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SRESA Newsletter

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Editors
Prabhaka V. Varde
P. Vaishnavi

SRESA Mission

Establishing the Sixth SRESA Chapter in Mumbai officially named as the 'SRESA Anushaktinagar Mumbai Chapter' is, an important milestone in SRESA's journey as part of its national outreach initiatives.

Apart from this, work on initiating a new project for 'Developing a Probabilistic Risk Assessment (PRA) application software' has been at discussion stage. Already, approval of General Body has been obtained. Further, activities are in progress.

From President's desk ...

I sincerely thank, on behalf of the SRESAmc and on my own behalf – the SRESA Chennai Chapter team for successfully organizing the 5th NCRS in virtual mode during March 10 – 12, 2022. I am sure this will inspire other SRESA chapters to initiate regional activities in the area of risk and reliability of national importance.

I am delighted to share with you that SRESA has been working on a very ambitious project. The objective is to setup an institute of national importance with the theme of risk and reliability. Accordingly, the institute has been provisionally named Indian Institute of Risk and Reliability – IIRR. The IIRR has two major aims. One, to performs research and developments in the area of risk and reliability for meeting aspiration of researchers, academicians and industries, Second, to run academic programme starting from B.Tech, M.Tech. and Ph.D. and finally advanced research in risk and reliability. Apart from regular branches of engineering, it is proposed to set up special wings to have multidisciplinary program in simulation, artificial intelligence, human factor, humanities, risk aspects for societal systems including security risk etc.. At present SRESA is actively working on developing a project report for the IIRR.

Prabhakar V Varde

In this issue ....

A Report on National Conference on Reliability and Safety (NCRS 2022) held virtually during March 10-12, 2022

Raghu V Prakash, K. Balaji Rao, C. Senthilkumar and R. Sujatha

The 5th NCRS conference was organized by Society for Reliability and Safety (SRESA), Chennai Chapter & Centre of Excellence on Safety Critical Systems, IIT Madras in association with Indian Institute of Risk and Reliability; CSIR-SERC, Chennai; Shiv Nadar University, Chennai; and Centre for Reliability, Chennai. The conference was held virtually through ZOOM application during Mar 10-12, 2022 and conducted between 1500 h – 1930 h on all three days. Dr. N. Anandavalli, Director, CSIR-SERC was the Chief Guest of the Inaugural program on the March 10, 2022 afternoon, which was presided by Dr. P. V. Varde, President, SRESA. The highlight of the inaugural was the commemoration of the 10th year of SRESA's Journal of Life Cycle Reliability and Safety Engineering, now published by Springer and the release of the book of NCRS-2022 abstracts.

Each keynote lectures were followed by two technical sessions conducted in parallel. The technical sessions covered wide area of topics that included Probabilistic safety assessment (PSA), Risk informed approach to decision making, structural reliability & health monitoring, life prediction & prognostics, Fuzzy & digital system reliability, Artificial intelligence & Machine learning techniques for life prediction, human reliability, uncertainty & sensitivity analysis and intelligent approaches in risk engineering. 44 oral presentations were made by authors representing various organizations and premier institutes such as BARC, CSIR-SERC, AERB, NPCIL, other CSIR laboratories, IITs, IISc, Anna University, SSN College, to name a few.

Salient observations from some of the technical presentations are given below:

Technical session on PSA covered important areas such as Experiences with deterministic safety assessment of existing nuclear power facilities, multi-unit PSA, application of PSA in nuclear and space sectors, novel techniques for human reliability, etc.

Sl. No.	Keynote Speaker	Topic
1	Prof. P. K. Kapur, Amity University, Noida	Modelling Peculiarities in Software Reliability vis-à-vis Interdisciplinary Research
2	Prof. Bernard Rolfe, Deakin University, Australia	Adventures in Bending: Uncertainty in forming Ultra High Steel when light weighting automotive vehicle structures
3	Prof. Jezdimir Knezevic, MIRCE Akademy, UK	MIRCE Science Approach to the Royal Reliability Challenge
4	Prof. C.S. Manohar, IISc	Laboratory testing for estimating the reliability of vibrating structures
5	Prof. Baidurya Bhattacharya, IIT Kharagpur	Deriving target reliabilities from socio-economic considerations: a well-meaning but impractical approach to design?
6	Prof. Subrata Chakraborty, IIEST, Shibpur	Adaptive Support Vector Regression Based Metamodel for Reliability Analysis of Structure

The presentation on 'Probabilistic modelling of non-gaussian wind induced peak pressures on a model of tall building' focused on different parameters to be considered in estimating the wind induced pressures in the flow separated regions of tall buildings. Application of improved variants of Hermite Polynomial Model to ascertain the peak factor was explained. Such data driven HPMs based peak factors provide rational estimation of peak effects, close to that of observed values in scaled down models.

