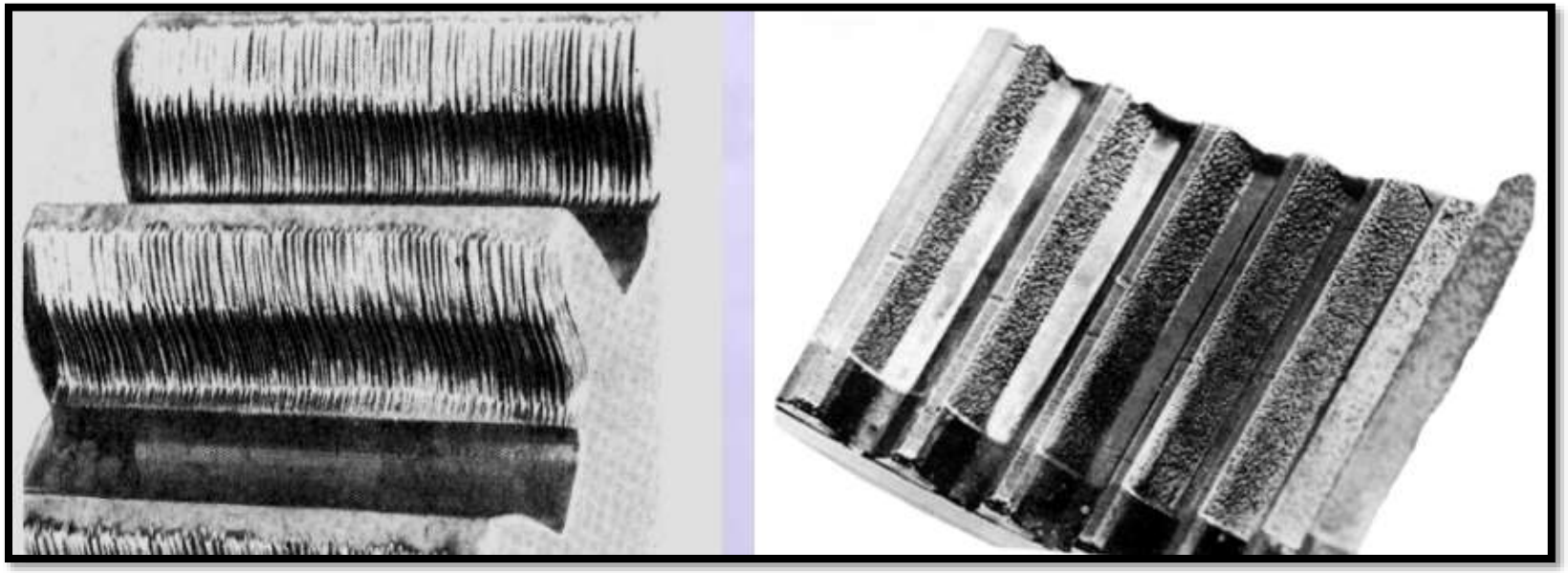
➢ CORROSIVE WEAR:

- Corrosive wear is due to the chemical action of the lubricating oil or the additives. Tooth is roughened due to wear.

