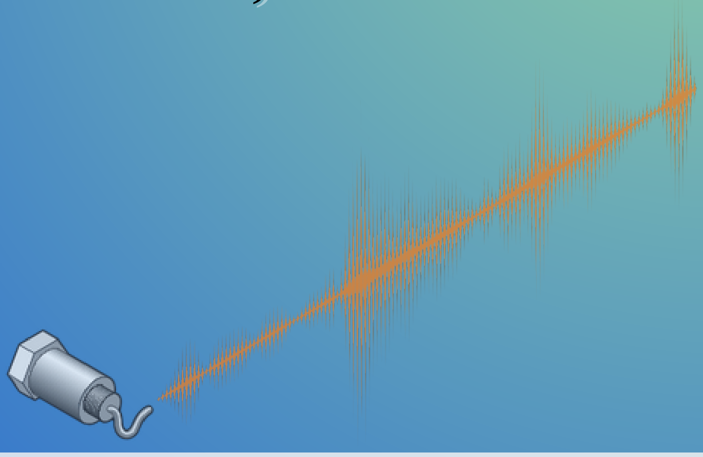
amplitude

DIAGNOSTICS & PROGNOSTICS NEWS

2024, Issue - 3



COUNCIL OF VIBRATION SPECIALISTS

www.covs.in

INDEX

Our Vision

CVS aspires to be the center of eminence at the national and global level for the dissemination of knowledge in the field of vibration science and engineering, through training and post graduate studies, to formulate standards, collaborate with national and international regulatory bodies on vibration science and engineering, to develop and compile information in the field to assist engineers in building reliable, vibration free, stable and longer lasting products in the form of machines, structures and systems

Our Mission

To provide a platform for scientists, researchers and engineers to come together for exchange of vibration knowledge through training programs, seminars, conferences, campus and corporate visits, vibration solution services, recognition of contribution made by the experts in the fields.

To collaborate with similar national and international institutes and organizations for imparting customized various levels of certified training programs, certifying the asset's integrity in industry and enhancing people's capability in solving vibration problems.

To review, modify / establish vibration standards in the fields of emerging domains such as smart structures, transportation systems, machinery, etc.

Dr Barun Chakrabarti, FCVS

Dear Colleagues,

Greetings from the Editorial Team of ***"amplitude"***.

We are happy to bring to you the latest issue of our Newsletter for the current year (Issue-3 / 2024).

We have put together the highlights of various activities within the CVS Family during the past quarter, along with the latest offerings of our regular features.

The month of August 2024 saw a flurry of activities, commemorating several key events – our 78th Independence Day, the 3rd Anniversary of the launch of CVS and the 2nd Anniversary of CVS Bengaluru Chapter. You will find a round-up of these events in the following pages, notably the Webinar Series from CVS Headquarters and the action-packed, colourful program over 3 days at RV College of Engineering by the CVS Bengaluru Team.

A series of three CVS Technical Webinars offered us the opportunity of learning and refreshing our knowledge on some key aspects of vibration measurements and analysis. Er. Rajshekhar Uchil provided a lucid overview on vibration analysis, drawing from his rich experience in measurements and instrumentation. Er. Praveen Gupta highlighted the practical aspects of signal processing. Prof. (Dr.) C. Sujatha provided an insight into some of the critical concepts like aliasing and the correct choice of key measurement parameters. Several participants happened to be ex-students of Sujatha Ma'am (yours truly included!). Her talk took me back over three decades into her classes at the Machine Dynamics Lab - IITM, filled with the same level of passion and meticulousness.

This issue of ***amplitude*** is enriched by the coverage of the latest awards, accolades and public recognition earned by our esteemed Members. Apart from being a testimony to their personal achievements, such events also bring glory to CVS. We are proud to be in such exalted company. Our heartiest congratulations to the Members!

By the time you have this issue in your hands, we would be in the midst of a long and much awaited festive season, starting with the Ganapati Festival and through Navaratri, Durga Puja, Dussehra, Deepavali and all the way to Christmas and the New Year. The Editorial Team is happy to extend festive greetings and best wishes to all our Members and their near and dear ones. Wish you happy reading!

Dr Barun Chakrabarti

International Conference on Vibration Engineering, Science and Technology

INternational conference on
Vibration
Engineering
Science &
Technology
INVEST
2025

HIGHLIGHTS:

- Pre-Conf. Tutorials & Workshop
- Technical Sessions

OPPORTUNITIES:

- Exhibition & Demo
- Sponsorship Opportunities
- Business Meets

COUNCIL OF VIBRATION SPECIALISTS
INDIA
Diagnostics and Prognostics Practitioners

DATE: 29, 30 & 31 May 2025

Jointly Organised by

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(New Delhi Chapter) &

INDIAN INSTITUTE OF TECHNOLOGY DELHI

(an Institution of Eminence)

Website : www.covs.in Email : cvs.hqs@covs.in

Er. Sandeep K. Mittal, FCVS

Er. Sandeep Kumar Mittal is a senior Control & Instrumentation (C&I) professional with over 28 years of experience in C&I and Project Management services for Thermal Power Plants. He holds a graduate degree in Engineering (BE Electronics) and Post Graduate degree in Management (MBA Finance). After completing BE and MBA, he joined the reputed engineering consultancy company, Desein Pvt. Ltd., Delhi as an Engineer in Control & Instrumentation Engineering discipline. He rose to the position of Vice President (Control & Instrumentation) at Desein Pvt. Ltd.

Er. Mittal has worked with various sizes of power plants from 8 MW to 800 MW. Being a C&I Engineer for Thermal Power Plants, he has extensive exposure to many aspects of Vibration Monitoring System and Vibration Analysis System for Turbines, HT Drives of machinery such as CEP, CW Pumps, BFP, PA Fans, ID Fans, FD Fans, Compressors and Conveyors.

