Fatigue Life Estimation of Connecting Rod

Presenter: Mr. Saharash Khare

Team Members:
Mr. Praveen Kumar Banda
Mr. Nagarjun Jawahar
Mr. Ashok Joshi

Company Background

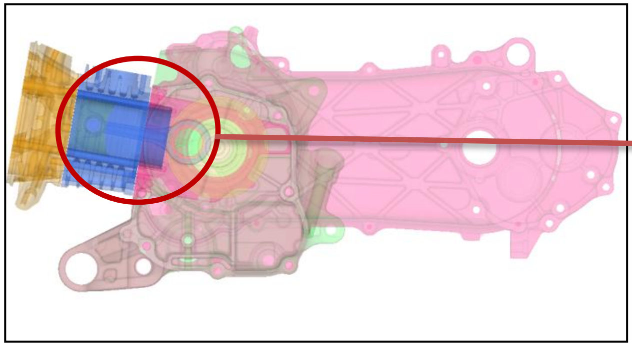
- Hero MotoCorp Ltd. is the world's largest manufacturer of two - wheelers, based in India.
- Hero MotoCorp has four manufacturing facilities based at Dharuhera, Gurgaon, Haridwar and Neemrana
- These plants together have a production capacity of 7.6 million 2-wheelers per year.

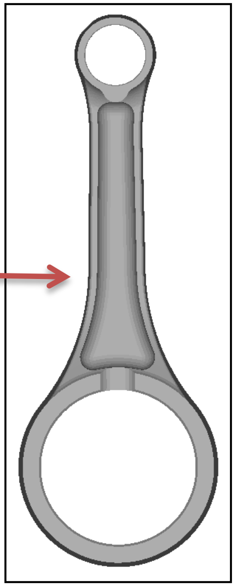
Agenda

- ✓ Objective
- ✓ Introduction
- ✓ Testing Method
- ✓ Fatigue Design Cycle
- ✓ Simulation Methodology
- ✓ Results
- ✓ Conclusion and Future Scope