ADHESIVE WEAR



ABRASIVE WEAR



CORROSIVE WEAR

PITTING OF GEARS

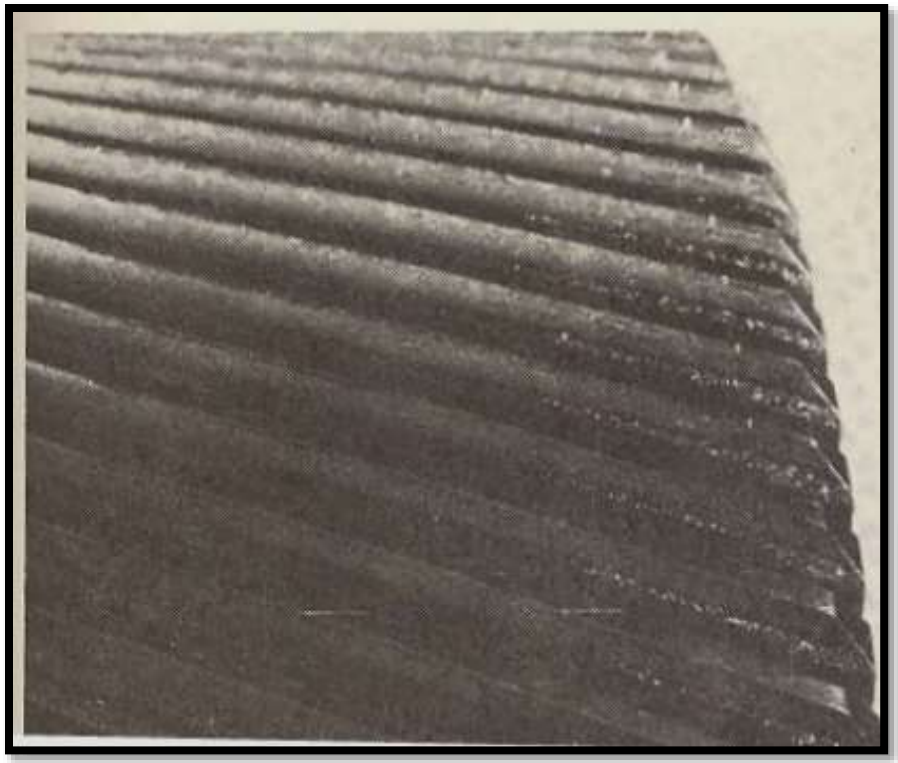
- Pitting is a surface fatigue failure of the gear tooth.
- It occurs due to repeated loading of tooth surface and the contact stress exceeding the surface fatigue strength of the material.
- Material in the fatigue region gets removed and a pit is formed.
- The pit itself will cause stress concentration and soon the pitting spreads to adjacent region till the whole surface is covered.
- Subsequently, higher impact load resulting from pitting may cause fracture of already weakened tooth.
- However, the failure process takes place over millions of cycles of running.
- There are two types of pitting, initial and progressive.

➢ INITIAL PITTING:

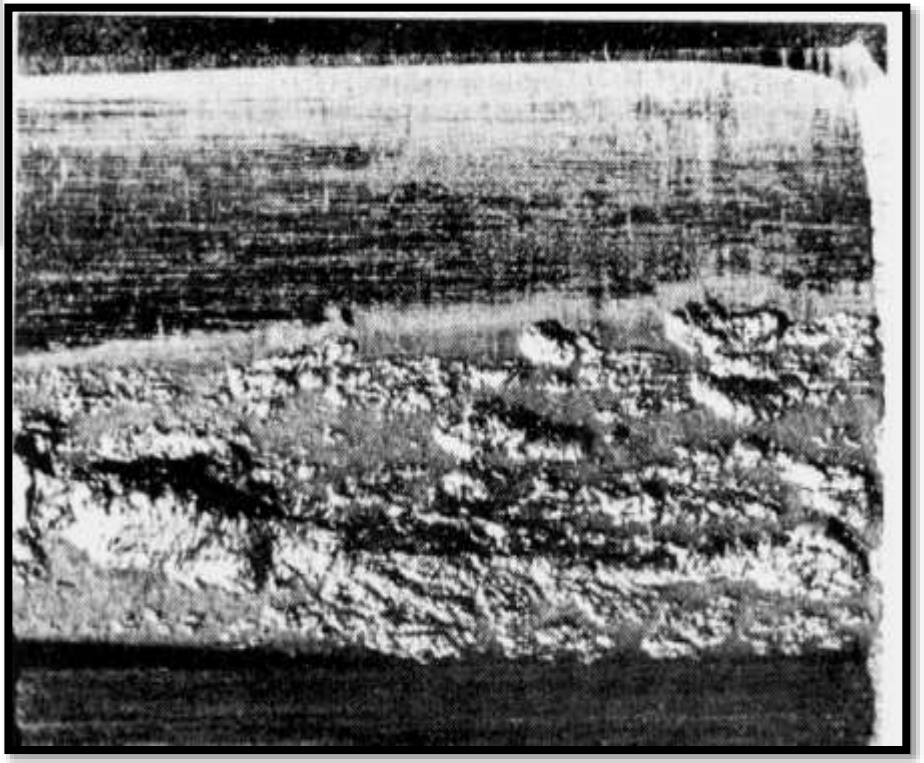
- Initial pitting occurs during running-in period wherein oversized peaks on the surface get dislodged and small pits of 25 to 50 μm deep are formed just below pitch line region. Later on, the load gets distributed over a larger surface area and the stress comes down which may stop the progress of pitting. The initial pitting is non progressive.