"Application of Probabilistic Risk Assessment Approach in Nuclear Power and Space Sectors": With a brief explanation of PRA in NPPs, the presentation focused on PRA implemented by NASA in the operational phase of human space flight programs. The paper covered how PRA has evolved in space applications and as a requirement during the design phase of NASA's next generation manned space vehicles as well as for high priority robotic missions.

"Development of Multi-unit PSA": the importance of multi-unit PSA was brought out and a framework developed to perform a PSA at a multi-unit nuclear plant site was explained. Various factors such as modelling of shared systems/components, interaction effects, inter and intra human error contributions, etc. were explained. Summary of case study results and important factors to be considered while performing a multi-unit PSA were highlighted.

"Subset simulation incorporating replica-exchange algorithm for structural reliability estimation": The treatment of limit surfaces in complicated geometry of multiple disconnected regions in structural reliability modelling was discussed. The need for Monte-Carlo simulation based methods and its limitation were highlighted. The importance and benefits of subset simulation to effectively explore the sampling domains for structural reliability estimation was explained.

"Human reliability analysis of a high-impact aeronautical situation using a second generation HRA technique": The importance of human operators for smooth performance of flight operations was discussed and methods for quantify human reliability to improve operation performance was explained with a case study of mid-air collision of two aircrafts. Application of CREAM HRA method for such scenarios was explained.

"Development of Conscious-based Human Model in support of Human Reliability Analysis for Safety Critical Systems": Different HRA methods available for safety critical applications were compared highlighting the difficulty of modelling complex subjects like cognition, context, environmental and operations stress. Risk based approach for a realistic human reliability considering risk-conscious culture for normal as well as emergency conditions to reduce uncertainties in HRA modelling was explained.

"Estimation of System Resilience through Independent Parameter Transient Profile": Resilience is defined as measure of a system's ability to absorb continuous and unpredictable change and still maintain its vital functions. The presentation introduced Resilience engineering as a relatively new paradigm for safety management to focus on how to cope with complexity under pressure or disturbance to achieve success, addressing the limitations of existing safety analysis measures. The presentation highlighted the importance of resilient model and its application in NPPs.

In a nut-shell, the NCRS 2022 conference, the Fifth conference in the NCRS series of SRESA, organized by the Chennai Chapter of SRESA - provided a forum for sharing of knowledge by peers and exchange of ideas to young researchers. The participants of this conference were quite impressed by the quality of talks presented at the conference and felt the need for future research in the domains of risk and reliability spanning several domains of practical applications related to safety critical systems. Peer review of draft manuscripts submitted to NCRS2022 conference proceedings is in progress. The delegates looked forward a future in-person conference.

The conference team wishes to place on record the gratitude to several organizations that helped in smooth conduct of this NCRS-2022, such as: IIT Madras, CSIR-SERC, Chennai, Shiv Nadar University. Chennai, Center for Reliability, Chennai, apart from sponsors for the conference such as RelSafe Consulting as Platinum sponsor and other sponsors. The support received from the Advisory and Technical committee comprising of experts from Academia and Industry as well as from other SRESA chapters and Executive Council members is gratefully acknowledged.

Development of a high-pressure facility for assessing internal leakage in a telescopic hydraulic cylinder

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1. Introduction

To meet an ever-increasing demand for compact hydraulic machinery that offers high power-to-weight ratio in a space constrained system, the multi-stage hydraulic cylinders have emerged as innovative solutions. A multi-stage cylinder is an extension of single-stage hydraulic cylinder that consists of two or more hollow concentric cylinder tubes and a piston rod. These hollow concentric tubes make it ~30-40% shorter in the fully retracted or fully extended position compared to single-stage cylinders. Also, the same slenderness ratio, multi-stage cylinders can handle loads which are significantly higher compared to that of single-stage hydraulic cylinders. . In the Indian context, these multi-stage cylinders are used in MLC-70 class bridges developed by Defence Research Development Organization (DRDO). A few of them include Arjun BLT, SARVATRA, etc. Multi-stage cylinders are also widely used in space and military applications like missile holding platforms. Day-to-day usage of multi-stage cylinders can be observed in tippers,