Objective

Fatigue Life Estimation of Connecting Rod





Connecting Rod

Challenges

✓Understand testing procedure

✓ Define fatigue cycle limit

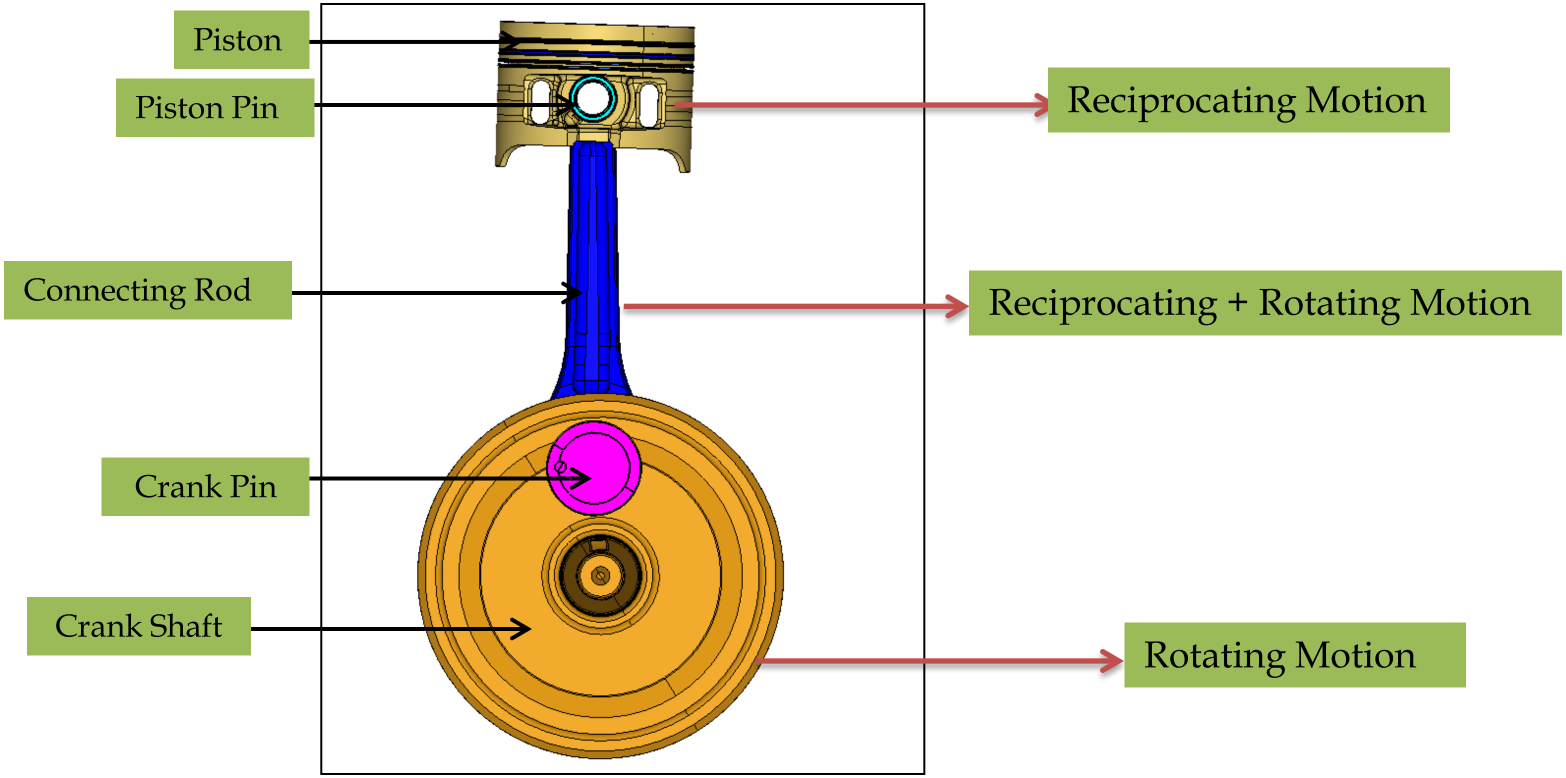
✓ Define all load cases

✓ Define fatigue design cycle

✓ Standardize simulation process

✓ Fatigue life estimation through FEA simulation

Introduction

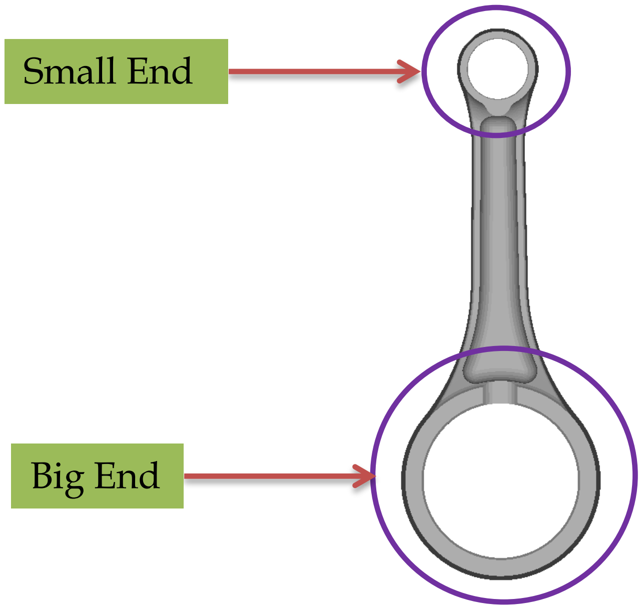


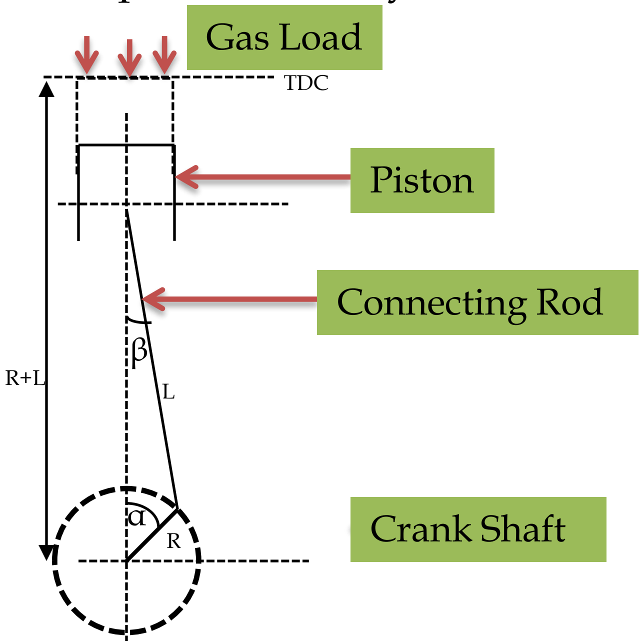
Engine : Source of power for Automobile, Convert chemical energy in to mechanical energy

Crank-Train : Convert Thermal energy of burned gases in to mechanical energy

Introduction

<u>Connecting Rod :</u> Convert reciprocating motion of piston in rotary motion of crankshaft





The connecting rod is one of the critical components of internal combustion engine. Crank Train dynamics generate continuous cyclic loading of reciprocating forces and rotating forces on connecting rod.

Process Flow Chart

Fatigue Load Calculation

- Combustion gas force
- Inertia of Piston
- Inertia of Connecting rod
- Inertia of Piston pin

FEA Pre - Processing

- FEA model building
- Identify all load cases
- Apply boundary conditions

FEA Static Analysis

- Nonlinear FEA for all load cases
- Stress output for all load cases
- Define fatigue load cycle

