ARAI® Progress through Research Update

Transformation towards Progressive Mobility

Design, Development and Testing Services at ARAI

October 2022 – December 2022

New Capabilities / Development

- 2-Wheeler / Motorcycle Crash Testing Facility at ARAI
- AE-MDB Barrier Testing at ARAI
- Tractor Duty Cycle Fuel Consumption – Simulation Approach

Conferences / Workshops

- Conference on "Innovative Technologies and Regulations Governing Safety Glasses"
- 1-Day Workshop on "Advanced Material Model Cards for Damage Prediction"
- Symposium on International Automotive Technology, 2024 (SIAT2024)
- 25 years of Automotive Industry Standards Committee (AISC)
- International Conference on Automotive Materials and Manufacturing (AMM 2023)

❑ 2-Wheeler / Motorcycle Crash Testing Facility at ARAI

India currently has more than 210 million two-wheeler vehicle population. This number is more than 3 times that of the other vehicles. Every year this number increases by close to 1.5 crore as new 2-wheeler sales.

With electric two-wheelers becoming more reliable with each passing day, this number is further going to rise. However, motorcycle occupant safety has become a major cause of concern. MoRTH Report on 'Road Accidents in India 2021' indicates that motorcycle occupants contribute to 25.2% of total number of road accident fatalities.

Motorcycles / 2-wheelers, by virtue of design concept, do not have option of restraining occupants as in case of passenger cars. Occupant protection systems such as safety belts, crumple zone or airbags have little effect on occupant protection in two-wheelers as the occupant gets detached from the motorcycle immediately upon impact. Hence, motorcycle occupants have to rely on Personal Protective Equipment, most important being, helmets. Additionally, Full Body Jackets help in preventing lacerations and other minor injuries.

Due to above mentioned aspects, there are no mandatory occupant protection standards applicable for two-wheelers anywhere in the world. Regulatory requirements are applicable for wearing qualified helmets. However, International Standards Organization (ISO) has published ISO 13232-6: 2005 as a guideline standard. ISO 13232 specifies minimum requirements for research into feasibility of **protective devices fitted to motorcycles**, which are intended to protect the rider in the event of a collision.

This standard specifies minimum requirements for :

- paired comparison tests
- preparation of dummy, motorcycle and opposing vehicle
- repeatability and reproducibility of impact test conditions within and between test sites
- minimization of variation in secondary test variables
- realistic and representative impact conditions for full-scale impact tests and
- means to verify analytical evaluations of proposed rider crash protective devices fitted to motorcycles, such as computer simulation.

ISO 13232 is applicable to impact tests involving:

- two-wheeled motorcycles
- specified type of opposing vehicle
- either a stationary and a moving vehicle or two moving vehicles
- for any moving vehicle, steady speed and straight-line motion immediately prior to impact
- one helmeted dummy in normal seating position on an upright motorcycle
- measurement of potential for specified types of injury by body region
- evaluation of results of paired impact tests (i.e. comparisons between motorcycles fitted and not fitted with the proposed devices) and
- evaluation of inflatable / triggered protective device

In addition to above assessment of protection of occupants or first attendants from the **electrical hazards** after crashes will be additional criterion for consideration in the above referred ISO and other national requirements, if any.

ARAI has developed capability of performing crash tests on motorcycles / 2-wheelers at Crash Test Facility located at ARAI-Chakan Center. With this capability, various configurations as specified in ISO 13232 will be possible.