trucks, trolleys of high capacity etc. As the number of stages of telescopic cylinder increases, it also increases the number of intermediate pistons . Since the pistons are wrapped by inter-stage piston seals and the guide seals that run under tight tolerances of 300-400 microns, the geometrical complexity of the telescopic cylinder increases. This is in turn makes a multi-stage cylinder more prone to wear. This ultimately degrades the performance of the hydraulic cylinder and the associated system. Literature search reveals that there is dearth of data on performance prediction of telescopic cylinders under leakage fault conditions. Although a few of the studies [1-3] have probed leakage fault in cylinders, they have been limited to single-stage cylinders where the leakage was simulated artificially via the use of by-pass lines, which does not represent the actual scenario of worn out seals.

A telescopic cylinder (2-stage hydraulic cylinder) based test rig is developed in the System Dynamics Lab at the Indian Institute of Technology Indore, India. This rig monitors the internal leakage by acquiring various parameters of the hydraulic system, namely pressure, flow rate, temperature, etc. The lab is actively working on condition monitoring of hydraulic systems and their associated components viz., hydraulic cylinders, axial piston pumps etc. The lab concurrently focuses on developing the model and the data-driven methods for condition monitoring of hydraulic systems. Here, in this newsletter, one of the recently developed hydraulic test rigs is introduced. This test setup can test the hydraulic system under different loading conditions. These loading conditions include ramp, square, absolute sinusoidal wave loading, etc. It is also capable of inducing the transient impulse loading condition, which is one of the most encountered loading conditions in practice and responsible for initiation of faults in cylinders. The system also facilitates the options for conducting experiments at different working pressure values and cycle times. Fig. 1 shows an isometric view of the telescopic cylinder (green in colour) and the loading cylinder (pink in colour) connected through a load cell (red in colour).

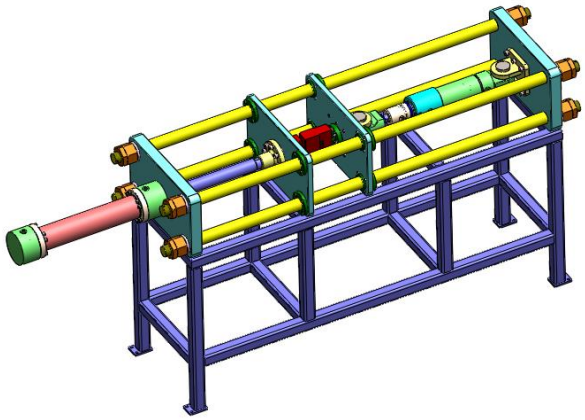

Fig. 1 Isometric view of the telescopic cylinder and loading cylinder of the test rig

2. Experiments and results

The experiments have been conducted to assess the difference in the working condition and the parameters under healthy and faulty conditions (internal leakage). The leakage is induced by grinding the seal to an extent. Two leakage conditions are induced to simulate moderate and severe leakage conditions. The pressure signals are acquired from both cylinder stages at a sampling frequency of 10 kHz. The maximum working pressure of the rig is 210 bars. Fig. 2 shows the acquired pressure signals for a complete cycle (extraction and retraction). Pressure transducer-1 (PT-1) is installed in the piston less section of the cylinder, whereas pressure transducer-2 (PT-2) is installed on the piston side of the cylinder to observe pressure variation in both stages of the cylinder. Fig. 2 illustrates two stages during extraction (see PT-1 sensor data) and retraction (see PT-2 sensor data) for the ramp wave loading condition.

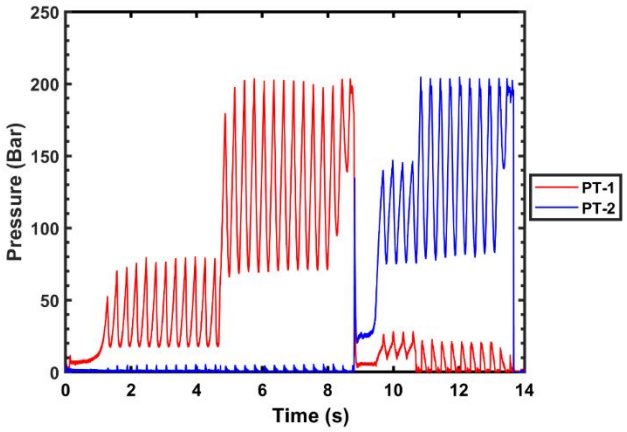

Fig. 2 Pressure variation in telescopic hydraulic cylinder for the healthy condition

The loading cylinder is connected to a proportional relief valve that stimulates different loading conditions by virtue of its property to provide the change in output pressure and flow in the same ratio as it receives the input. The change in the input is being supplied to it by a dedicated programmable logic controller (PLC). The test rig can simulate real-life loading conditions to a close match.