He is an active member of IETE, ISA and CVS. He was honoured with the prestigious ***"Outstanding Professional Award"*** from ISA, Delhi Chapter in 2019.

In spite of his disability, Er. Mittal is continuously contributing his best efforts towards the development of best engineering practice and new innovations for Thermal Power Plants.

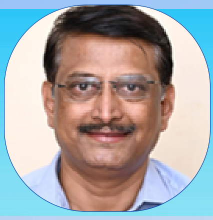
In addition to his professional contributions, Er Mittal is also actively engaged in social services together with her wife.

Er. Harvinder Singh Kalsi, FCVS

Er. Harvinder Singh Kalsi is the Founder of Kollabral Ventures, specializing in Engineering and Business Consulting for the Power, Energy, and Oil & Gas industries. With over 32 years of rich industrial experience, he leverages his extensive background to provide strategic insights and solutions.

Er. Kalsi earned his Bachelor of Engineering in Electronics and Communication from Gulbarga University in 1988. He began his career in the Telecommunications sector before transitioning to Industrial Engineering with Woodward India, where he dedicated 29 years to various roles, including Application Engineering, Field Service, Manufacturing, Project Management, and Sales. Notably, he served as the Turbomachinery Business Segment Leader for India, establishing the Governing and Compressor Controls business and later becoming the Regional Engineering Leader for India and the Middle East.

In addition to his professional pursuits, Er. Kalsi is passionate about sports, particularly badminton and squash. He also serves as an Executive Board Member of the ISA Delhi Section, contributing to the advancement of the industry.



Dr. Vikas Phalle, FCVS

Dr. Vikas Phalle is an Associate Professor in Mechanical Engineering Department, Associate Dean of Educational Outreach and Former Head of Mechanical Engineering Department, at V.J.T.I. Mumbai. He holds a M.E. in Mechanical Engineering from V.J.T.I., Mumbai, University of Mumbai and a Ph.D. from I.I.T. Roorkee in the year 2011. He has an academic experience of 30 years.

His research and teaching areas include Tribology, Bearings, Machine Design and Vibration. He is Ph. D. Research Guide at VJTI Mumbai and Ph. D. examiner in various Universities. Under his supervision, five Ph. D. degrees have been awarded and presently he is supervising five research scholars. Dr Phalle received the AICTE Visvesvaraya Best Teacher Award 2021, conferred by AICTE, Government of India. He is also a recipient of Dewang Mehta National Education Award as "Best Professor in Mechanical Engineering Studies". He has been awarded with the prestigious Mumbai University Best Teacher Award 2021-22.

Dr Phalle has published more than 170 research papers in peer reviewed international journals and international/national conferences. He is a reviewer of several international journals, such as Journal of Tribology Transaction, Lubrication Science, Tribology International, IMechE, etc. He is an Executive Committee Member of Tribology Society of India. He has also been associated with the National Board of Accreditation (NBA), AICTE, DTE and University Committees, including the BOS of Mumbai University. He networks with several foreign universities such as University of Columbia, New York - USA, and Texas A&M University, Texas - USA where he was a Visiting Faculty in 2017. Dr Phalle has organized two international conferences and a Mini Symposium in International Conference 'Nonlinear Solid Mechanics' (ICoNSoM-2019) at Rome - Italy, jointly with McGill University Canada & TRE University, Rome - Italy.

Er. Neeraj Bhargava, FCVS

Er. Neeraj Bhargava, a Founding Fellow of CVS, is a result-oriented professional with 35 years of rich experience in overseeing Asset Care Development, Reliability Services, Plant Maintenance, Reliability Consultancy, Condition Based Maintenance, Asset Management, Project Planning & Project Management, Team building and Training & Development. His professional career spans diverse sectors and geographies, covering FMCG, Petrochemical, Oil & Gas, Process and Engineering industries in India, Africa, the Middle East, Australia and Vietnam.

Neeraj has a Bachelor's Degree in Mechanical Engineering and a Master's Degree In Industrial Production from BITS Pilani. He has worked in Multinational Companies including AVT, U.K, SKF, GE, SABMiller, ABinBev and Grasim Industries.

3-Day Workshop on Noise & Vibration Organized by RV College of Engineering & CVS Bengaluru Chapter

(29th – 31st October 2024)

A 3-Day Workshop on Noise & Vibration was jointly organized by the RV College of Engineering (RVCE) – Bengaluru and the Bengaluru Chapter of CVS during 29th – 31st August 2024. The Departments of Mechanical Engineering and Aerospace Engineering of RVCE actively participated in organizing this Workshop. The event marked the launch of the CVS Students' Chapter at RVCE. In addition, the 3rd Anniversary of the CVS Foundation Day and 2nd Anniversary of CVS – Bengaluru Chapter were also celebrated on the sidelines of the Workshop.

The Workshop started off with a grand Inaugural Session on the first day, in presence of Office Bearers of CVS Bengaluru Chapter along with Deans, Associate Deans, Heads of various Departments, Faculty Members and Students of RVCE. The Students' Chapter was launched through lighting of the ceremonial lamp and unveiling of the Students' Chapter banner. Key Speakers at the inaugural function included the Chief Guest, Shri T. M. Naidu, Ex Project Director of ADA, Dr K N Subramanya, Principal – RVCE, Dr M. Krishna, Prof. & HOD – Dept. of M.E., Dr. R. S. Kulkarni, Prof. & HOD – Dept. of ASE. A video message from Dr. Harvindar Singh Gambhir, President – CVS, highlighted the Objectives and key activities of CVS.

