



1. Drive-in 4-Poster with Integrated Climatic Chamber
2. Metallurgical Failure Analysis and Process Improvement Projects at Materials Lab of ARAI - Forging Industry Division
3. Offline & Real - Time Simulator for Electric and Hybrid Electric Vehicles
4. Seminar on Tyres - Technology and Regulations 2016

□ Drive-in 4-Poster with Integrated Climatic Chamber

Full-Vehicle Simultaneous Vibration, Noise & Environment Performance & Durability Evaluation

This is to announce establishment of state-of-the-art facility for full vehicle multi-disciplinary simultaneous evaluation at Fatigue and Materials Centre of Excellence (FMCE) at Homologation and Technology Centre (HTC), ARAI, Chakan. This facility is useful not only for evaluation of performance, but also ultimate durability as well. Four Post Test System can perform variety of test applications, including structural durability, vehicle dynamics, squeak and rattle evaluations. Four poster in combination with Drive in Environmental chamber facility is available for perform tests, including fit and finish dimensional change studies at various temperature / humidity / sun-load combinations and hybrid or electric powertrain cold start tests.

Use of 4-Poster Chamber: 4-Poster Chamber is used for :

- | | | |
|------------------------------|-------------------------------------|----------------------------------|
| ✓ Track Simulation | ✓ Durability | ✓ Temperature & Humidity control |
| ✓ Heat Ageing | ✓ Pure Vibration | ✓ Ride quality, Comfort |
| ✓ BSR (Buzz, Squeak, Rattle) | ✓ Characterization | & ... the way we can explore.... |
| ✓ Sun Simulation | ✓ Electric Vehicles & Battery Tests | |



Vehicle inside Drive-in 4-Poster with Integrated Climatic Chamber

4-Poster-Chamber - Test System Applications

In the highly competitive global automotive market, need to develop high quality products and achieve product excellence in all areas to obtain market leadership is critical. Elements in determining quality of vehicle are performance, durability, safety along with noise & vibrations. Earlier, these elements could be validated individually with predefined conditions of other elements. These scenarios may cause incomplete validations, cost and time expenditure when validated individually.

Now, ARAI has established 'Drive-in 4-Poster with Integrated Climatic Chamber', a complete validation solution, for simultaneous assessment of vehicle in terms of durability, vibrations, noise, along with environmental -- sun, humidity, temperature simulations. This will certainly benefit vehicle manufacturers to build confidence in vehicle quality excellence with faster vehicle development time.

We say, we are "*Working forward* → from Software-in-Loop (SIL) -to- Component-in-Loop (CIL) -to- Human-in-Loop" thus bringing road to laboratory : Laboratory to Desk : with Human-in-Loop.

Vehicle manufacturer performs following tests regularly:

- Four-poster drive file creation (lab simulation) and durability test
- AIS-006 Bumper validation test
- Heat ageing
- BSR (Buzz, Squeak & Rattle) test

These and other feasible tests can now be performed using the unique "**4-Poster in Chamber**", the first of its kind facility in India.

Test Methodologies

Four-Poster Test: This methodology is generally used for durability testing of frame and suspension. In this 4-poster testing, data like force, acceleration, strain, etc. is acquired while vehicle running on track. In lab, vehicle mounted on 4 actuators is excited to simulate acquired track signals. Product development time of vehicle is reduced, in this case, as simultaneous validation of components, aggregates and in terms of Full Vehicle occurs with accelerated durability testing methodology.

Bumper Validation: AIS-006 standard establishes requirements for approval of vehicles of category M1 (Cars, SUVs) with regard to integrity of anchorages of front and rear bumpers to the vehicle. Four poster test procedure for evaluation of bumper fitment is specified in the standard.

BSR (Buzz, Squeak, Rattle) Evaluation: Full vehicle BSR evaluation is conducted on the tire coupled four-poster road simulator. For BSR evaluation trained observer has to sit inside the vehicle while assessing vibrations on the four-poster. As the customer perceives irritating noises like buzz, squeak, rattler as direct indicator of vehicle build quality and durability, BSR performances are evaluated till vehicle end-of-life, in early development process itself. BSR problems can be attributed to structural deficiencies, incompatible material pairs, poor geometric control and alignments, etc.