Fig. 3 shows the variation of mean and kurtosis values of the pressure signals for PT-1 under different working conditions. As the intensity of leakage increases, the mean working pressure decreases by approximately 17-20% for the moderate and ~40% for the severe leakage condition, respectively. Fig. 3 shows another line graph that shows the variation of kurtosis, a sensitive statistical fault indicator on the secondary axis. Kurtosis is the fourth moment of the statistical indicator, and the details can be found in references [4-5]. The numerical value of kurtosis for healthy conditions lies around 3, which is also observed in this case. As the leakage dominates, the kurtosis also attains lower values and thus indicating the presence of faults in the cylinders. The experimental study indicates that as the cylinder develops leakage, the working pressure drops significantly, and the time taken for the extraction and retraction of the cylinder increases proportionally i.e., the cylinder movement in response to the applied load develops a lag.

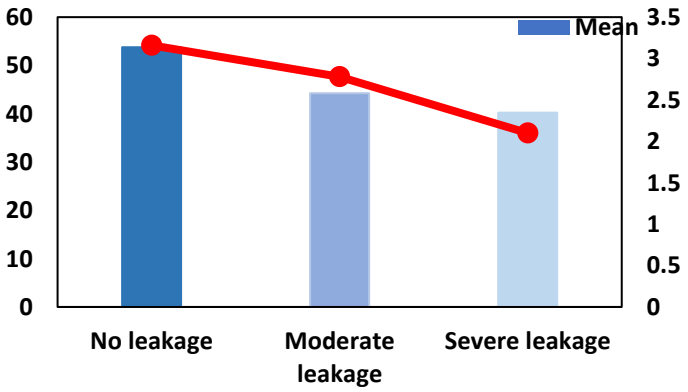

Fig. 3 Mean and kurtosis for increasing severities of leakage in telescopic hydraulic cylinder

3. Conclusions

This article presents the key features and functionality of a high-pressure experimental facility that is developed for leakage fault diagnosis of a telescopic hydraulic cylinder under different loading conditions. The effects of internal leakage on the statistical parameters of the pressure signals are presented and it is demonstrated that the mean working pressure drops to ~40% and kurtosis decreases to ~35% of the healthy condition under severe leakage conditions.

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Authors Profile

Mr. Jatin Prakash is a research scholar in System Dynamics Lab in the Department of Mechanical Engineering at Indian Institute of Technology Indore. He completed his Masters' from PDPM IIITDM Jabalpur in 2018. Since 2019, he's pursuing his Ph.D. He has been awarded the SERB-Overseas Visiting Doctoral Fellowship in 2019-20 to carry out part of his Ph.D. research at University of Alberta, Canada. The results presented in this article are part of Mr. Parakash's Ph.D. work. His research interest includes hydraulic system, fault diagnosis and machine learning for engineering applications.

Dr. Ankur Miglani is an Assistant Professor in the Department of Mechanical Engineering at Indian Institute of Technology Indore since 2019. Before this, he has served as a SERB Indo-US Post-doctroal fellow at Purdue University, USAand Brain-Korea 21 Postdoctoral fellow at Korean Advanced Institute of Science and Technology (KAIST), South Korea. Dr. Miglani obtained his Ph.D. from Indian Institite of Science (IISc), Bengaluru, India in 2015. His research interests include health monitoring of high-presure fluid systems and application of functional droplets to industrial processes. He currently heads the Microfluidics and Droplet Dynamics Lab at IIT Indore.

Dr. Pavan Kumar Kankar is an Associate Professor in the Dpartment of Mechanical Engineering at Indian Institute of Technology Indore since 2018. Prior to this, he was an Assistant Professor in the Department of Mechanical Engineeirng at PDPM IIITDM Jabapur, India. He is having more than 17 years of teaching and research experience. Dr. Kankar obtained his Ph.D. from the Mechanical and Industrial Engineering Department at Indian Institute of Technology Roorkee, India in 2011. His research interests include vibration, design, condition monitoring of mechanical components, nonlinear dynamics, soft computing etc. He has established System Dynamics Lab at IIT Indore. Dr. Kankar is a member of Editorial Board of Springer Journal "Life Cycle Reliability and Safety Engineering". He is fellow member of International Institute of Acoustics and Vibration, USA. He is a member of various professional bodies like American Society of Mechanical Engineers, Society for Reliability and Safety (SRESA), Tribology Society of India.