The Technical Session on the first Day included the Keynote Address by the Chief Guest, Shri Naidu, covering the Structural Dynamic Analysis and Testing of Modern Combat Aircraft (Tejas). This was followed by an Expert Talk by Shri Girish Doddamani, Secretary – CVS Bengaluru Chapter and CEO – Enviro Sense Tech, on vibration testing and signal processing. The concluding session of the day covered live demonstration, with hands-on practice of vibration and noise measurements in the Wind Tunnel set up of the Dept. of ASE.

The second day of the Workshop started with a keynote talk by Prof. C S Manohar (IISc – Bengaluru) on vibration and structural dynamic aspects of civil structures, including concepts of seismic vibration and stochastic considerations in structural dynamics. Shri Sivakiran from Bosch delivered an Expert Talk about automotive vibration and demonstrated the predictive and diagnostic tool developed by the company. The celebrations to mark the 3rd Anniversary of CVS also took place on the second day. This was followed by a hands-on demo session of vibration measurement and analysis in the Machine Shop.

The third day of the Workshop started with a keynote session by Dr Kishore K. Brahma, Ex-NAL and Consultant, covering the vibration fatigue aspects and related analytical techniques, mainly with respect to aerospace applications. Prof. Amalesh Barai, Dept. of Aerospace Engineering at Jain University and President of CVS Bengaluru Chapter, delivered an Expert Talk on Aircraft Aeroelasticity and explained the key aspects through several interesting videos. Shri Rajshekhar Uchil, DGM – Technical Services at Jost's Engineering, delivered an Expert Talk on the interesting topic of Human Vibration and its measurement, with several practical examples. The celebrations to mark the 2nd Anniversary of CVS – Bengaluru Chapter also took place on this day. The technical program concluded with a session on Modal Testing & Analysis by Shri SKM Rao, CEO – Envicon Vibrotech Pvt. Ltd., with hand-on demonstration of such testing techniques.

The Workshop came to an end with a Valedictory Session. Prof. Amalesh Barai and Shri Girish Doddamani distributed the Participation Certificates to the students. The colourful 3-Day Event concluded on a memorable note, the grand finale being a synchronised and energetic team activity led by Shri Girish Doddamani, symbolising the "vibrant" future of CVS Bengaluru Chapter and the RVCE Students' Chapter.

Heartiest Congratulations to the all the organizers, dignitaries, speakers and participants for this great show. Keep it Up!

Here are some memorable moments from the 3-day event.






COUNCIL OF VIBRATION SPECIALISTS

Cordially invite you for the Inaugural function
of
"CVS Student Chapter at RVCE"
HAPPY ANNIVERSARY

FCRIT – Navi Mumbai Conducts Faculty Development Program In Association With CVS Mumbai Chapter

Fr. C. Rodrigues Institute of Technology (FCRIT) – Navi Mumbai conducted a 5-Day Faculty Development Program during 8th – 12th July 2024. The theme of the course was "Fault Diagnosis of Machinery using Vibration Analysis". The lectures were conducted in hybrid mode, with both in-person presentations and online talks by speakers from other locations. The technical sessions were conducted by senior Industry Experts and Consultants associated with CVS as well as faculty members from FCRIT. The program was ably coordinated by Ms. Shamim Pathan, Dr. V. G. Salunkhe and Mr. Praseed Kumar.

The Faculty Development Program (FDP) aimed at providing an in-depth understanding of vibration analysis techniques for fault diagnosis in industrial machinery. The key objectives were:

- To comprehend the fundamentals of vibration and vibration analysis
- To select and use appropriate sensors and instrumentation for vibration monitoring
- To analyze vibration patterns and detect common machinery faults such as misalignment, unbalance, and bearing issues
- To apply condition monitoring techniques in real-world scenarios and gain practical experience using vibration analysis tools and software

The FDP focused on the importance of vibration monitoring for maintaining the reliability and performance of industrial equipment. It covered the diagnosis of common mechanical faults that cause vibrations, such as unbalance, misalignment, looseness, and bearing defects. The sessions emphasized the use of various sensors for vibration measurement and real-time condition monitoring of rotating machinery. Furthermore, machine learning approaches were introduced for predictive maintenance, allowing participants to explore advanced diagnostics for enhancing operational efficiency and reducing maintenance costs. Practical demonstrations provided hands-on exposure to vibration analysis tools and software, equipping the participants with the skills necessary to implement these techniques in industrial environments.

The program provided the participants an opportunity to refresh their knowledge of vibration fundamentals and learn about various types of machinery problems and their diagnosis through vibration analysis techniques. They also obtained hands-on experience is selection of appropriate vibration sensors, use of analysis instrumentation and fault diagnosis using software tools. The lectures also provided an insight into advanced condition monitoring techniques and application of emerging technologies such as AI/ML in machinery diagnostics.

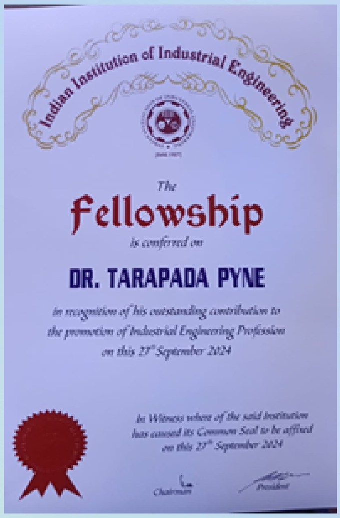
Here are a few glimpses from the FDP Event.


Fr. C. Rodrigues Institute of Technology, Vashi
Department of Mechanical Engineering
In association with
COUNCIL OF VIBRATION SPECIALISTS (CVS)
Mumbai Chapter
Welcomes You to
Valedictory Ceremony

Heartiest Congratulations! We are proud of you.