Heat Ageing : In this, material under test can be exposed to rapid (but controlled) changes in temperature, humidity, sun load, etc. to simulate effect of day and night for the defined period. It is used to estimate deterioration in performance and useful life span of product. Generally polymers / rubbers are kept at elevated environmental conditions, in order to accelerate chemical breakdown.

Actual Site Photo:



Test System Specifications

CAR /SUV Four Poster Test System Technical	
Parameter	Details
Max Sprung Mass/Corner	1300 kg
Max Unsprung Mass/Corner	100 kg
Wheelbase length	1800 to 3200 mm
Track width	1200 to 1800 mm
Actuator force per corner	51 kN
Max Velocity	4 m/s
Max Displacement	+/- 125 mm
Wheel pan tire sizes	135/70R12 to 275/35R20
Resonant frequency@ 60 kg	100 Hz
Minimum test frequency	0.85 Hz

Environmental Chamber Technical	
Parameter	Details
Insulation chamber (Internal dimensions)	Height : 5000 mm, Width : 6000 mm, Depth : 8000 mm.
Main test vehicle entrance door:	Height : 3500 mm, Width : 3000 mm
Temperature Range & Rate:	-45°C to +80°C without solar Rate: ±1°C/minute
Sun Simulation	0°C to 70°C with solar simulation
Humidity Control Range	10 to 95 % r.h. for Temp. +10 to +80°C

□ Metallurgical Failure Analysis and Process Improvement Projects at Materials Lab of ARAI-Forging Industry Division

ARAI-Forging Industry Division (ARAI-FID) is conveniently located at Chakan Industrial hub, near Pune city where industry, among others, avails the services related to material testing, metallurgical analysis and quality assurance test certificates. Also, research & development projects related to materials and manufacturing processes are carried out at ARAI-FID.

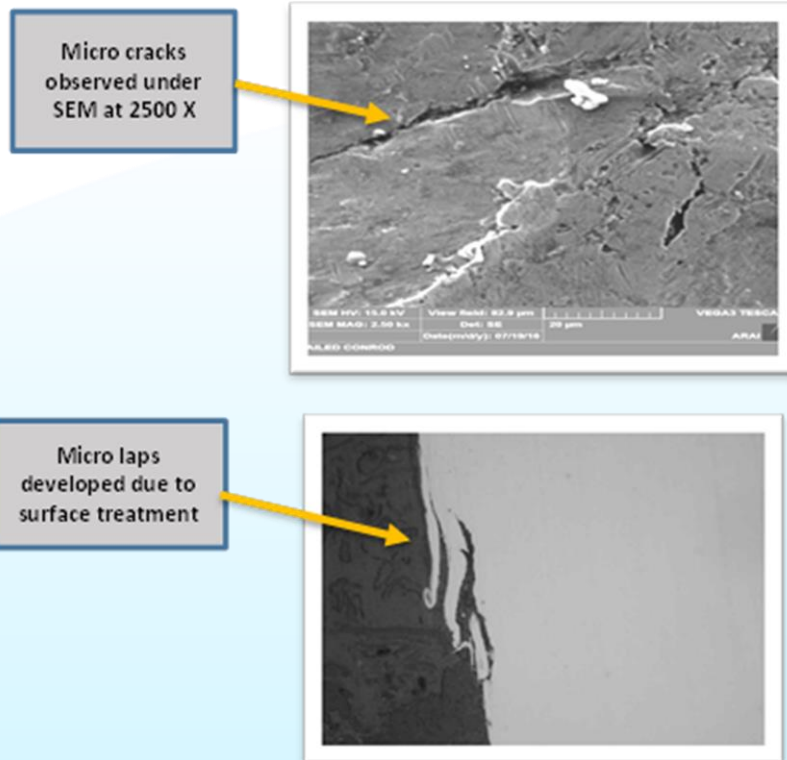
Materials Lab of ARAI-FID has expertise in metallurgical failure analysis and testing of all types of automotive and non-automotive components manufactured by different processes like forging, casting, rolling, etc., to find out root cause of failure and provide solutions to avoid such failures in future. The Lab is equipped with state-of-the-art instruments like X-Ray Diffraction (XRD), Residual Stress Analyser, Optical Emission Spectrometer (OES), Quenching Dilatometer, Metallurgical Microscope with Image Analyser and Hot microscopy. The Lab is also equipped with Forging plant and heat treatment facility for manufacturing of prototype components to establish new forging and heat treatment processes. The Lab works in close association with Automotive Materials Lab at ARAI, Pune, which also has many advanced facilities and expertise developed over the years