➢ PROGRESSIVE OR DESTRUCTIVE PITTING:

- During initial pitting, if the loads are high and the corrective action of initial pitting is unable to suppress the pitting progress, then destructive pitting sets in. Pitting leads to higher pressure on the unpitted surface, squeezing the lubricant into the pits and finally to seizing of surfaces. Pitting begins on the tooth flanks near the line along the tooth passing through the pitch point where there are high friction forces due to the low sliding velocity. Then it spreads to the whole surface of the flank.



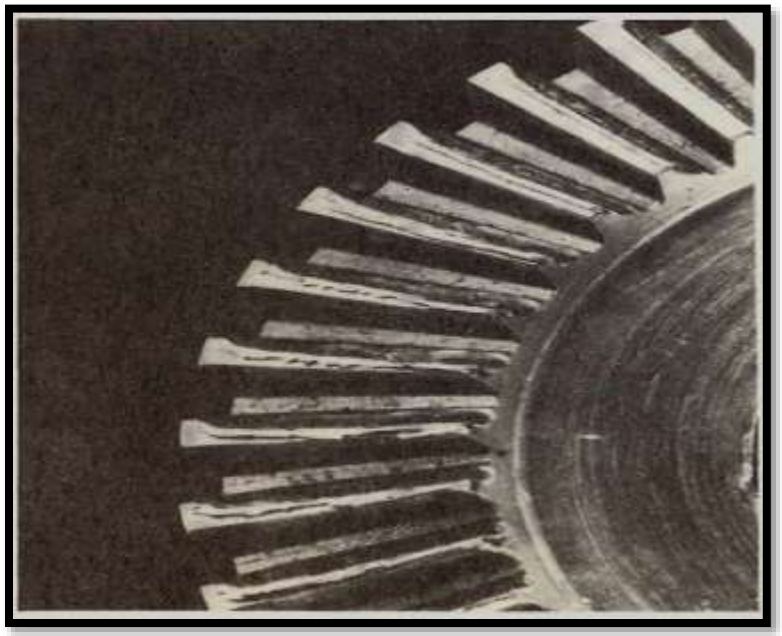
INITIAL PITTING



DESTRUCTIVE PITTING

PLASTIC FLOW

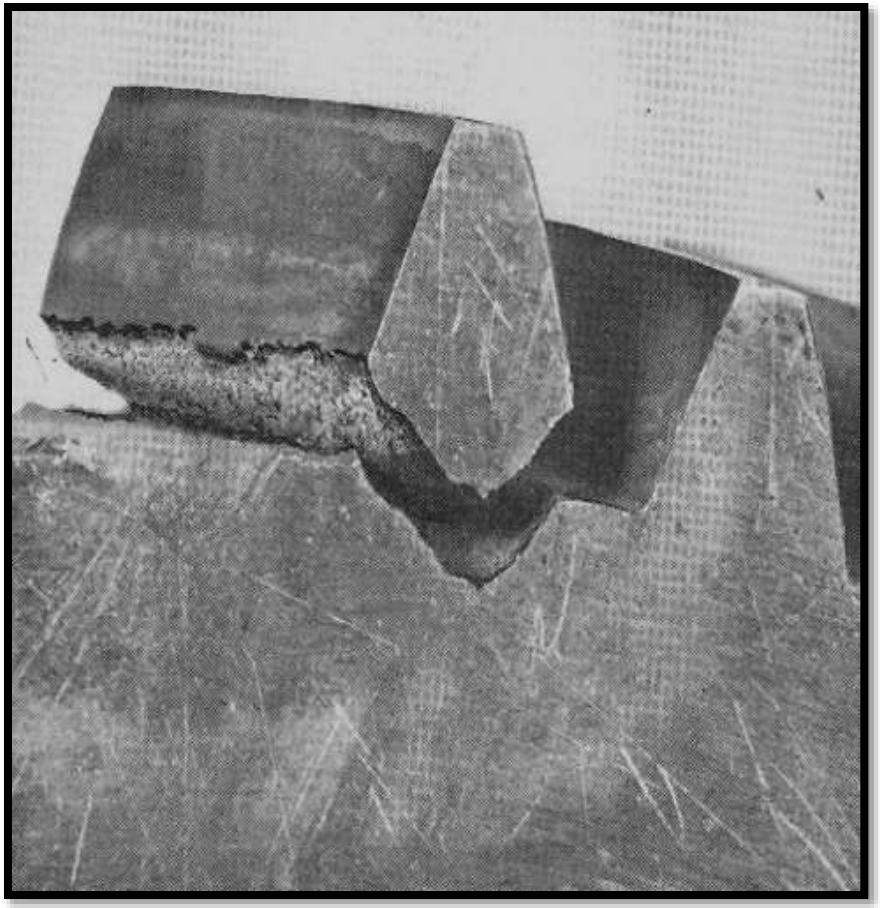
- Plastic flow of tooth surface results when it is subjected to high contact stress under rolling cum sliding action.
- Surface deformation takes place due to yielding of surface or subsurface material.
- Normally it occurs in softer gear materials.
- But it can occur even in heavily loaded case hardened gears.