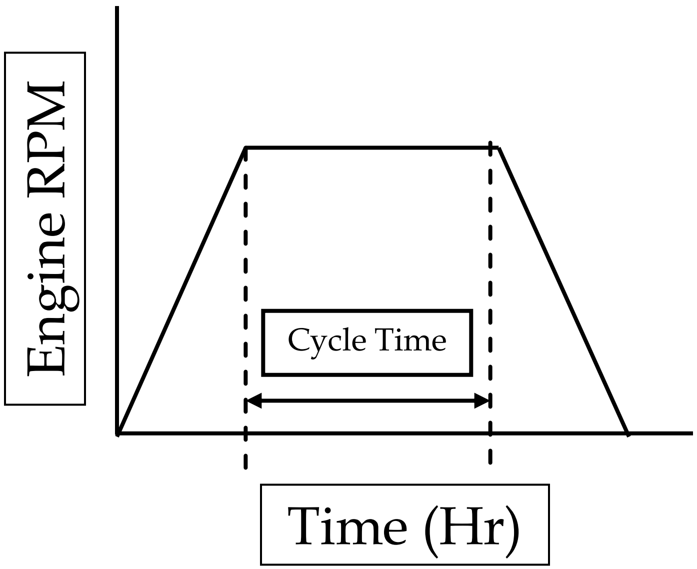
FEA Fatigue Analysis

- FEMFAT Trans Max
- Fatigue model building
- Endurance factor of safety

Testing

- Engine Endurance Test

Testing Methodology



Engine RPM = n

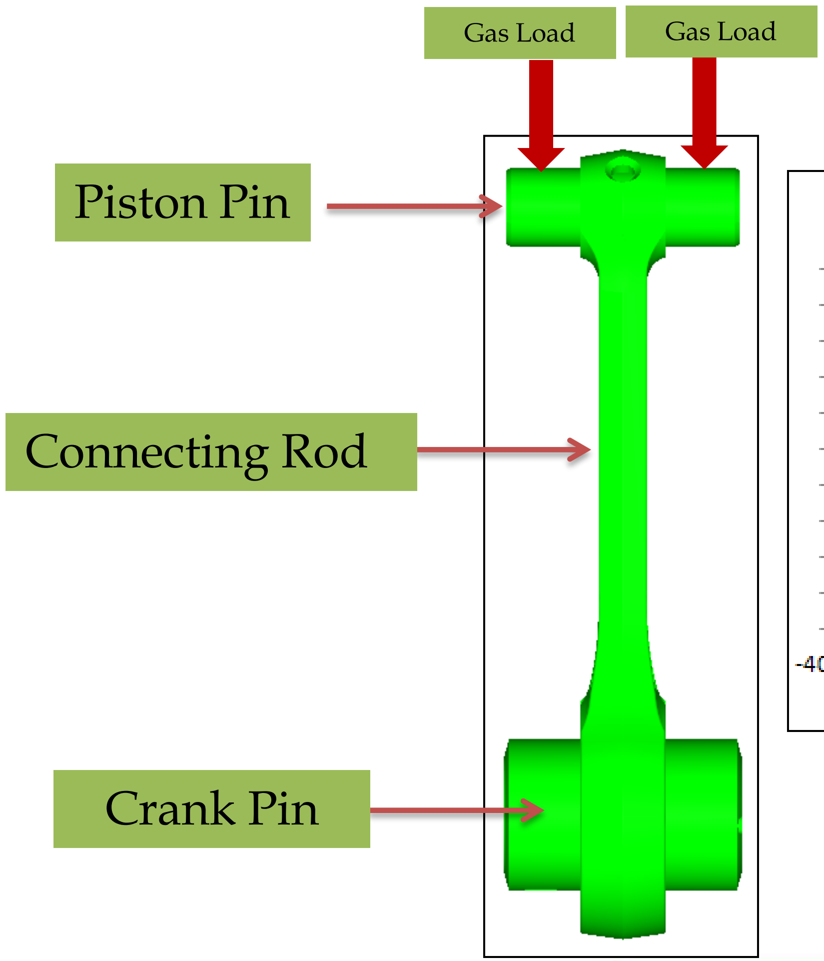
Cycle Time = T

Engine Endurance Test: Put Engine on dynamometer at specified condition for defined cycle time

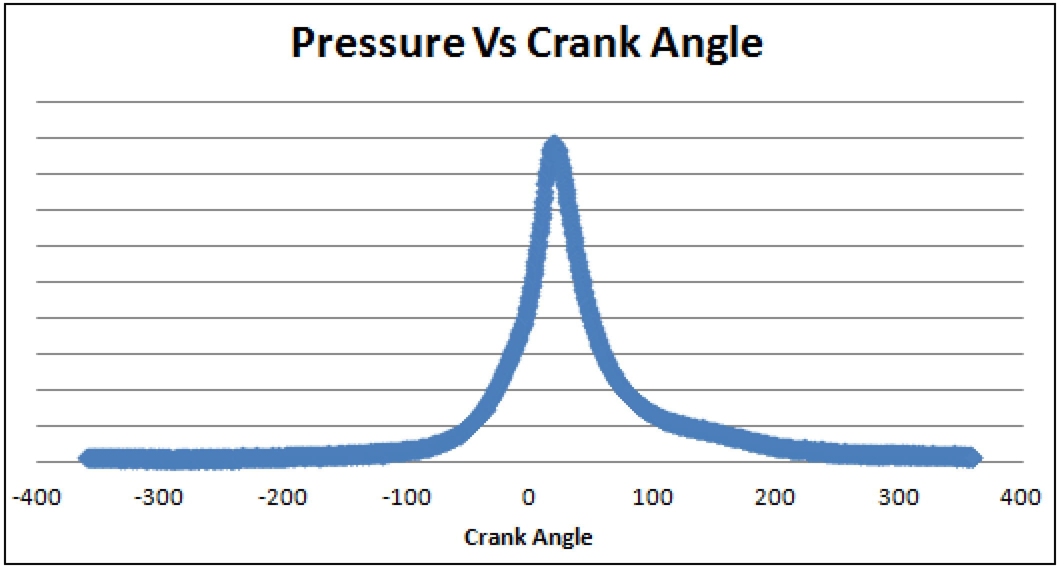
No. of Fatigue Cycle $N = (n \times T \times 3600)/2$