**Scanning Electron Microscope with EDS, Model Vega3 LMU,
Tescan, Czech Republic make**

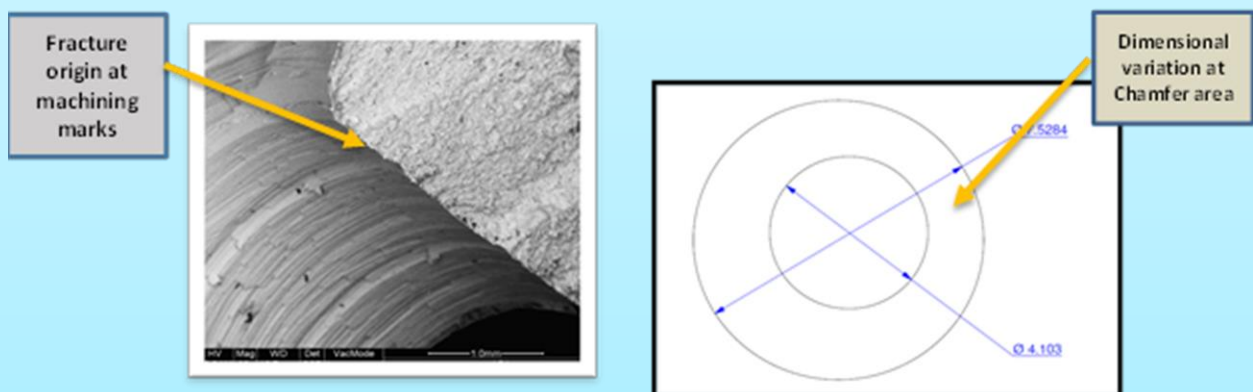
Sample case studies are presented here, along with probable root causes of component failure, found after conducting various metallurgical tests, including destructive and non-destructive tests like chemical, mechanical, residual stress analysis, microstructural examination and scanning electron microscopy studies.

Case study 1 – Connecting Rod



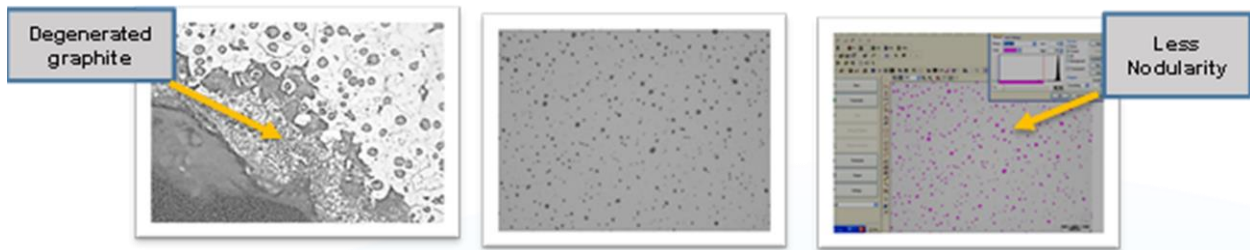
Presence of Micro cracks / laps on surface of connecting rod near and away from region of fracture

Case Study 2 – Connecting Rod



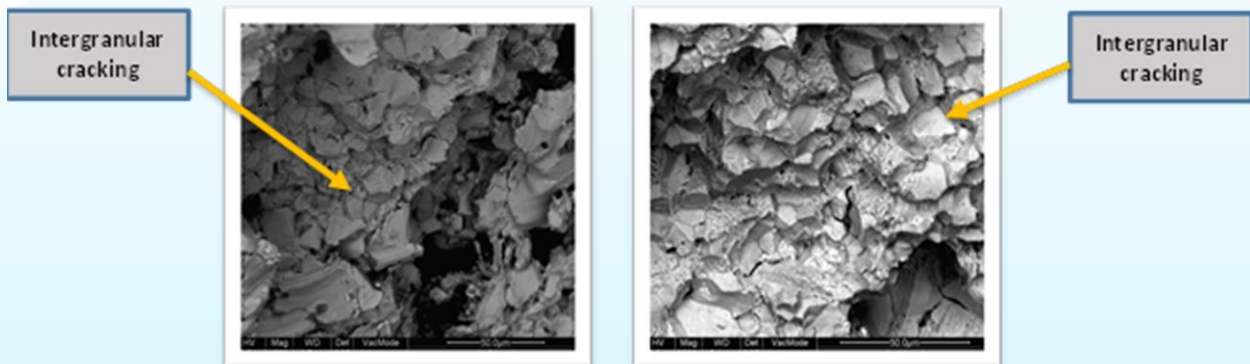
Premature failure during fatigue testing occurred due to improper machining and dimensional variation of chamfer at oil hole of connecting rod