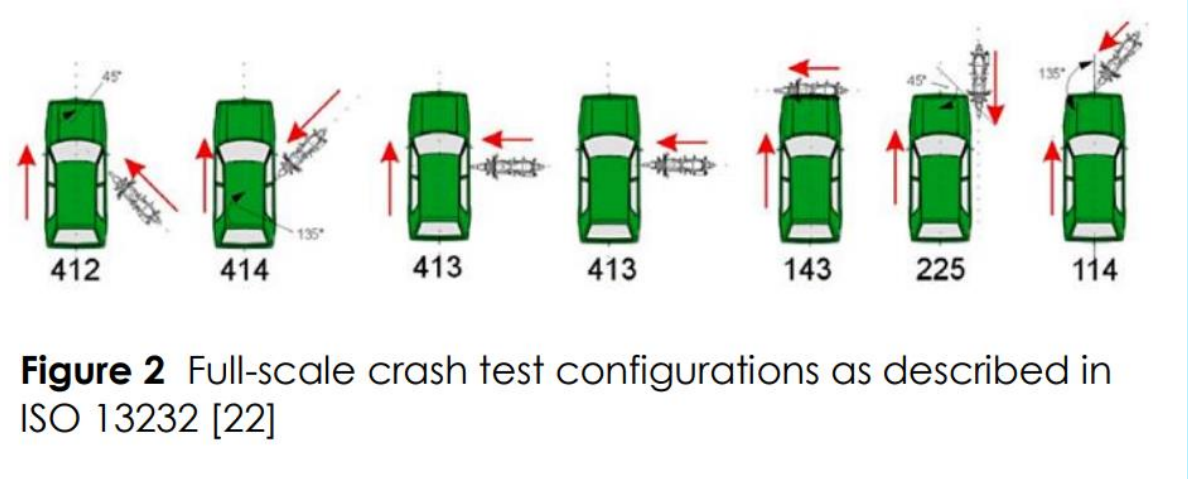


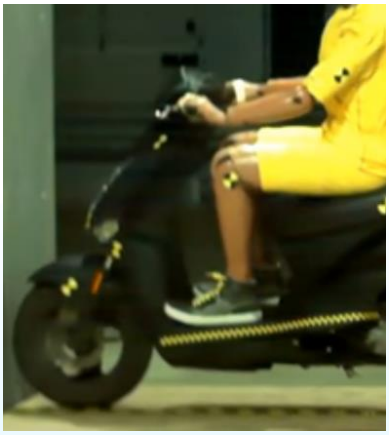
Figure 2 Full-scale crash test configurations as described in ISO 13232 [22]

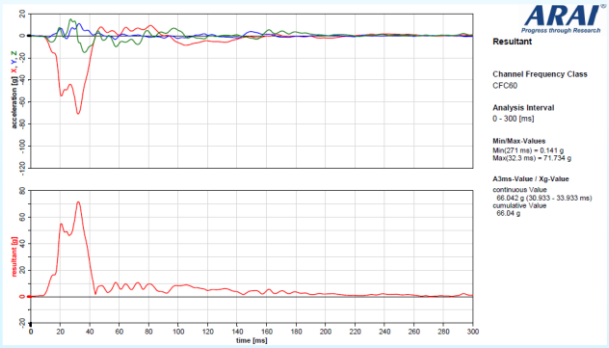
Crash Tests on EVs: ARAI successfully conducted 3 crash tests on an Electric Two-Wheelers against rigid barrier and a side pole. Primary objective of these tests was to investigate behavior of structure of the two-wheeler:

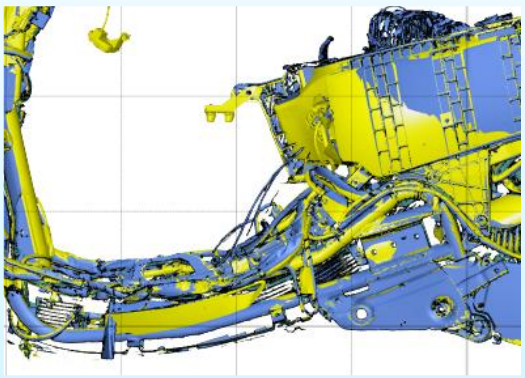
ARAI performed various measurements during the test, including:

- Assessment of deceleration on structure at various points using triaxial accelerometers
- Assessment of battery cut-off function and absence of high voltage immediately after tests
- Assessment of deformation behavior of the two-wheeler frame under load

2-Wheeler Crash test Set-Up and Measurements from Crash Tests







ARAI's capabilities are benchmarked against other global labs that take up such 2-wheelers crashes. The end-to-end service includes consultation, design of experiments, test conduction, recording of required critical data and detailed post-test analysis of battery pack (for electric two-wheelers).

❑ AE-MDB Barrier Tests at ARAI

In pursuit of providing state-of-the-art testing and evaluation services, ARAI has invested hugely on capability building to be at par with the renowned international test houses.

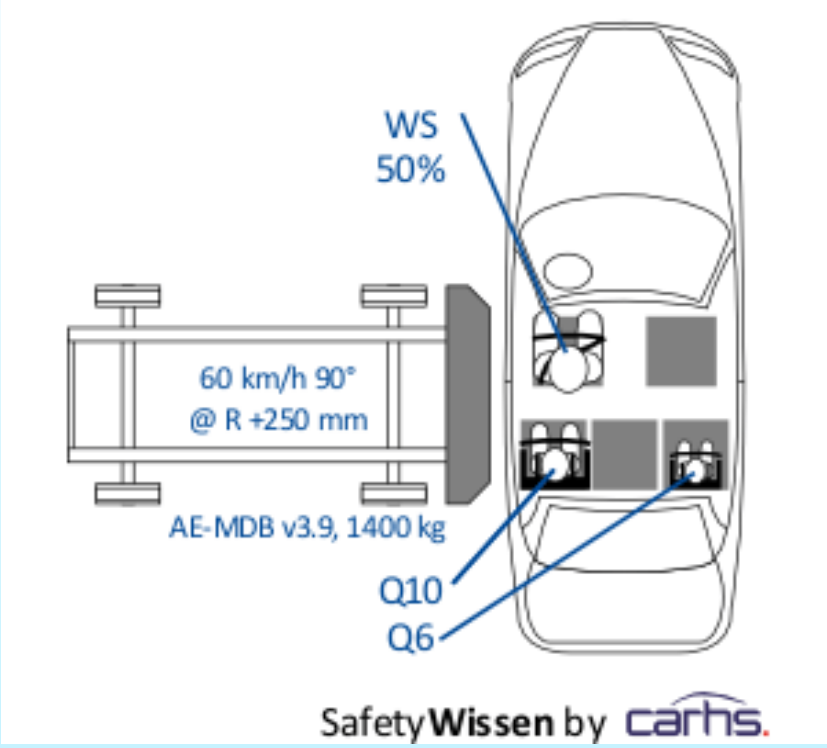
One such development is in-house development of AE-MDB Mobile Barrier (Advanced European-Mobile Deformable Barrier).