SRESA Welcomes New Members

In the SRESA's 2nd Managing Committee meeting held held on May 12, 2022, Life Membership of following members has been approved . SRESA takes pleasure in welcoming the new Members. There are 11 Life Members from from one institution the Graphic Era University, Deharadun, Uttarakhand, under the leadership of Prof. Mangey Ram have joined SRESA. It is heartening that with this group membership SRESA has its presence in Uttarakhand State also. Following is the list of new members along with a brief resume

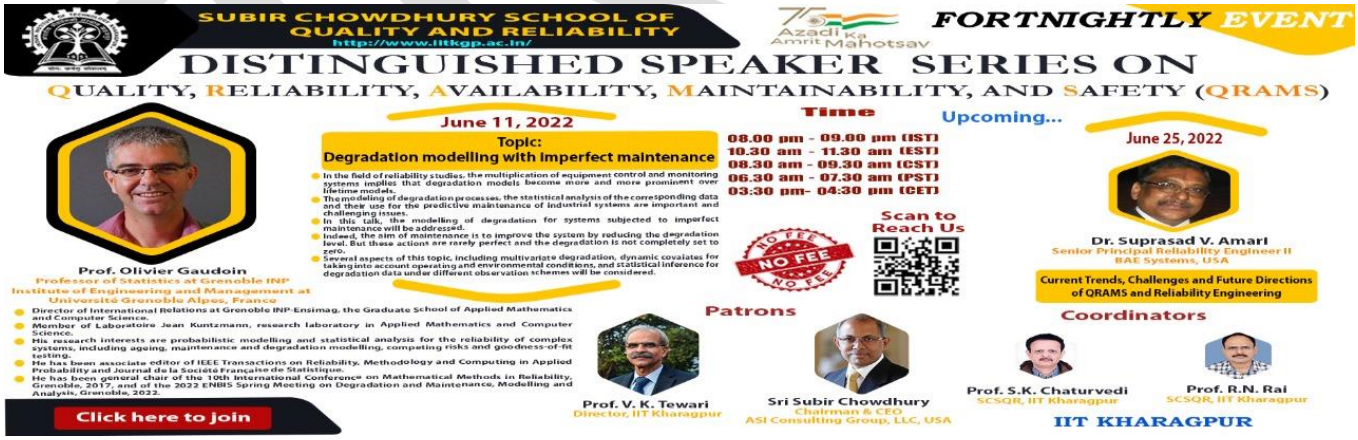
S.No.	Membership No.		A Brief Introduction of Life Member
1	LM-210	**Dr. Santosh Kumar Pradhan** 	**Dr. Pradhan** is B.Tech.,(Mech),later he completed his MS, and PhD. Presently he is working with Atomic Energy Regulatory Board (AERB) of India having his office at AERB headquarter in Mumbai. He is working at AERB as Scientific Officer 'G' in Nuclear Reactor Safety Analysis Division of AERB.

2	LM-207	**Mr Dhanesh B. Nagrale** 	**Mr Nagrale** is Serving as Scientifi Officer F at Nuclear Reactor Safety Analysis Of Atomic Energy Regulatory Board (AERB). He is an M.Tech. post graduate in Chemical Engineering
3	LM-212	**Prof. Mangey Ram** 	**Prof. MANGEY RAM holding his** PhD And presently serving as Professor at Graphic Era University, Dehradun. His specialization is Reliability Theory.
4	LM-214	**Prof. Ganga Negi** 	**Prof. NEGI** is a working as Assistant Professor at Graphic Era University, Dehradun and also pursuing her PhD research. Her areas of specializations are Reliability theory and Optimization
5	LM-215	**Prof. Nupur Goyal** 	**Prof. GOYAL is a** PhD holder and serving as Assistant Professor at Graphic Era University, Dehradun She has her specialization in Reliability Theory
6	LM-219	**Ms Sadiya** 	**Ms Sadiya** is a Research Scholar and pursuing her Ph.D. at Graphic Era University, Dehradun. She is performing her R&D in the area of Reliability theory.
7	LM-220	**Ms Shivani** 	**Ms Shivani** is a Research Scholar and pursuing her Ph.D. at Graphic Era University, Dehradun. She is performing her R&D in the area of Reliability theory.