Case Study 3 – Cast Iron Component



Failure of Cast iron component probably due to degenerated graphite and less nodularity

Case Study 4 – Gear



SEM photographs at 1600x & 2000x, showing inter granular cracking on fractured surface of gear occurs due to embrittlement - probable reason of failure

❑ **Offline & Real-Time Simulator for Electric and Hybrid Electric Vehicles**

Brief Description

With Faster Adoption and Manufacturing of Hybrid and Electric vehicles in India (FAME-India) scheme bunches under the scheme National Electric Mobility Mission Plan (NEMMP), E-mobility has become a buzz word today. ARAI has identified E-mobility as a key development platform and had started working early (2012). A consortium approach consisting four agencies: ARAI, CDAC(T), IISc, IITB, by utilizing their complementary strengths for “**Development of Offline & Real-Time Simulator for Electric and Hybrid Electric Vehicle**” is an initiative towards it.

Need of Simulation in EV / HEV

- Involves multiple control systems
- Multiple systems can be easily configured and tested in simulation, all with the same facility
- Multiple configurations and iterations possible in less time
- Multiple configurations and test cases possible which may be difficult with conventional system
- Saves time, effort and money

What is offline & Real-Time simulator?

Offline Simulator is a simulation tool which simulates behavior of intended system, including sub-systems in various external scenarios / environments. EV/HEV Plant model offline simulator will be a vehicle behavior simulator driven by electric machine. To execute this offline model in Real-time environment, RT Simulator is required.

Where can it be used?

- Component sizing such as Motor capacity, gear ratio requirement, battery sizing for specific requirements.
- Performance comparison with different types of components / sub-systems.
- Design level configuration and performance estimation such as range, energy consumption, peak speed, acceleration, etc.
- Hybrid Controller design and development.
- Controller calibration and V&V.

Offline & RT Simulator packages are available internationally with licensed packages at higher prices as a black box. Presently, India has no public IP on the Simulation of EV systems. A cost effective indigenous Offline and Real-Time simulation package is not available.

The objective of the project was to develop an indigenous offline and real time simulator system for EV/HEV systems. The offline and real time simulator developed, is first of its kind indigenous simulation platform, which can be used by academic institutes as well as Indian industry as well. It is an open development platform, giving flexibility of modifications / additions to the user to suit specific requirements. The simulator outcome has been benchmarked with internationally available similar simulators.

Project Highlights

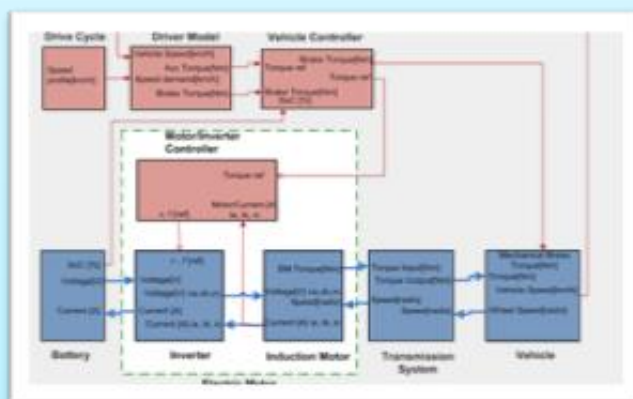
- First Indigenous Offline Simulator for Electric & Hybrid Electric Vehicles
- Open Design and Development Platform for EV-HEV Systems
- Benchmarking with other internationally available simulators is done to ensure that developed models are at par with the available models
- One of the very projects, in which collaborative work with Research Institute & Academia has led to Industry ready and industry acceptable product; which is at par with international products / offerings.