Starting 2015, European New Car Assessment Programme (Euro NCAP) updated its lateral crash test to replace the existing Mobile Deformable Barrier test (specified in UN Regulation No. 95) with a new and advanced AE-MDB Test (as per Euro NCAP technical bulletin 014). The update was centered around -

a. Adoption of a new Worldwide Harmonized Side Impact Dummy, viz. WorldSID

b. Representation or better reflection of front-end stiffness and heavier mass seen in today's passenger car fleet due to growing trend of SUV compared to that of the current legislative barrier face.

EuroNCAP specifies a 60 kph test for passenger vehicles with an AE-MDB barrier with a mass of 1400 kg and evaluates occupant protection offered by the vehicles using WorldSID dummies at front driver position and Q6 and Q10 child dummies at rear seating positions.



Over the years, AE-MDB Test has been adopted by various other NCAP programs such as Japan-NCAP, China-NCAP, Korea-NCAP and Australian-NCAP.

In India, currently, mandatory requirement of AIS099 specifies use of a 950kg Mobile Deformable Barrier with a honeycomb deformable element whose properties are as per UN Regulation No.95 with impact speed of 50kph. Proposed Bharat-NCAP also specifies the same barrier and test for occupant Protection Evaluation in Side impacts.

Successful development of such a mobile barrier and new test capabilities allow ARAI to not only take up routine certification tests, but also offer the OEMs an opportunity to test as per the latest EURO NCAP and other major NCAP protocols around the world.

This makes ARAI better equipped to take up projects from global automotive players, where such tests are standard requirement. This also serves the cause of the Make-in-India initiative where export vehicles manufactured in India can also be tested in India. This development also brings ARAI at par with other global test labs.

❑ Tractor Duty Cycle Fuel Consumption – Simulation Approach

Introduction

India is the world's largest market for farm vehicles, with its sales doubled from 2011 to 2022 and hit a record high of 9.5 lakh units in 2022-23, up 12% year on year, as per the industry estimates. Accordingly, agricultural sector is accounting for about ~13% of total diesel consumption in India (https://pib.gov.in/newsite/printrelease.aspx?relid=102799), i.e. approx. 11 MMT for 2022-23. As per IEA 2021 reports, energy demand is continuously increasing (about 4.6% increase in energy demand in 2021 as compared to 2019) which indicates that this scenario leads to increase in Green House Gases (GHG) furthermore. More than 196 countries agreed in COP-21 (2016 PARIS-Agreement) to limit the global temperature rise below 1.50 ^{o}C by controlling GHG. In line with the other developed countries, India also taken several initiatives such as electric vehicle policies, alternate fuels policies, encouraging renewable electricity production, etc. to reduce GHG gases by 33-35% of 2005 level by 2030. However, off-road transportation segment is typical segment, which will depend on diesel fueled prime movers for next one or decades. In this context, manufacturers are working on various technological improvements to reduce fuel consumption/CO_2 emission, which will also benefit in reducing overall fleet operational cost.

Fuel consumption reduction at single operating point at engine level may not reflect the actual duty cycle fuel consumption due to several combinations in the field such as type of operation, implement, soil nature, climate, driving conditions, etc. To estimate the tractor duty cycle fuel consumption, there is standard methodology available like in heavy commercial vehicles. EUROPE has developed HCVs' real drive fuel consumption methodology using simulation approach, viz. VECTO procedure. Similar approach is required for tractors for India to calculate fuel consumption calculation through simulation. ARAI is extensively working in this direction to establish methodology to support tractor industry to prediction duty cycle fuel consumption using simulation approach and use the same for R&D purpose. This approach helps in identifying potential areas for improvement in fuel economy and parameter-wise contribution in CO_2 emissions.

Complexity in Tractor Real Drive Fuel Consumption: Tractors are generally associated with farming, as farmers use them alongside machinery to perform operations like ploughing, tilling, sowing, harrowing, harvesting, haulage, water bowser, ripper machine, etc. Additionally, tractor is used for pushing or pulling the machinery. More than 150 implements are being used for different applications in India and variation in soil characters continuously shift the engine operating zone. Most commonly used implements are given in the following below figure,