Shri S. Somanath, Chairman – ISRO, Chairman – Space Commission and Secretary, Dept. of Space, has been awarded the Ph.D. Degree by IIT Madras in recognition of his research contributions in the field of vibration isolators. A Distinguished Scientist, an esteemed CVS Fellow and the winner of CVS Lifetime Achievement Award, Shri Somanath already has nearly a dozen Honorary Ph.Ds from various prestigious institutions. But he has earned the Ph.D. from IIT Madras as the culmination of his own hard work of over 35 years, which he aptly described as "a village boy's dream fulfilled". The CVS Family is truly proud of his latest achievement.

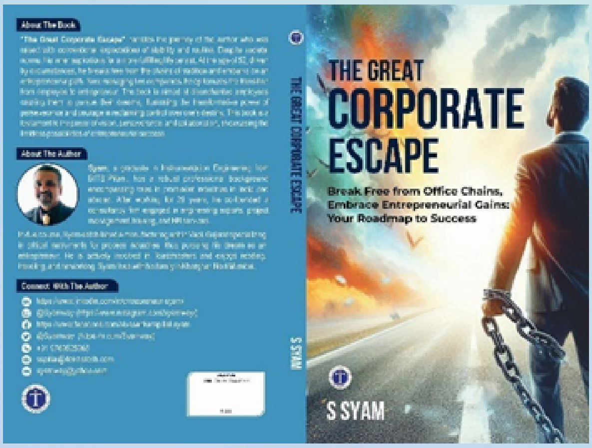
Prof. T G Sitharam, Chairman – AICTE and CVS Fellow, has been recognized by the Stanford University as being among the top 2% of the world's most-cited research scientists for the year 2024, across various disciplines. Prof. Sitharam has achieved this distinction for the fifth consecutive year since 2020. Apart from being a renowned educationist and administrator, his continued excellence in active research is truly inspiring for all aspiring researchers.



Dr. Tarapada Pyne, Founding Fellow, Secretary & Director General – CVS, has been awarded the prestigious Fellowship of the Indian Institution of Industrial Engineering (IIIE), in recognition of his outstanding contributions to the field of Industrial Engineering and the IIIE. The Fellowship was awarded to Dr Pyne in a glittering ceremony on the occasion of the 66th National Convention and the 8th International Conference of IIIE, held at Jamshedpur during 27 – 28 September 2024.

Er. N P Sundar, FCVS, from Stellar Innostrat Consulting, has been elected unopposed to the prestigious IAM Council of The Institute of Asset Management. He will represent the India Chapter Members at the IAM Council.

Prof. Nilaj N. Deshmukh, Dean (Admin. & Faculty) and Professor of Mechanical Engineering at Fr. C. Rodrigues Institute of Technology, Navi Mumbai has won the Best Faculty of the Year Award in the Sub-Category of "Thought Leader", instituted by The Computer Society of India – Mumbai Chapter. The award was presented at the Industry Academia Conference and Academia Award – 2024 event during 30 – 31 August 2024.



Er. S. Syam, FCVS and Founding Director of Deiktis Technologies, has authored a book entitled "The Great Corporate Escape". The book was formally released on 27th July 2024 in a colourful ceremony during the TLC Masterminds Business Conclave at Navi Mumbai. A passionate Instrumentation professional, Syam has had a successful corporate career in core industries before starting hisentrepreneurial venture in manufacturing of critical instruments for process industries.

Er. Debadatta Mishra, FCVS and CEO (Offg.), Aerospace & Aviation Sector Skill Council, NSDC, Govt. of India, received the "Best Skill Council Award" in the Institute category, as part of the National HR Excellence Award – 2024, during the Awards Ceremony in Bengaluru on 31st August 2024. He was also the Chief Guest in the National Space Day event at the Gopalan College of Engineering & Management, Dept. of Aeronautical Engineering, Bengaluru on 24th August 2024 and delivered a talk on Human Space Exploration Area. Er. Mishra recently received the prestigious REPUTE Brand Award – 2024 for the Aerospace & Aviation Sector Skill Council.

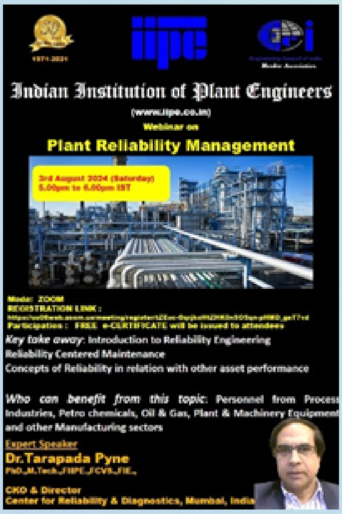
Prof. Rajesh. S. Prabhu Gaonkar, FCVS from IIT Goa (School of Mechanical Sciences) has been awarded the inaugural Gomantak Engineering Excellence Award – 2024 in the category "Engineer's Role in Education". The award was presented by Shri Suresh Prabhu, Former Union Railway Minister. This award has been instituted by Gomantak TV from this year, in association with the Government of Goa, to recognize Goan Engineers who have excelled in various professional fields.

Er. Partha Sarathi Ghose, FCVS, Group Director - Projects at Kalyani Steels Limited, was invited through PMI – Bengaluru Chapter to deliver a lecture on Project Life Cycle Management at ISRO – Sriharikota. Space Programs have their own unique challenges and his talk focused on how such challenges can be effectively addressed from a Project Management perspective.