Simulation Package - Technical Details

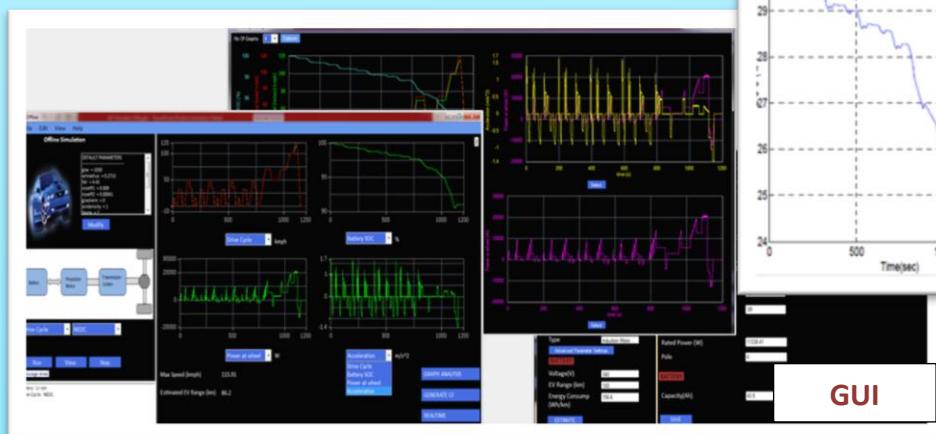
- Modeling of the plants done in MATLAB Simulink platform.
- Wide range of deliverable component library elements required for simulation of all possible EV / HEV configurations.
- Pool of types of components / sub-systems.
- Standardization and interchanging capability of different sub-systems.



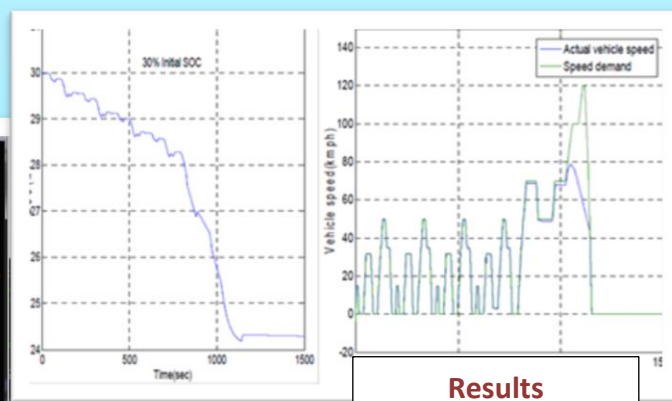
Real Time Simulator



Vehicle Plant Model



GUI



Results

□ Seminar on Tyres – Technology and Regulations 2016

Seminar on Tyres – Technology and Regulations, the second in the series, was conducted on 8th and 9th August 2016 in the Golden Jubilee year of ARAI. It was greeted with enthusiastic response and participation from practicing engineers, scholars and students in engineering discipline.

Mr. Anilesh M. David, Head – Bureau of Indian Standards, Pune inaugurated the Seminar, in the presence of Mr. Rajiv Budhraja, Director General, ATMA and Mr. Tom K. Thomas, Executive Director – Technology and Projects, CEAT Tyres as a Guest of Honour. The seminar witnessed presentation of papers by renowned speakers from Tyre, Automotive and Allied industry.



Dignitaries at the Inauguration: From Left: Mr. Tom. K. Thomas, Mr. Rajiv Budhraja, Mr. A. M. David, Mrs. Rashmi Urdhwareshe and Mr. A. V. Mannikar

Speakers at the event:

- Prof. R. Krishnakumar, IIT Madras
- Dr. T. Sundararajan, Wheels India Limited
- Mr. Sunil Bhatambrekar, Maxion Wheels
- Mr. Hemant Desai, TUV Rheinland India
- Mr. Mandip Singh Tack, IDIADA
- Mr. Joan Puig, IDIADA
- Mr. S.S. Gusain, Bridgestone, India
- Mr. P. Sankar Ganesh, Apollo Tyres India
- Dr. Rajesh Babu Ramanujam, Apollo Tyres India
- Mr. Kumaraswamy Shivashankaraiah, Siemens
- Mr. Karthikeyan Varadarajan, EDS Technologies
- Dr. Abhirami Srikanth, Momentive
- Mr. Animesh Tripathi, Michelin India
- Mr. Vivek Bhandari, Lanxess India

Technical sessions started with the keynote presentation on “Tyre technology R&D Roadmap for India”, by Prof. Dr. R. Krishnakumar – IIT Madras. His talk focused on R&D roadmap for tyre technology in India. Dr. T. Sundararajan-Wheels India, in his keynote, took review of “New Trends and Testing of Wheel Rims”, focusing on the current and future technologies and testing methods in Wheel Rim testing.