Plough

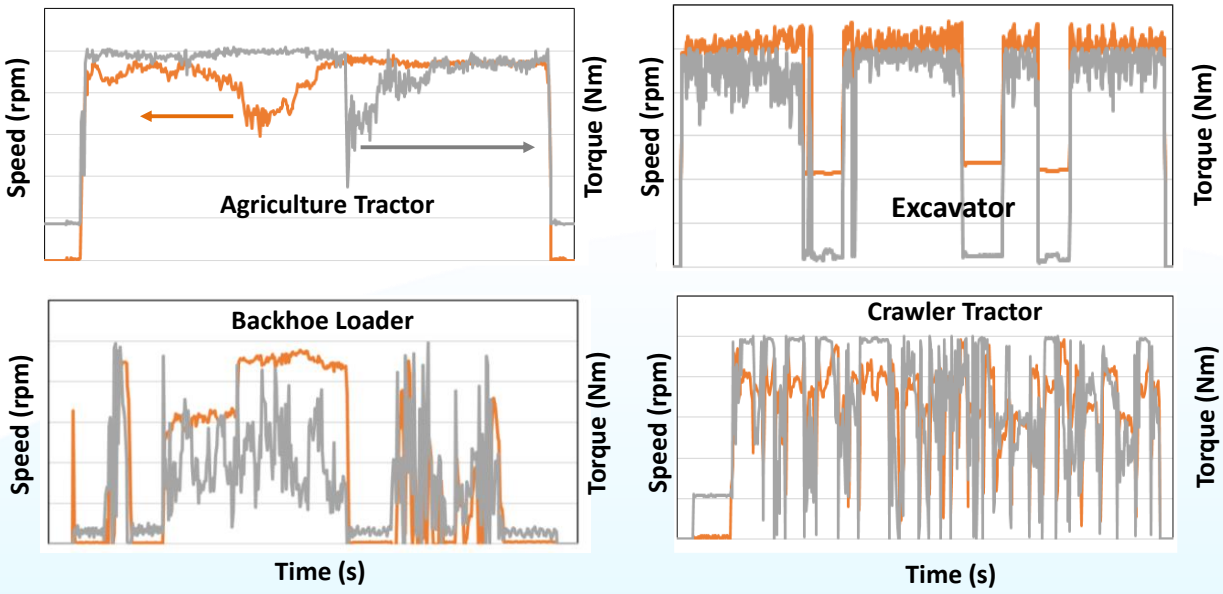
Harrow

Cultivator

Haulage

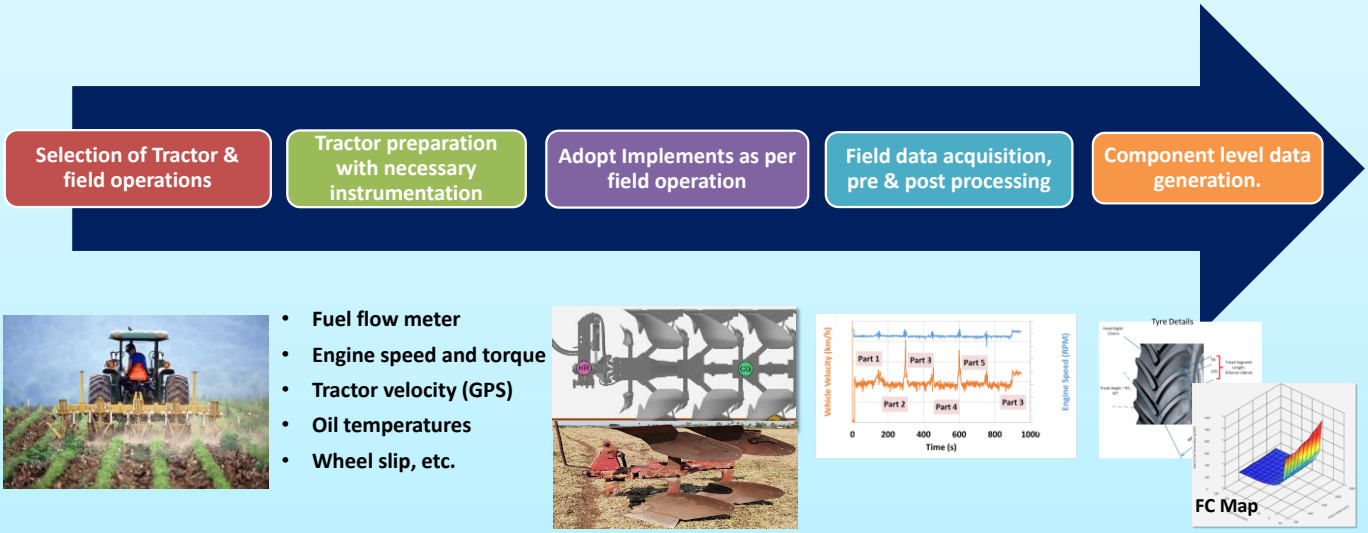
Critical approach for data acquisition for tractor simulation model:

For Off-road vehicles no such methodology exists to measure Duty Cycle Fuel Consumption (DCFC). Implement changes with change in operation and soil characteristics change with the change in ambient conditions. This makes DCFC calculation as a complex phenomenon. Below duty cycle data shows variations in speed and torque with different operations.