Dr. Barun Chakrabarti, FCVS, Managing Director – Bonitas Consulting Services, was invited to deliver two Guest Lectures at the Rotating Machinery Boot Camp program conducted by the Centre for Continuing Education (CCE), IISc – Bengaluru during 26 – 28 September 2024. The training course is a part of the SamridDHI Skill-Building Initiative of the Ministry of Heavy Industries, Govt. of India, being implemented by IISc in partnership with ModeliCon Infotech LLP – Bengaluru. Dr Chakrabarti spoke on the topics of Monitoring & Diagnostics of Critical Rotating Machinery and Case Studies on Vibration Problems in Rotating Machinery.



Shri T M Naidu, FCVS, graced the 20th Foundation Day Celebrations of the Telangana Composites Manufacturers Association (TECMA), held on 11th September 2024 at Hyderabad. Shri Naidu, a renowned expert in design, analysis, testing and materials-related applications in Aerospace domain, has had four decades of association with ADA and NAL and was involved in many strategic projects of national importance. Shri Naidu briefly spoke at the TECMA event and was felicitated by the organizers.



Dr. Tarapada Pyne, Founding Fellow, Secretary & Director General – CVS, and CKO & Director, Centre for Reliability & Diagnostics (CRD), delivered an Expert Talk on Plant Reliability Management, as part of a webinar organized by the Indian Institution of Plant Engineers (IiPE) on 3rd August 2024.

Er. Subba Rao Ganti, FCVS, a CAT-IV Certified Vibration Analyst, Trainer and Consultant, conducted a training course on "Turbo-machinery Vibration Analysis & Diagnostics" during 16 – 19 September 2024. The training program was organized by AIVA Tech Solutions through hybrid mode

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CRD (Center for Reliability and Diagnostics) is a registered service based company, based in the commercial capital of India, Mumbai, dedicated to the management of critical industrial assets by providing consultancy services in plant reliability and maintenance, R&D and Process Assessment (through our partner M/S Experiqs, IIT Mumbai campus) to clients from different industries, such as oil & gas, fertilizers, metal, petrochemicals etc. CRD also attempts to bridge the knowledge gaps between industry & academia in multiple disciplines, namely mechanical, electrical, chemical, structural, instrumentation and control, information technology etc.

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PEOPLE first

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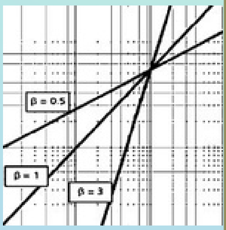
- *Institute-Industry Initiative (I3), a Bridge Program, coded as 'CCC' (Campus Corporate Curriculum) to enhance students' employability*
- *Faculties for FDPs, MDPs, STTPs*

OUR SERVICES AND CERTIFICATIONS IN CONSULTING,EDUCATION,RESEARCH &TRAINING(CERT)

Industry

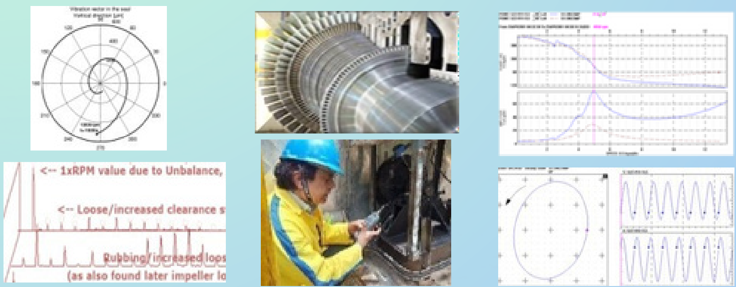
- ***MachineryDiagnostics(VibrationAnalysis,Ferrography, ThermalImaging)***
- ***PdM/CBMandReliabilitySystem Developmentforprocess/power plants***
- ***RCM &FMECAforcriticalrotors (STG,GTG,Compressors,Pumps,Blowers)***
- ***Reliability & Maintenance Management Systems Development Asset Life***
- ***Assessment/ Residual Life Assessment***
- ***StructuralandPipingAnalysis(heavydutyCranes)***
- ***PredictiveMaintenance&Analyticsin Industry4.0***
- ***Dynamic Balancing and Alignment***



Academia:

- ***FDP, SDP, MDPs, STTPs, Visiting Faculty***
- ***M. Tech, PhD Project / Research Guide***
- ***Mechanical/ Condition Monitoring Lab. Development***

CRDAssistsinBESTUSEofyour Assets'SurveillanceSystems (Parker-Meggitt,Bently Nevada,B &K,Rockwell,Emerson)



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Industries :

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- ***Steel***
- ***VibrationOEMs***
- ***Oil&Gas***
- ***Engineering***
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Dr. Tarapada Pyne

