**3. DESIGN FOR FLUCTUATING LOADING**

**FLUCTUATING LOADING:** When the variation of load w. r. t. time is sinusoidal then the dynamic loading is said to be fluctuating loading.

|  |  |
| --- | --- |
| Maximum Load | Minimum Load |
| Mean Load | Amplitude Load |

|  |  |
| --- | --- |
| Maximum Stress () | Mean Stress() |
| Minimum Stress () | Amplitude Stress() |

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| **TYPES OF FLUCTUATING LOAD** | |
| **REPEATED LOADING** | **REVERSED LOADING** |
|  |  |
| Design is based on maximum load. | Experimental Results are used for design. |

**FATIGUE LOADING:** It’s the weakening of component due to reversal of loading or cyclic loading. And material fails suddenly (Ductile and brittle both).

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| **RR MOORE’S /ROTATING BEAM EXPERIMENTAL ANALYSIS** | |
| **Specimen:** Mild Steel   1. Free from defects. 2. No sudden reduction in cross section. 3. Mirror Finished Surface.   Radius: 3.5in to 10in (88.9 mm to 254 mm)  Min. Dia.: 0.3in (7.62 mm)  Max. Dia.: 0.481in (12.217 mm)  Total Length: 3.4375in (87.312 mm) | Fatigue | SpringerLink |

* Specimen is simply supported beam. And subjected to reversed pure bending (As shown in fig.).

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| **S N DIAGRAM:** | |
| S-N Fatigue | Fatigue of Metals: Part Three :: Total Materia Article |

For aluminium, there is no endurance limit region where as mild steel has endurance limit region.

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| --- | --- |
| **ENDURANCE LIMIT:** It’s the point of loading at which the component starts experiencing fatigue due to cyclic loading. | **ENDURANCE STRENGTH:** It’s maximum amplitude stress that the standard specimen can withstand for a minimum of 106 cycle when subjected to completely reversed loading without fatigue. |
| Fatigue lifespan of a fillet welded joint - Hybrid approach to obtain the S-N  curve with a reduced number of tests | **For Steel,**   |  |  | | --- | --- | |  |  |  |  |  | | --- | --- | | **For Iron,** | **For Al, Cu,** | |  |  | |  | Maximum life | |

**IMP POINTS RELATED TO STANDARD SPECIMEN USED IN EXPERIMENT:**

|  |  |
| --- | --- |
| 1. Min. diameter . 2. Surface of the specimen is polished to mirror finishing. 3. No sudden reduction in cross section. 4. Experiment is conducted at room temperature. | 1. Loading is pure bending. 2. Specimen may or may not fail at endurance limit. 3. The failure stress corresponding to cycles is endurance strength . |

**ACTUAL COMPONENT USED IN THE MACHINE:**

|  |  |
| --- | --- |
|  | Corrected Endurance Strength. |

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| --- | --- | --- |
| **SURFACE FINISHED FACTOR ()** | | **SIZE FACTOR** |
| Shrigley Equation,  Find using experiments. | If ,use  For cast iron | Shrigley and Mitchel equation; |

|  |  |
| --- | --- |
| **LOAD FACTOR ()** | **RELIABILITY FACTOR ()** |
| For reversed Bending,  For reversed axial loading,  For reversed torsional loading,  From distortion energy theory, ] | |  |  | | --- | --- | | **% Success** | **Reliability** | | **50%** |  | | **90%** |  | | **99%** |  | | **99.9%** |  | | **99.9999%** |  | |
| **TEMPERATURE FACTOR ()** |
| |  |  | | --- | --- | |  |  | | Shrigley and Mitchel equation; |  | |
| Shrigley and Mitchel equation;  Can’t use for Cu, Mg, Al, Etc… |

**STRESS CONCENTRATION:**

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  | | --- | --- | |  | depends material, reduction rate, Dimensions of cut. |   Gradual reduction of Cross section induces less stress concentration. And sudden reduction causes high stress concentration. | Length of semi major axis,  Length of semi minor axis [Longitudinal],  Normal Stress/ Stress at minimum cross section,  Maximum stress at minimum cross section due to stress concentration, |
| **STRESS CONCENTRATION FACTOR ():**  It’s maximum concentration factor for a given component and shape of cut. | “” depends on dimension of cut, material. |
| depends on shape of cut and it’s not dependent on material. |  |

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| --- | --- | --- |
| **FATIGUE/ ACTUAL STRESS CONCENTRATION FACTOR** | | |
| For given material, maximum stress due to change in cross section at minimum cross section due to stress concentration given by, | |  |
| Failure condition in actual, |  |  |
|  | | |

**NOTCH SENSITIVITY:** It’s sensitivity of material toward cuts or notches.

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For circular Cut, .

**METHODS TO REDUCE STRESS CONCENTRATION:** Stress concentration is localization of stress due to reduction in cross section. We can reduce stress concentration by Gradually reducing cross section,

|  |  |
| --- | --- |
| Providing fillet radius | Providing Small Holes/ Notches near to vicinity region of the sudden reducing cross section |

**IMPORTANT POINT:**

|  |  |  |
| --- | --- | --- |
| If and are given, find | If and are not given, | If given but is not given, |

**INFINITE LIFE:** For reversed loading, life of component

**FINITE LIFE:** For reversed loading, life of component

|  |  |
| --- | --- |
| At , | At , |
|  | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  |  |  |  |  | | --- | --- | --- | --- | --- | | Fatigue Stress |  |  |  |  | | Life Span (in time) before fatigue |  |  |  |  | | No of Revolution Actually Spend (in cycles) |  |  |  |  | |

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| **SODERBERG THEORY** | **GOODMAN THEORY** | |
|  |  | |
| **GERBER THEORY (Parabolic Curve)** | **ASME THEORY (Elliptical Curve)** | |
|  |  | |
| **LANGER THEORY** | **MODIFIED GOODMAN THEORY** | |
|  |  |  |
|  | Use Goodman Theory | Use Langer Theory |
|  | are intersection point of Langer’s line and Goodman line | |

**COMBINED FLUCTUATING LOADING:**

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| --- | --- |
| 1. Use Theory of failures to find .   Here all mean and amplitude loads will be given for combined loading condition.   1. Use the theory of fluctuating loading. Find required parameters. |  |