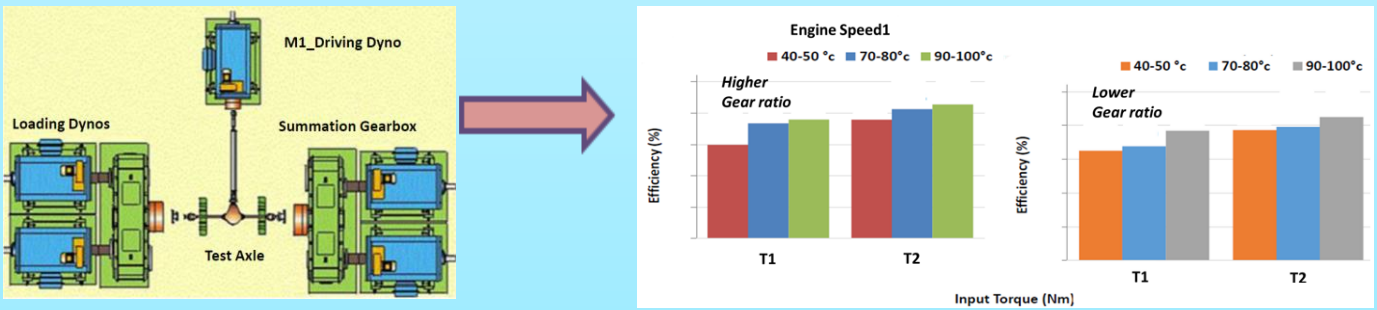
Considering the complexities and challenges involved, ARAI executed R&D project and formulated the procedure to calculate tractor real drive cycle fuel consumption using simulation approach. Combination of mathematical and empirical approach is inherently followed in simulations, thus leading to reduced testing time and cost.

Critical approach for data acquisition for tractor simulation model:

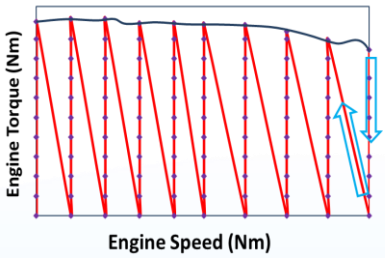


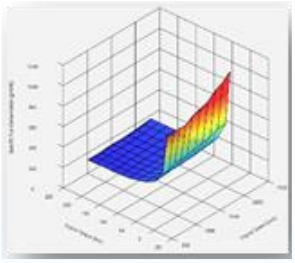
Component Level Data Acquisition

Transmission Efficiency Mapping

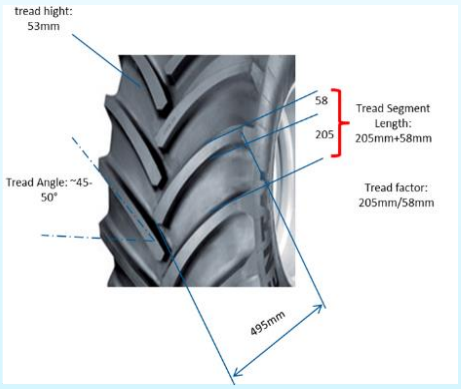


Engine Efficiency Mapping: Engine fuel efficiency and friction mapping carried out as per VECTO



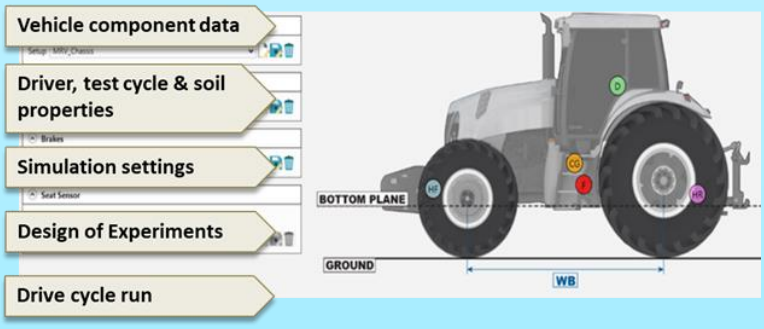


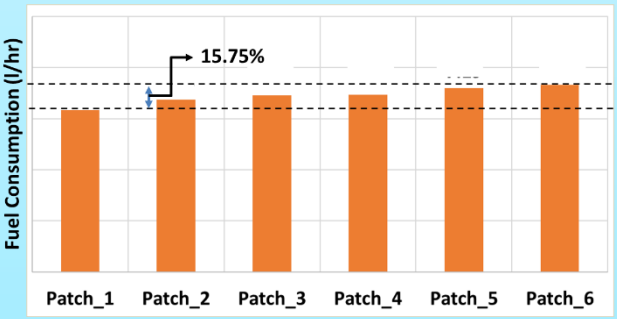
Tyre, Implement and ploughing details: To prepare tractor model in simulation, both implements and ploughing details are required for validation. Accordingly, during the field trials we have physically measured tyre, implement and ploughing details.



Implement used for ploughing

Simulation Model Built using AVL-VSM Software: We have built a simulation model using data generated from field trials and component testing. Duty cycle fuel consumption calculated for 6 different patches within reasonable agreement. In the same field, changes in soil parameters observed from patch to patch and more accurate soil parameters will give good agreement with measurements. Variation in fuel consumption between patch_1 to Patch_6 is mainly due to variations in change in soil nature from patch to patch. Variation in fuel consumption between patch 1 to Patch 6 is mainly due to variations in change in soil nature from patch to patch, which pose huge challenge on repeatability of FC. Also, properties, which are very different from Studies, are further taken up for bridging the gap in simulation and real-world FC along with parameter sensitivity study.