Fatigue Cyclic Load

<u>Combustion Pressure Force</u>

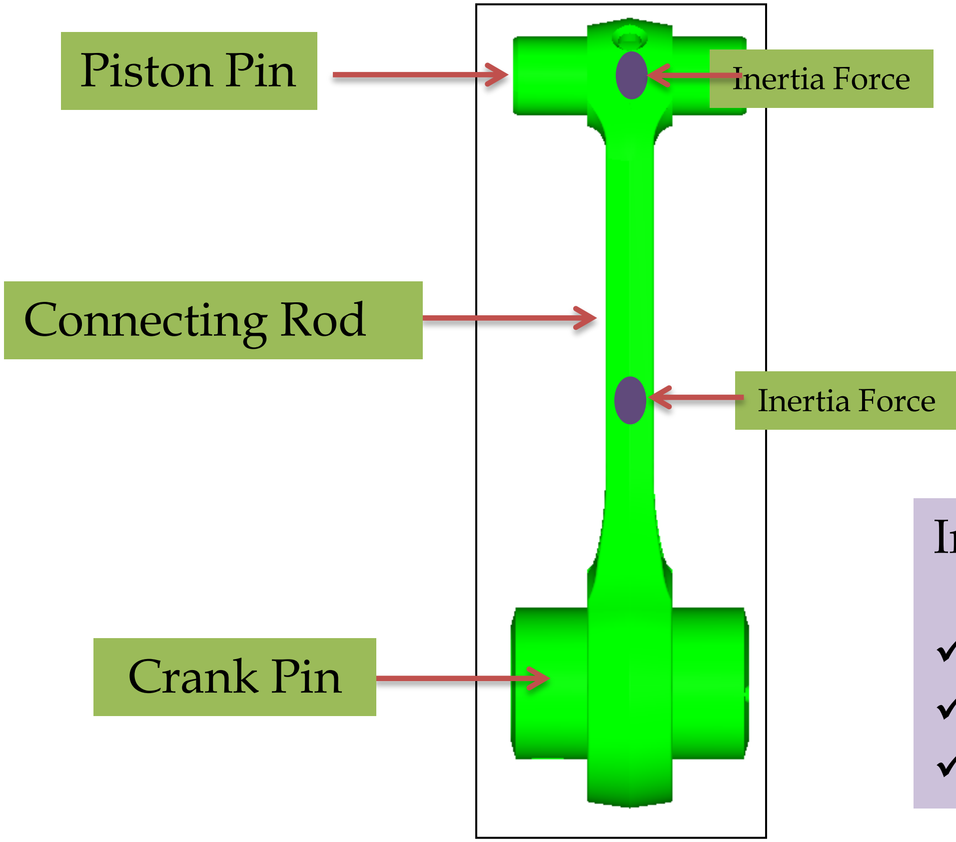


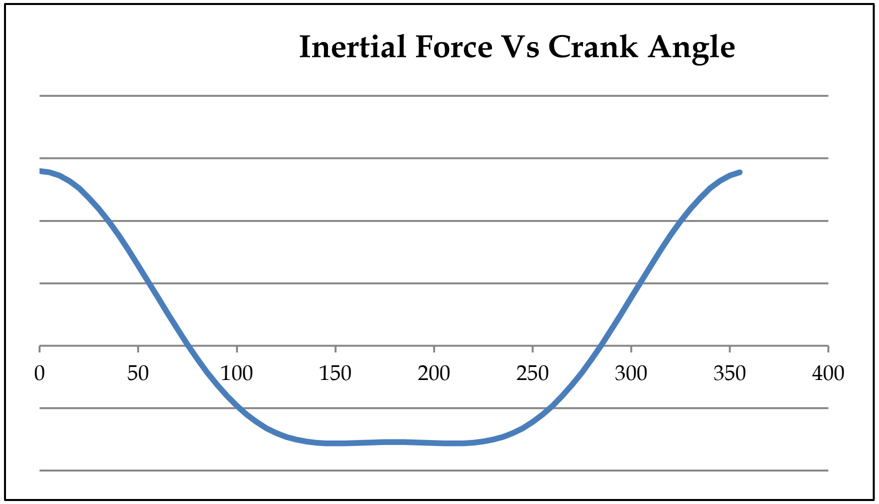
Distributed Pressure Force



Fatigue Cyclic Load

Inertia Forces



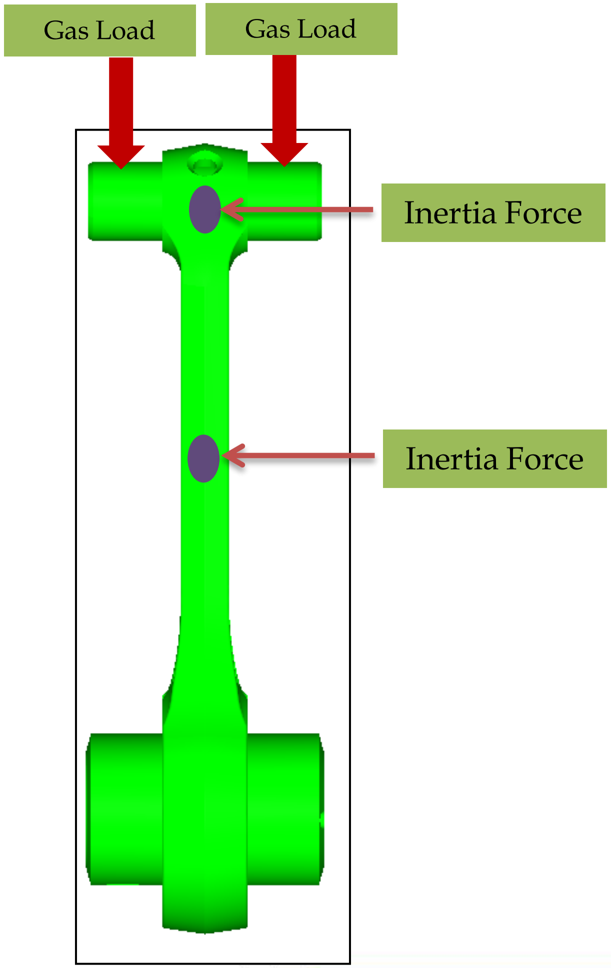


Inertia Forces:

- ✓ Inertia Force of Piston
- ✓ Inertia Force of Connecting rod
- ✓ Inertia Force of Piston Pin