8	LM-221	**Ms Shivani Chowdhury** 	**Ms Shivani** is a Research Scholar and pursuing her Ph.D. at Graphic Era University, Dehradun. She is performing her R&D in the area of Reliability theory.
9	LM-213	**Prof. Akshay Kumar** 	**Prof. KUMAR** has earned his PhD and presently working at Graphic Era University, Dehradun as Assistant Professor His specializations are Reliability Theory, Fuzzy Reliability.
10	LM-216	**Prof. Ashok Singh Bhandari** 	**Prof. Bhandari has done his** M.Sc. postgraduation. Presently is Assistant Professor and NET-JRF and pursuing his Ph.D. from Graphic Era University. His specialization includes Reliability theory and Reliability Optimization.
11	LM-222	**Ms Shristi Kharola** 	**Ms SHRISTI** is a Research Scholar and pursuing her Ph.D. at Graphic Era University, Dehradun. She is performing her R&D in the area of Reliability theory.
12	LM-218	**Ms Ayushi Chachra** 	**Ms AAYUSHI** is a Research Scholar and pursuing her Ph.D. at Graphic Era University, Dehradun. She is performing her R&D in the area of Reliability theory.
13	LM-223	**Ms Subhi Tyagi** 	**Ms Shubhi** is a Research Scholar and pursuing her Ph.D. at Graphic Era University, Dehradun. She is performing her R&D in the area of Reliability theory.

14.	LM-217	**Dr Vaishali Tyagi** 	**Dr. TYAGI is a** Ph.D. holder and presently serving as Assistant Professor at ABES Institute of Technology. Her major specialization is Reliability Theory.
15.	LM-2011	**Dr. Rajendra P. Rokade** 	Senior Principal Scientist, CSIR - Structural Engineering Research Centre
16.	LM-208	**Dr. SANKAR VELAMURY**	**Dr. VELAMURY has** M.Tech., PhD, presently serving as Professor in EEE & Dean of Academics at Srinivasa Ramanujan Institute of Technology. He is a Professor (Retired) in JNTUACEA. His specializations include Power systems and Reliability Engineering
17.	LM-209	**Dr. (Ms.) SWARNA BAI AMIKER**	**Dr. (Ms.) AMIKER is a** M.Sc., M.Tech. and PhD (Canada). Presently, she is Scientist 'F' and serving as, Group Head Quality & Reliability, Dr. Amiker's specialisations are Electronics, Quality Assurance and Reliability of Space Systems.

Some Events in the area of Reliability and Risk in India



Invitation for Submitting Articles for SRESA Newsletter

SRESA Newsletter is a quarterlay publication. SRESA invites articles for publication in SRESA Newsletter. This Newsletter provides an opportunty to the academics, R&D staff and Engineers and scientists in Industy to share their work with others. Share your articles at pvvarde@gmail.com or vaishmk@gmail.com.

Society for Reliability & Safety (SRESA)

(REG. NO. : F-43051 (Mumbai))

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MEMBERSHIP APPLICATION FORM. **MEMBERSHIP NO'.** ____

1.	Name of applicant		Affix your stamp / passport size photograph and send a soft copy by email
2.	Qualification		
3.	Affiliation		
4.	Position held		
5.	Specialization		
6.	Official address ☐	Residential Address ☐ (Please tick the address to be used for official communication)	
7.	Brief Bio-data:		
8.	Cell phone number and email address	Email:	Cell No:
9.	Date of birth (DD/MM/YY)		
10.	PAN Number (not applicable for student)		
11.	Type of membership (Tick applicable category)	Petron (By Invitation) : Nil Honorary Member (By Invitation): Nil Life membership : Rs. 2,200/- Membership (annual) : Rs 1200/- Student membership : Rs 500/- (Please tick the applicable category)	☐ ☐ ☐ ☐ ☐
12.	Payment mode: i) Cheque ☐ ii) Demand draft ☐ iii) On-line transfer: ☐ Cheque /DD/online transfer details :.....Date: ..... Amount: ..... Name of the Bank:.....Account number.....IFSC code		
12	Signature of applicant:		

- Please send the scanned copy of the form duly signed by email to Secretary, SRESA along with a soft copy of the passport size photograph to secretary@sresa.org.in and a copy to treasurer@sresa.org.in
- SRESA account details are as follow: Money to be transferred in favour of 'Society for Reliability and Safety', SRESA Account number: 31110442604, Bank Name: State Bank of India, Branch: Anushaktinagar, Mumbai 400094, Branch Code 010124, IFS Code: SBIN0010124.
- *will be allotted by SRESA Office