ARAI offers following services to the Tractor Industry:

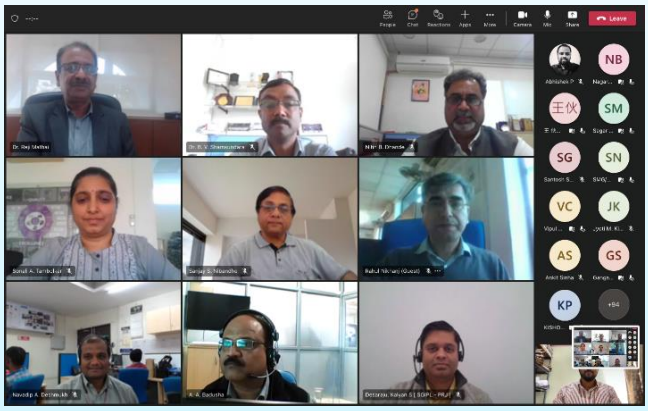
- Field data acquisition and analysis
- Instrumentation support for field trials
- Component level testing
- Simulation support for development

❑ Conference on “Innovative Technologies and Regulations Governing Safety Glasses” - 30th November 2022

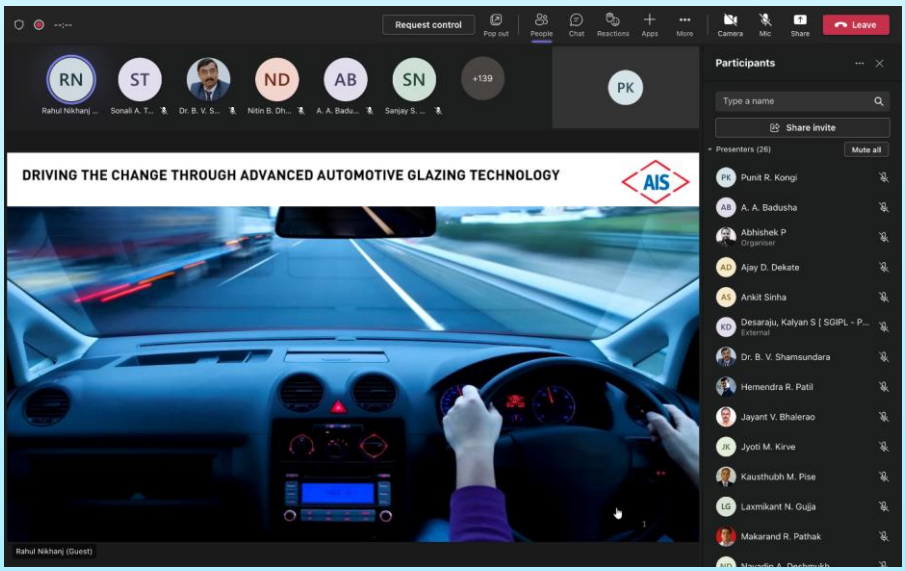
ARAI and SAEINDIA - Western Section, had jointly organized Conference on “Innovative Technologies and Regulations Governing Safety Glasses” on 30th November 2022, with an aim towards sharing of knowledge on new trends, regulations and upcoming QCOs in safety glasses. The Conference witnessed participation of 225 delegates from the industry as well as Academia.

This conference was a Congress of the best minds in the industry with the participation of the representatives of vehicle manufacturers (2-Wheeler, 3-Wheeler, 4-Wheeler, Tractor, Construction Equipment Vehicle and Electric Vehicle), Safety Glass Manufacturers, Bureau of Indian Standards (BIS) and Test Agencies.

This event was inaugurated by Dr. Reji Mathai, Director - ARAI, in the presence of Shri N. B. Dhande, Shri A. A. Badusha, Shri S. S. Nibandhe and Dr. B. V. Shamsundara.



Shri Rahul Nikhani (Head – Production Technology, Asahi India Glass Ltd.) made a presentation on “Driving the Change through Advanced Automotive Glazing Technology”



Shri Rakesh Kumar (Scientist D, Central Marks Department, New Delhi), in his presentation on “Implementation of QCO Order for Safety Glass for ISI Marking in India”, elaborated the process of obtaining ISI marking, giving information on the latest product manual.

Mrs. S. A. Tambolkar, (General Manager - ARAI), presented the “Testing Requirements for Safety Glass”. In her presentation, she touched upon relevant testing standards for Automotive and Non-Automotive Glass applications. Testing requirements were explained in detail for IS 2553 (Part 1) – 2018 and IS 2553 (Part 2) - 2019.

Shri Kalyan Desaraju (Team Leader-Special Projects, Saint-Gobain India Pvt. Ltd., Sekurit Business) made a presentation on the topic “Trends in Safety Glass Technologies for Automotive Applications”.