Chief KnowledgeOfficer&Director

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CRD **CVS**

Hosts

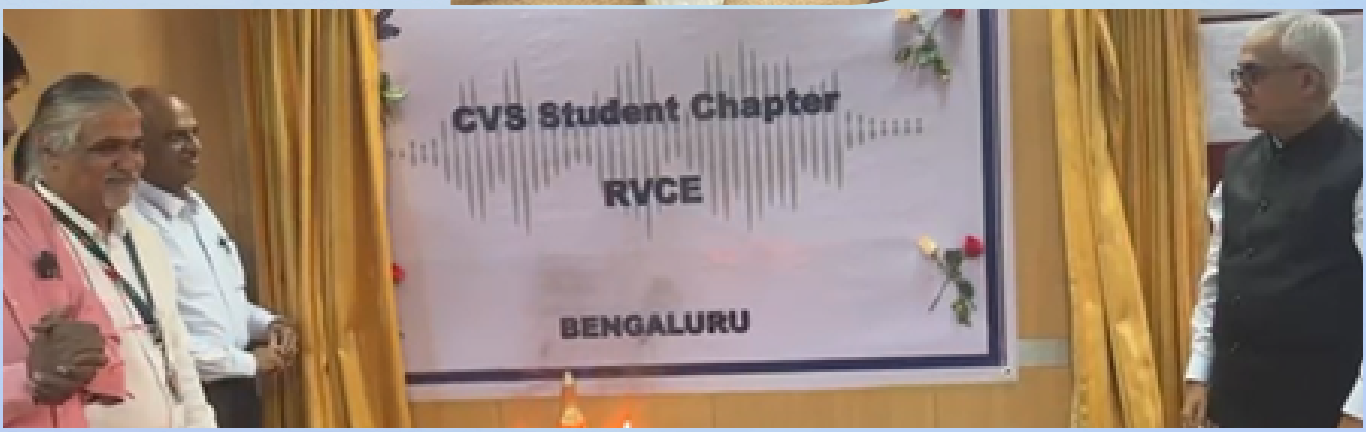
GSTNo.: 27AAPFC8355B1ZB

CVS Bengaluru Chapter Launches First Students' Chapter At RVCE – Bengaluru

The Bengaluru Chapter of CVS has launched its first Students' Chapter on 29th August 2024 at the RV College of Engineering (RVCE) – Bengaluru. The Students' Chapter was inaugurated concurrently with the opening of the 3-Day Noise & Vibration Workshop jointly organized by CVS Bengaluru Chapter and RVCE during 29th – 31st August 2024. The Students' Chapter started with the first batch of 60 members comprising Mechanical and Aerospace Students (UG and PG).

The colourful inauguration ceremony took place in the presence of CVS Bengaluru Chapter Office Bearers, senior academicians from RVCE and senior Bengaluru-based industry professionals who are CVS Fellows. The event was marked by the traditional lighting of the auspicious lamp followed by the symbolic curtain raiser for the new Students' Chapter.

Our Hearty Congratulations to the Bengaluru Chapter and Best Wishes for the RVCE Students' Chapter!



CVS Bengaluru Chapter Celebrates the 3rd Anniversary of CVS

The Bengaluru Chapter of CVS organized a colourful event to mark the 3rd Anniversary of the founding of Council of Vibration Specialists. The celebratory event took place on 30th August 2024, the second day of the 3-Day Noise & Vibration Workshop organized jointly by the RV College of Engineering and CVS Bengaluru Chapter at the RVCE Campus during 29th – 31st August 2024

The event was marked by ceremonial cutting of the customary Anniversary Cake by Prof. C. Manohar, FCVS from IISc – Bengaluru. Prof. Amalesh Barai, Chairman of CVS Bengaluru Chapter, Er. Girish Doddamani, Secretary of CVS-BC and Er. Rajshekhar Uchil, Chapter Liaison Officer represented the Bengaluru Chapter. Senior faculty members from RVCE also graced the occasion.

Celebration of 2nd Anniversary of CVS Bengaluru Chapter

The Bengaluru Chapter of CVS has now completed two years and stepped into its third year. To mark this important milestone, a function was organized to celebrate the 2nd Anniversary. The celebrations took place on 31st August 2024, the concluding day of the 3-Day Noise & Vibration Workshop organized jointly by the RV College of Engineering and CVS Bengaluru Chapter at the RVCE Campus during 29th – 31st August 2024.

The celebrations took place in the presence of CVS – BC Office Bearers and senior faculty members from RVCE. The event was marked by ceremonial cutting of the customary Anniversary Cake by Prof. Amalesh Barai, Chairman of CVS Bengaluru Chapter, in presence of Er. Girish Doddamani, Secretary of CVS-BC and Er. Rajshekhar Uchil, Chapter Liaison Officer.

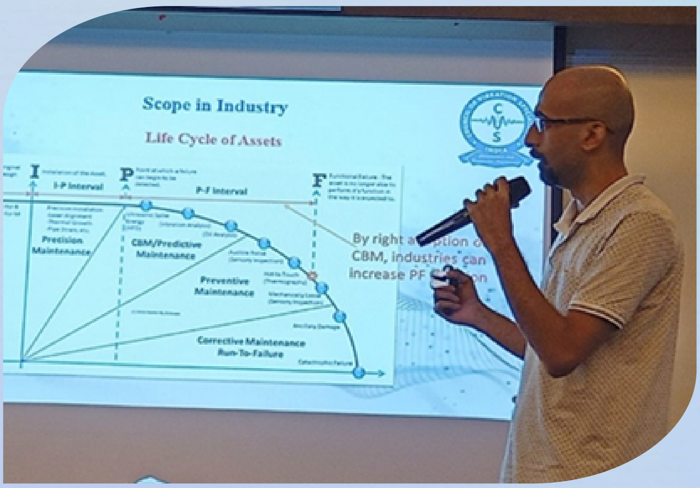
The Bengaluru Chapter has distinguished itself by organizing the highly successful INVEST23 mega event in November 2023. It also launched its first Students' Chapter at RVCE concurrently with the inauguration of the 3-Day Noise & Vibration Workshop.

Our Hearty Congratulations to the Bengaluru Chapter and Best Wishes for many vibrant achievements in the years to come!

CVS Students' Chapter at RGIT – Mumbai Organizes Guest Lecture on CBM

The CVS Students' Chapter at MCT's Rajiv Gandhi Institute of Technology (RGIT) – Mumbai celebrated the 3rd Anniversary of CVS by organizing a Guest Lecture on the topic "Current Trends of Condition Based Maintenance (CBM) in Industry" on 4th September 2024. The technical talks were delivered by Ms. Soloni Gosalia, FCVS and Treasurer (CVS Mumbai Chapter) and former VP at AIIPLTECH, and Er. Dipayan Pyne, MCVS from the Centre for Reliability & Diagnostics (CRD).