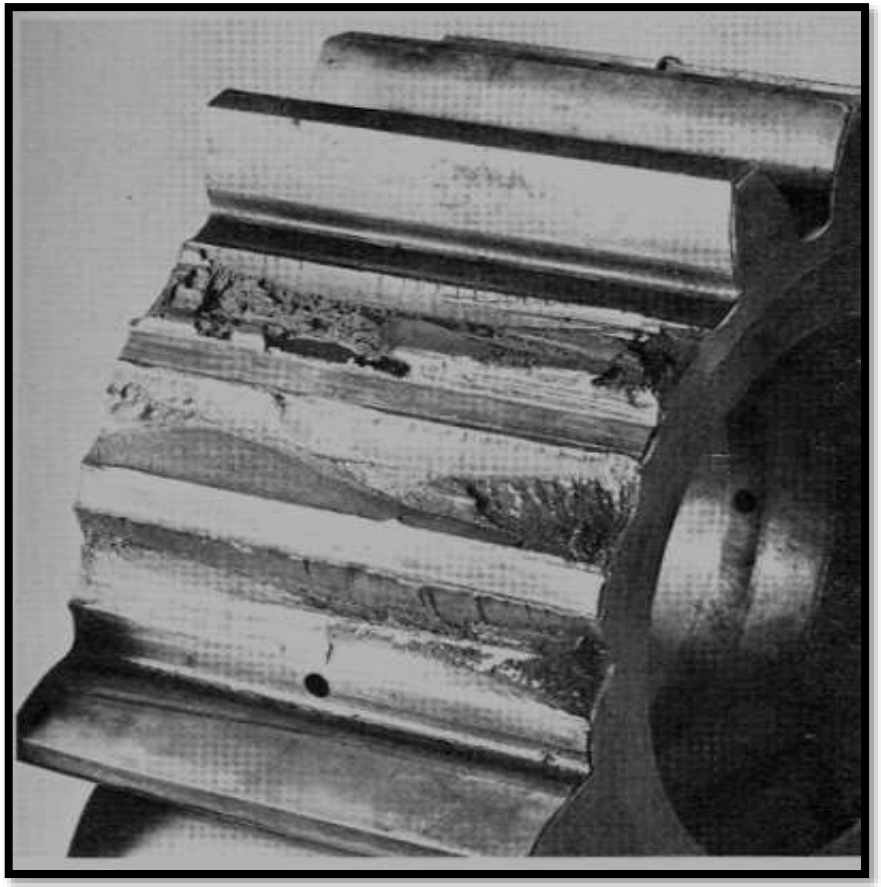
PLASTIC FLOW - COLD FLOW

TOOTH BREAKAGE – BENDING FATIGUE

- Bending fatigue failure occurs over a long period of time.
- The initiation of crack takes place at the weakest point, normally at the root of the tooth or at the fillet where high stress concentration exists together with highest tensile stress from bending or from the surface defects.
- The crack slowly propagates over 80 to 90% of the life.
- Then crack propagates fast and suddenly results in fracture of the tooth.
- The fractured surface will exhibit beach marks in the slow crack propagation region and brittle fracture behaviour in sudden fracture region.



TOOTH BREAKAGE



BENDING FATIGUE

THANK YOU ☺