Shri Hemant Lohar, Manager – Mobility, TUV Rhineland (India) Pvt. Ltd., addressed the gathering on “Overview of Global Regulations for Safety Glass”. He explained the requirements and certification process followed in different countries. which helps safety glass manufacturers to understand the requirements of exports.

In summary, we have received encouraging feedback on the technical contents of the presentations made in the Conference.

Mrs. S. A. Tambolkar presented Vote of Thanks, expressing gratitude to the hosts for successful organization of the event and to the presenters for interesting and useful coverage in their presentations as well as to the participants for making the event more meaningful.

❑ 1-day Workshop on “Advanced Material Model Cards for Damage Prediction”

Fatigue & Materials Center of Excellence (FMCE) of ARAI had organized Workshop on **“Advanced Material Model Cards for Damage Prediction”** as 6th episode of its customer-connect program ‘SAMVAAD’. This topic was chosen to create awareness in the industry as it is one the emerging techniques, which yields good results in CAE simulations.

Material Model Cards deal with quantification of physical material properties (i.e. ability of material to respond to physical influences). It is a mathematical representation of functional relationship between the material behavior and the physical influence (such as loading conditions, state of stress, etc.). ARAI team is working on developing various material model cards for accurate prediction of material behavior and damage prediction in complex loading conditions. These cards play an important role in design of components, optimization and various test simulations. This method helps accelerate product development cycle by simulating multiple iterations with various materials until the desired results are achieved.

Attendees were from various domains such as CAE experts, Material Selection Team, Validation Engineers, etc. The session was inaugurated by Mrs. Medha Jambhale, Head of FMCE Dept. where she opened up the idea of the need for advanced material characterization. This was followed up by Keynote Presentation by Mr. Pratap Daphal, Deputy General Manager– Tata Motors Ltd. He highlighted use of material model card in crash simulation applications and also briefly explained about the physical validation of these cards with some basic test rigs.

Next session was taken by Mr. Suhail Mulla, ARAI on “Development of material model cards: ARAI capabilities”. He explained the methodology and step by step process for formulation of material model cards, such as GISSMO in LS Dyna. Final session was taken by Mr. Saurabh Deshpande of ARAI on “Need and usage of material model cards”. He spoke on the application of these cards in virtual workspace and regarding the choice of cards as per end requirement.

More than 50 delegates from various industries as OEM, Tier 1 manufacturers, material manufacturers as well as non-automotive industries participated in the workshop. The event received encouraging feedback in all respects specially the lab visits and live test demo. The workshop succeeded in accomplishing its purpose of knowledge sharing and providing a platform for exchange of thoughts between the experts and the participants.

During the discussions, participants and experts highlighted necessity of databank of material model cards of advanced materials readily available. This will increase availability of immediately deployable resources at economical costing. Considering this requirement, ARAI is coming up with the project on Generating Databank of GISSMO Material Model cards (MAT_024 with MAT_ADD_Erosion). In the first stage, eight AHSS and / or aluminum alloys will be undertaken.

Also, there was significant participation of engineers working in Plastics and composite materials. They emphasized on increasing demand of material model cards for these materials. ARAI is also taking up this activity as internal competency building project.

The industry participation is sought for these projects. ARAI will soon come up with more details.

Symposium on International Automotive Technology (SIAT), widely acclaimed by the global automotive fraternity, is a benchmark biennial international event, organized by ARAI, that serves as a platform for exchange of ideas and brainstorming for the automotive industry, with participation of eminent worldwide experts in various automobile arenas.

We are delighted to announce 18th edition of SIAT, viz. SIAT 2024, being organized by ARAI, in association with SAEINDIA and SAE International in Pune (India), from **23 – 25 January 2024** with a concurrent SIAT EXPO 2024.

Theme of SIAT 2024 is **"Transformation towards Progressive Mobility”.**

First Announcement and Call for Papers was released at the auspicious hands of Dr. Mahendra Nath Pandey, Hon'ble Minister for Heavy Industries, Government of India, on 19th January 2023 at Pune.

Upcoming SIAT will witness presentation of over 200 technical papers, including keynotes, on futuristic topics, by the renowned experts, world-over. These papers will be published in the form of Symposium Proceedings. In addition to the Symposium Proceedings, Technical Reference Bulletin, containing technical articles, case studies, products / services information, etc. will be published.

The concurrent SIAT EXPO 2024 would offer appropriate platform for spectrum of worldwide companies to showcase their products / technologies / innovations / services through various stalls.

TOPICS OF SIAT 2024

- Active and Passive Safety
- Advanced Powertrain Technology
- Agriculture Tractors
- Autonomous Vehicles
- Construction Equipment Vehicles
- Emission Measurement & Control Technology
- Harmonization of Regulations
- Intelligent Transportation Systems (ITS)
- Noise, Vibration & Harshness (NVH)
- Simulation & Modelling
- Testing & Evaluation
- Vehicular Electronics
- Advanced Driver Assistance Systems (ADAS)
- Advanced Vehicle Dynamics
- Alternative Fuels
- Automotive Lighting
- E -mobility
- End of Life & Recycling
- Hydrogen Fuel Cell and Hydrogen I.C. Engine
- Materials & Manufacturing
- Public Transportation Systems
- Structural Reliability
- Tyre Technology
- Vehicular Systems

CALL FOR PAPERS

Abstracts of technical papers in respective topics as mentioned in First announcement should reach the Convenor at siat2024@araiindia.com on or before 30th April 2023. Simultaneously, authors should upload abstracts on below link under MyTech Zone.