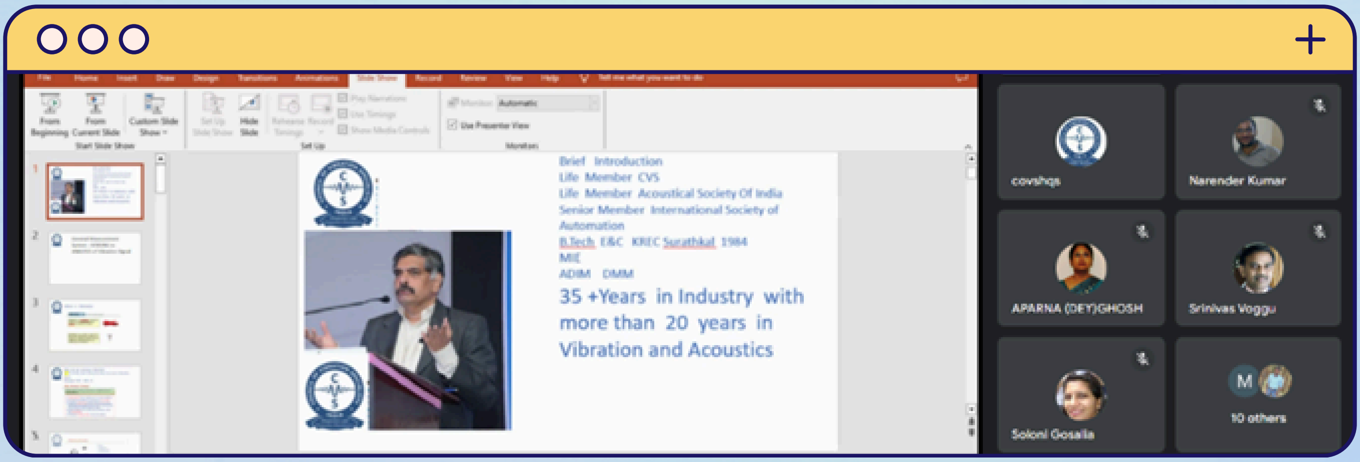
The lectures covered various aspects of CBM as applied in Industry, including the CBM philosophy; elements of vibration analysis; application of CBM in machinery monitoring, diagnosis and life cycle management of assets; evolution of technology from monitoring, diagnostics and auto-diagnostics using emerging technologies such as data analytics and AI/ML. For the benefit of students looking for a career in the core industries, the speakers also talked about the prospects of CBM as an enabling skill and scope of higher study and research in this domain. The day-long event provided a great opportunity to the budding engineers to understand and appreciate the importance of CBM in effective Asset Management in industries and the prospects of building a successful career in this field.

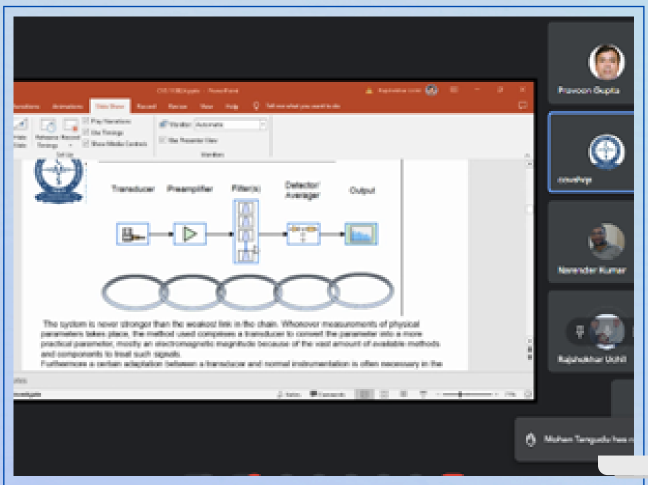


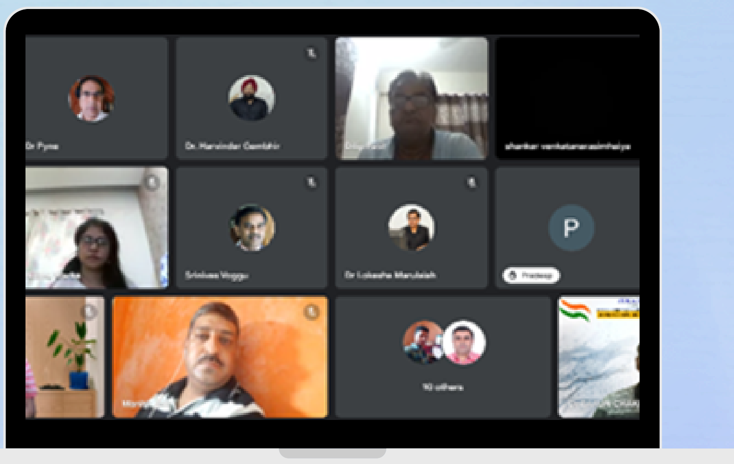
General Measurement System – Sensing to Analysis - of Vibration Signal (11 August 2024)

Er. Rajshekhar Uchil, FCVS
DGM – Technical, Jost's Engineering Company Limited - Bengaluru

Er. Rajshekhar Uchil presented an overview of the entire sequence of vibration analysis – from sensors to signal conditioning to signal processing and interpretation. He drew upon his rich experience in the area of vibration instrumentation and measurement techniques to bring forth the critical issues that one must take care of in order to ensure successful analysis and troubleshooting. He also explained some of the common errors in vibration analysis and how these can be avoided. Er. Uchil also touched upon the emerging trends, with increasing use of intelligent hardware and IIoT-enabled monitoring and diagnostic systems.