Fatigue Cyclic Load

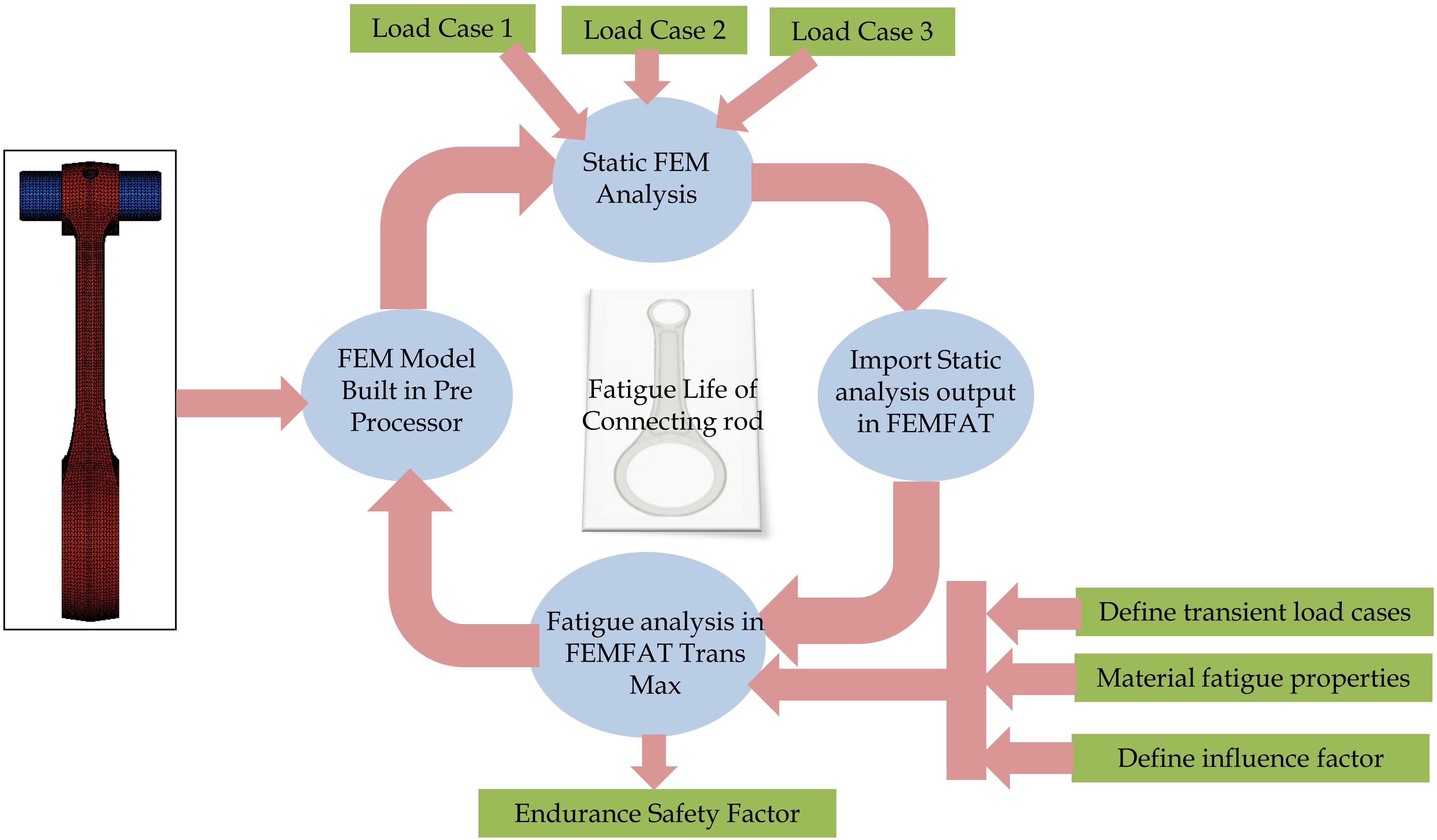
Load Cases



Engine RPM = N (Testing RPM)

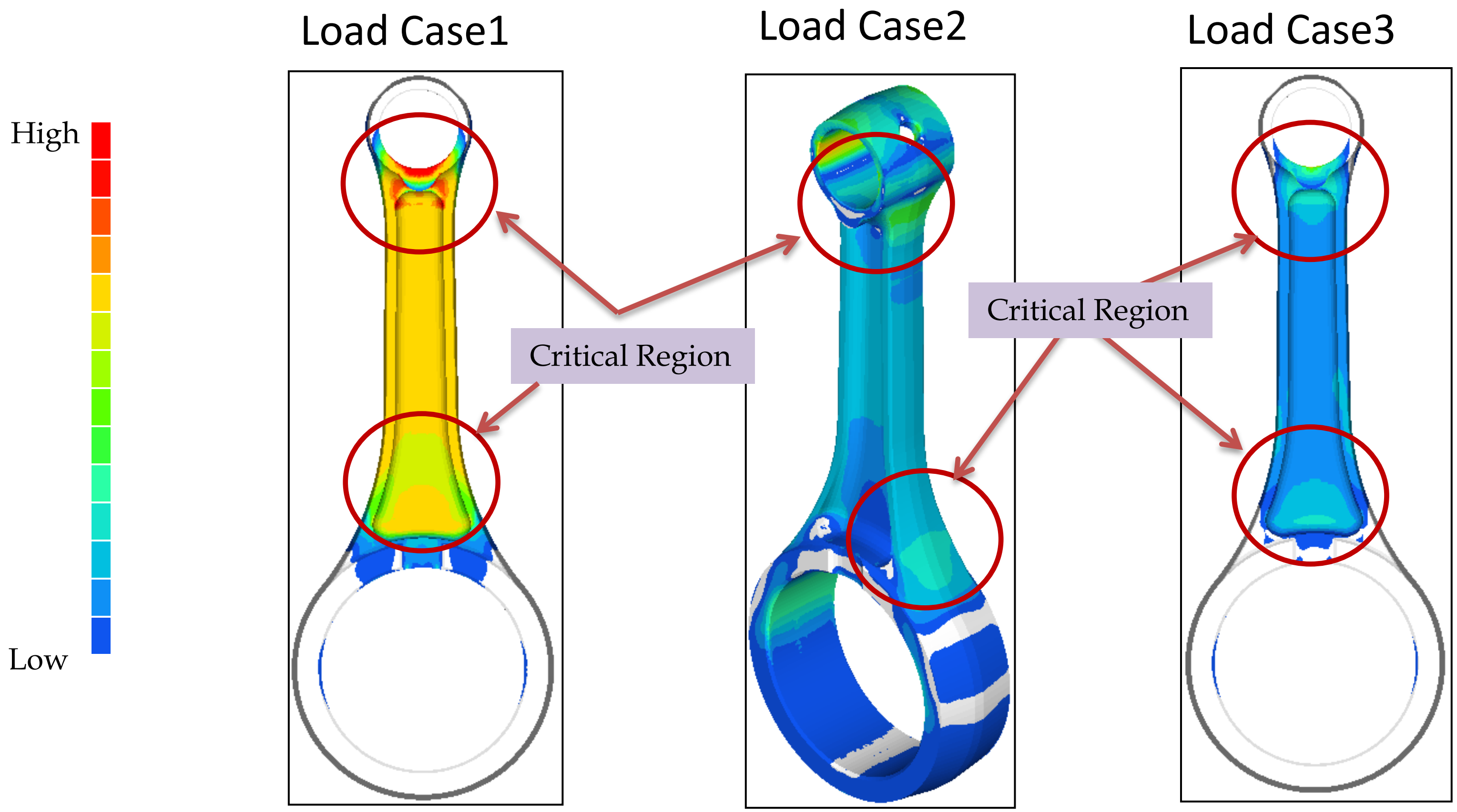
Load Case 1 = Gas Force + Inertia Load
Load Case 2 = Inertia Load ↓
Load Case 3 = Inertia Load ↑