Mr. Mandip Singh Tack, IDIADA talked about the role of IDIADA in the international market and tyre development services. He also shared the current market growth scenario in the tyre industry.



Audience

Mr. S.S. Gusain, Bridgestone India educated the audience on “Inflation Pressure: Effects on Tyre Performance”. He shared knowledge on the need of regular checks of inflation pressure of tyre from his long experience in tyre industry.

Mr. Karthikeyan Varadarajan, EDS Technologies shared knowledge on tire analysis using Simulia. He discussed Tire Simulia Timeline and various applications of Simulia. His presentation concluded with a talk on Simulation Lifecycle Management.

Mr. Sunil Bhatambrekar of Kalyani Maxion Wheels, made informative presentation on Analytical & Experimental Study of impact on Performance of Wheel Rim of Commercial Vehicles due to variation in Tyre and Wheel contact during operation. He presented two case studies, which included impact of Tire inflation pressure and tire and wheel contact.

Mr. P. Sankar Ganesh, Apollo Tyres covered in his presentation, tyre modeling challenges on growth and development in India. He explained about the global challenges faced by the tyre industry and the complexities in tyre modeling.

Mr. Joan Puig, IDIADA, made presentation on “Tyre Simulation role in the process of tyre integration on vehicle”. He elaborated subjective and objective roles of tyre integration in vehicle process and also explained Tyre simulation and various Tyre Models.

Dr. Rajesh Babu Ramanujam, Apollo Tyres presented “Tyre R&D testing facilities in India: demand vs availability” and shared the current research and test facilities in India and different tyre characteristics such as wet grip, rolling resistance, friction and tyre labeling.

Mr. Hemant Desai – TUV Rheinland India described the process of type approval of tyres in different countries like China, Indonesia, Brazil, etc. In his presentation he also highlighted the challenges faced during type approval certification in different countries.

Mr. Kumaraswamy Shivashankaraiah, LMS Test Solutions and Engineering Services elucidated on Tire development and regulations on tire noise. He described Pass-by noise Airborne Source Quantification and showcased the LMS Test Lab Software as a single platform for Noise and Vibration testing and evaluation.

Mr. Animesh Tripathi, Michelin, presented Tubeless Technology Benefits for HDV. He helped the participants understand that tubeless tyre gives better life cycle and fuel efficiency. He also compared Fuel Consumption in the light of a test, comparing tubeless and Tube type conducted in India. He also enlightened about other such benefits of Tubeless Tyres.



Dignitaries visiting display of ARAI Tyre Test Capabilities

Panel discussion on “Roadmap: Tyre Regulations for India” was a much sought-after session of the event. The Panel constituting following members, encompassed various areas concerning tyre regulations in India:

1. Chairman - Mr. A. Akbar Badusha, Sr. Deputy Director and Head – HMR & VEL, ARAI
2. Mr. D. P. Saste, CIRT, Pune
3. Dr. P. Chattaraj, NATRAX
4. Mr. Niteesh Shukla, IRMRA - Thane
5. Mr. T. C. Kamath, MRF Tyres
6. Mr. I. A. Joy, Apollo Tyres
7. Mr. Joan Puig, IDIADA - Spain



Panel discussion in progress

Panel discussion started with the address by the Chairman, Mr. Akbar Badusha, who introduced the topic and set the tone for discussion. The discussions included current status of GTR-16 and UN R 117. The panel also discussed the Indian perspective and need and objective of UN R 117. Tyre labeling in India, co-existence of IS standards and global regulations in certification were the topics of discussion as the session progressed. Panel members then responded to the queries from the Chairman and the audience, resulting in an interactive session.

Mrs. Rashmi Urdhwareshe, Director, ARAI

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