The abstract submission link, please click here: MyTech Zone

Important Dates for Technical Paper submission:

• Receipt of Abstracts	30th April 2023
• Acceptance of Abstracts	30th May 2023
• Receipt of Manuscripts	16th August 2023
• Receipt of Final Papers with editorial correction	31st October 2023

For more information, please go through the link given below,

SIAT24 First Announcement

❑ 25 years of Automotive Industry Standards Committee (AISC)

Automotive Industry Standards Committee (AISC) was formulated by Ministry of road Transport and Highways in the year 1997. AISC, under the Chairmanship of Director-ARAI, has played a key role in development of Automotive Industry Standards. To mark the 25 years of contribution of AISC in standard formulation activities an event was organized by ARAI, AISC Secretariat, on 29th November 2022, to acknowledge the contribution of member organizations and various experts. During the event past Chairpersons, key contributors and Panel Conveners were felicitated. This memorable event was attended by the members from different test agencies, viz., Indian Institute of Petroleum, Central Institute of Road Transport, International Centre for Automotive Technology, Global Automotive Research Centre and National Automotive Test Tracks (NATRAX) and different member organizations, viz. Bureau of Indian Standards, Society of Indian Automotive Manufacturers, Automotive Component Manufacturers Association, The Tractor and Mechanization Association (TMA), Indian Construction Equipment Manufacturers' Association (ICEMA), Automotive Tyre Manufacturers Association and Indian Tyre Technical Advisory Committee. Present Chairman, Dr. Reji, Mathai, Past Chairpersons - Mr. B Bhanot, Mrs. Rashmi Urdhwareshe; Head of Test Agency, Shri K. V. R. K. Prasad Director-CIRT, Industry leaders, Shri P. K. Banerjee, SIAM; Mrs. Seema Babal, ACMA; Shri S. S. Gussain, ATMA & ITTAC, key contributors Shri S. Ravishankar, Shri D. P. Saste and Shri A. A. Badusha presented their views on the past work and the future ahead.

The Committee also acknowledged the support and key contributions of various officials from Ministry of Road Transport and Highways who have been proactively contributing and supporting towards the standard formulation activities.

Veterans were delighted to share their memories of the work done by the Committee to address crucial subjects in time bound manner. The event was well received and cherished by all the stakeholders.

❑ International Conference on Automotive Materials and Manufacturing, 2023 (AMM 2023)

ARAI, in association with SAE India and ASM International (Pune Chapter), is organizing fourth edition of International Conference on Automotive Materials and Manufacturing, 2023 (AMM 2023) at ARAI–Homologation Technology Center (HTC) at Chakan, Pune from 31st May to 2nd June 2023.

The central theme of the Conference is **"Shaping Progressive Mobility through Emerging Materials & Manufacturing Technology".**

AMM 2023 will bring together industry leaders and technocrats in the field of materials and manufacturing technologies from automotive, defense and aerospace industries to discuss various subjects such as advanced materials, plastics and composites, manufacturing processes, additive manufacturing, e-mobility, design and simulation, Industry 4.0, AI / ML, etc.

In this Conference, eminent speakers, like Dr. Ajit Sapre (Reliance Industries Ltd), Ms. Debbie Aliya (Aliya Analytical, USA), Dr. Rajkumar Singh (KCTI- Bharat Forge Ltd), Dr. Alankar (IIT – Bombay), Mr. Akella Sarma (M&M), Mr. Sagar Dhamorikar (Hindalco), Mr. A.L.N. Rao (Exigo Recycling), Mr. Sreekanth Rao (Collins Aerospace) and many more will be sharing their expertise, thoughts and experiences with the audience.

Additionally, 45 contributory papers from renowned industries (Tata Motors, Mahindra & Mahindra, Ashok Leyland, Hyundai, BEML, Tata Steel, Inteva Products, Eaton, i3, Mahle Thermal, Valeo Alleima EMEA AB, MacDermid Alpha Electronics, etc.). Research Institutions (ARAI, HASETRI, CECRI) and Academia (IIT- Bombay, Kanpur, Hyderabad, Madras and Bhilai, VIT, SVNIT, etc.).

The conference will also host Panel Discussion revolving around the theme of the Conference.

An Exposition, viz. AMM Expo 2023, is also organized concurrently. Over 25 exhibitors will be showcasing their products, processes and technological innovations in this Expo. Panatech Asia, Saraswati Dynamics, Jost's Engineering, Conation Technologies, Cenergy Offshore, Envysis, STPL, Hexagon are some of the exhibitors.

This conference offers unique opportunity to the technocrats for networking, exchange of ideas for meeting the challenges ahead.

Dr. Reji Mathai, Director, ARAI
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ARAI®
Progress through Research

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