Simulation Methodology



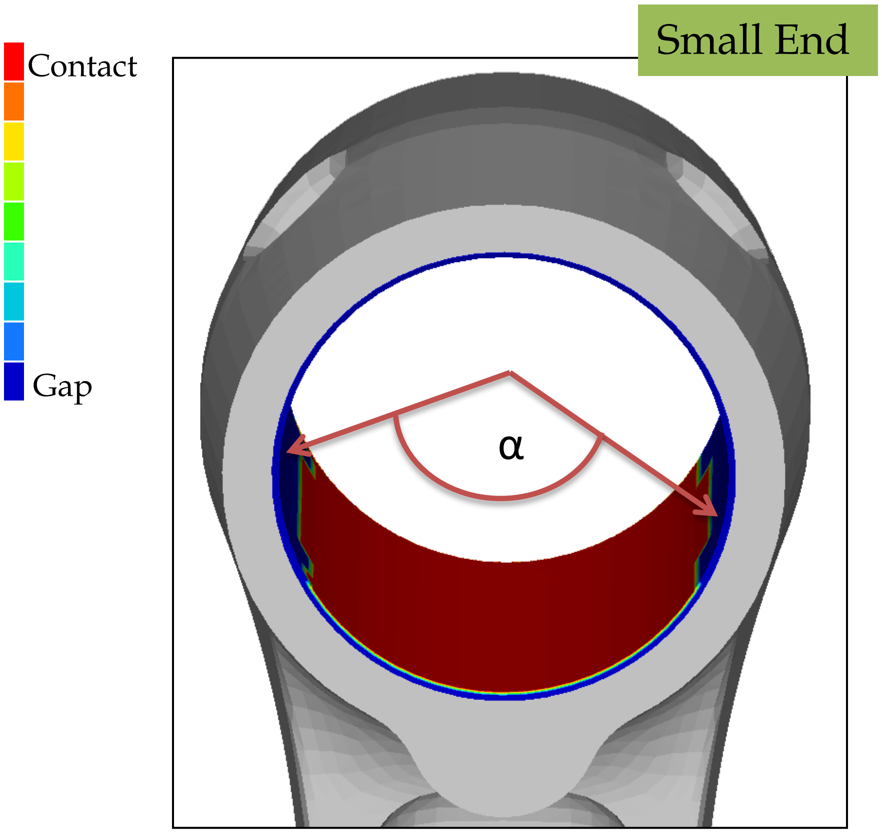
Static Analysis

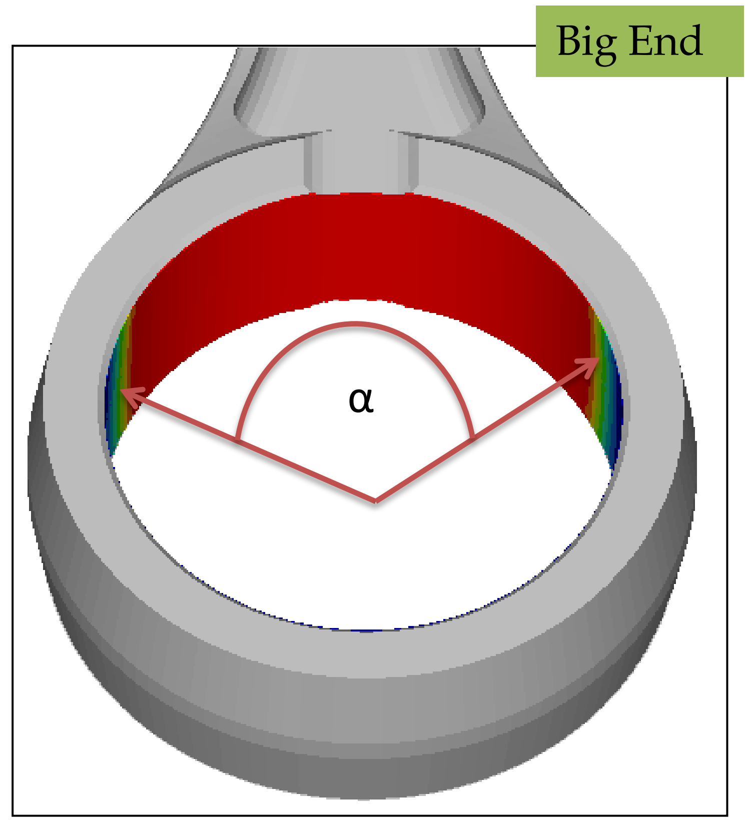
Von Mises Stress



Static Analysis

Open Gap

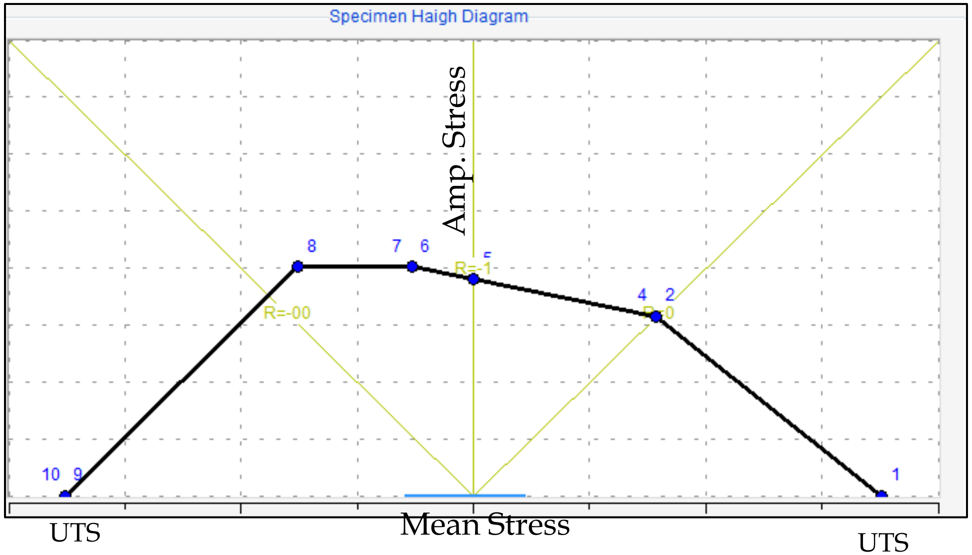




Contact angle α should be more than design specification

Fatigue Analysis – FEMFAT Trans Max

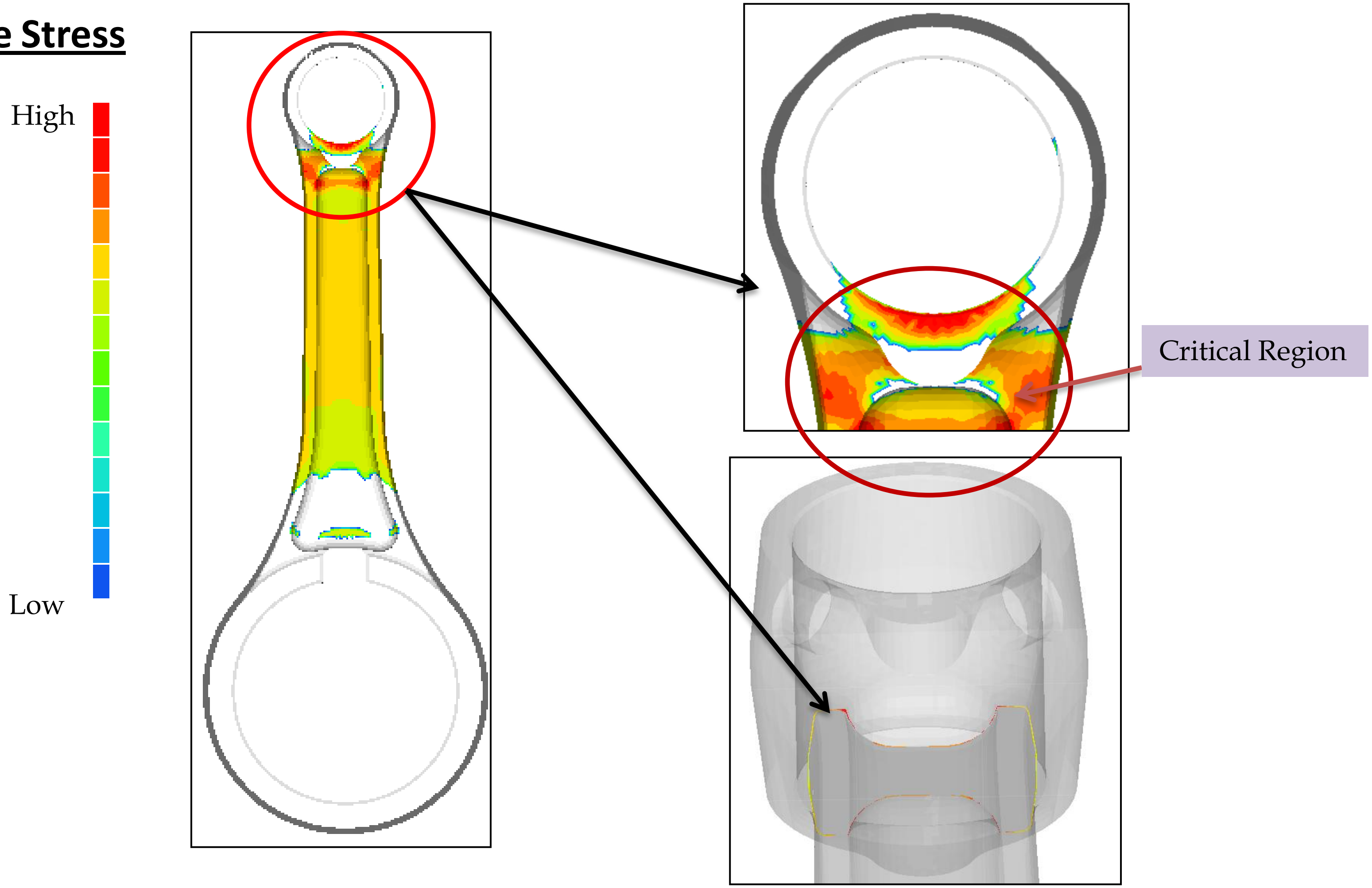
FEMFAT Trans Max Solution Parameter	
Stress Gradient	ON
Mean Stress	ON
Surface Roughness	ON
Mean (and Amplitude) Rearrangement	ON
Modified Haigh Diagram	ON
Statistical Influence	ON
Temperature Influence	OFF
Survival Probability	99.99%
Design Target Life	N (Endurance Test)
Analysis Type	Endurance safety factor



Typical Haigh Diagram of Hardened Steel material

Fatigue Analysis – FEMFAT Trans Max

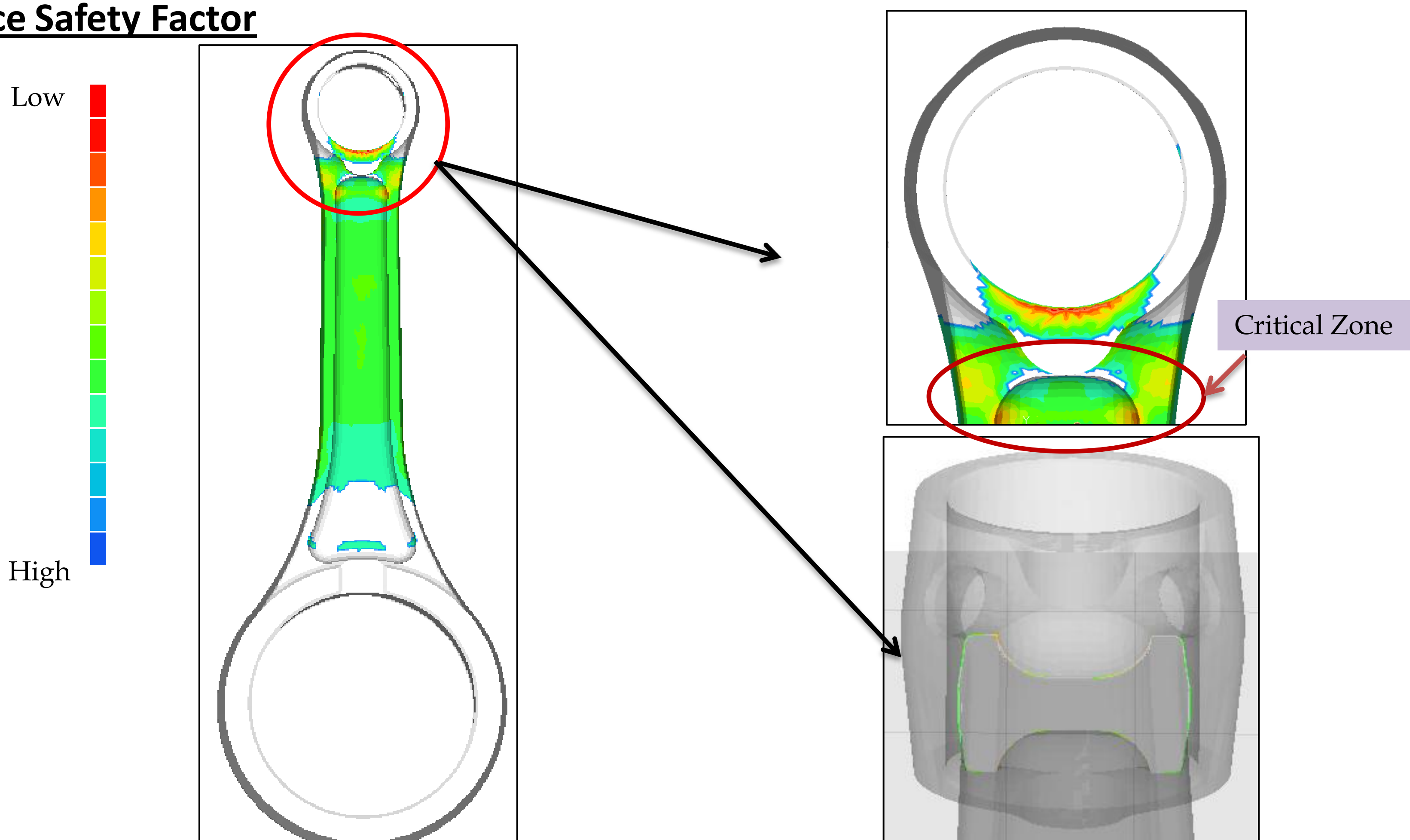
Amplitude Stress



Amplitude Stress at critical Plane

Fatigue Analysis – FEMFAT Trans Max

Endurance Safety Factor



Amplitude Stress at critical Plane

Minimum Life of Connecting rod is X times target life

Fatigue Analysis – FEMFAT Trans Max

Conclusion

✓ Target fatigue life of connecting rod has been defined based on engine endurance test

✓ Fatigue cyclic load was calculated by crank train dynamics

✓ Static analysis of connecting rod shows that small end is more critical for durability

✓ FEMFAT Trans Max module was used for fatigue life estimation

✓ Fatigue result shows the small end region is critical for fatigue life

Future Scope

✓ Component level testing can be develop for defined fatigue load cycle