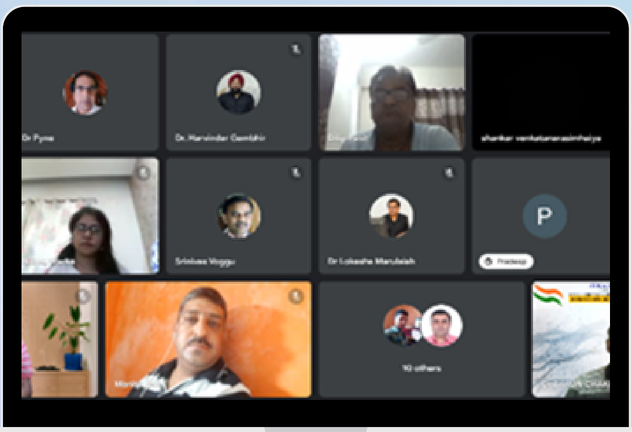


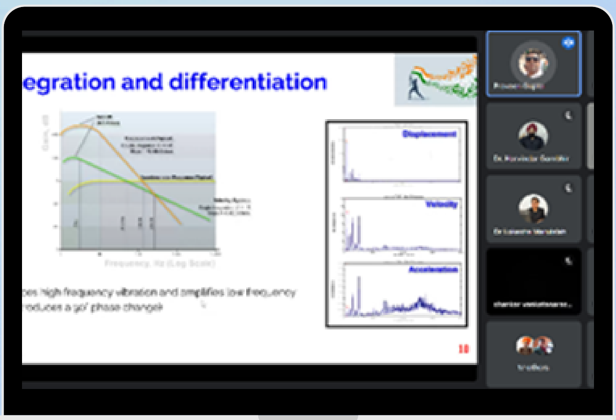


Demystifying Signal Processing & Data Acquisition Pitfalls (25 August 2024)

Er. Praveen Gupta, FCVS
COO, AIVA Tech Solutions (P) Ltd., Hyderabad

Er. Praveen Gupta covered a range of topics that are of interest to engineers performing vibration measurement and analysis in the field. He explained the concepts behind various sensor parameter settings, pre- and post-processing operations and key specifications of signal analysers. He also discussed common pitfalls associated with measurement and analysis, and how to avoid these. Er. Gupta explained some of the key digital signal processing techniques such as different types of averaging, order tracking, auto-correlation functions, etc. and selection of the right window function depending on the type of signal and objective of analysis.

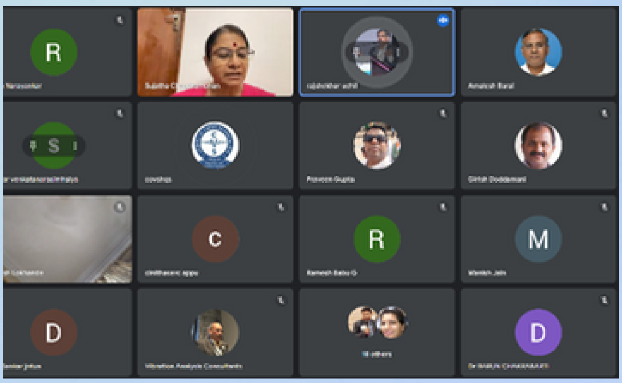




Nyquist Criterion – Aliasing, Sampling & Resolution in Vibration Signal Processing (08 September 2024)

Prof. (Dr.) C. Sujatha, FCVS
Dept. of Mechanical Engineering, IIT Madras (Retd.)

Prof. C Sujatha presented an in-depth exposure to the finer aspects of signal processing. She explained the key concepts such as Analog-to-Digital signal conversion, Time to Frequency Domain conversion through FFT algorithm, Frequency Response Function and its applications. The Nyquist Criterion was presented in detail and its role in avoiding the problem of Aliasing was explained.The importance of Resolution in signal processing was highlighted and the factors affecting Resolution were also explained. The talk was followed by a lively Q&A session, with Prof. Sujatha effectively addressing the queries from participants.



Bracing Systems

(Book Preview)

Prof. (Dr.) Suhasini Madhekar, FCVS
Former Professor, College of Engineering, Pune

Prof. (Dr.) Vasant Matsagar, FCVS
Professor & Head, Dept. of Civil Engineering, Indian Institute of Technology, Delhi

1. Introduction

Dynamic loads impart a significantly greater effect towardthe response of a structure compared to staticloading. As such, the properties of the structure, viz. lateral stiffness and damping, play a pivotal role in achievingefficient structural performance against dynamic loads, such as typhoons, earthquakes, blasts, wind and many others. To avoid structural failure and minimizethe excessive lateral movement of the structure, part of the energy exertedby the dynamic loading needs to be dissipated. One of the most efficient methods to achieve this objective is installation of structural bracings, which work by providing lateral stiffness and stability to the structure, especially for the multistory and high-risebuildings. Bracing systems subsequently increase the lateralload resistance of the structure and reduce the internal forces in the primary structural system, throughan appropriate arrangement of members. In suchsystems, the beamsand columns formingthe primary structural system could typicallybe designed to resist verticalloads, whereas the bracing systemsresist lateral loads.Braced frames may be considered as cantilevered vertical trusses resisting lateral loads, primarily through the axial stiffnessof columns and braces. Since the lateral loads are reversible, braces are subjected to alternate cycles of compression and tension. Hence, they are most often designed for the more severecase, i.e., compression. The diagonal bracingmembers work as web membersresisting the horizontal shear in axial compression or tension, depending on their orientation and direction of inclination. Common types of bracings include the buckling-restrained brace (BRB), concentrically braced frame (CBF), and eccentrically braced frame (EBF). Figure 1 presents different structural vibration control approaches, including bracing systems.

2. Buckling-Resistant Braces (BRB)

During severe earthquake events, the braces may be subjected to repeated cycles of lateral loading and stresses beyond their elastic limit. In such cases, the braces may yield in tension and buckle in compression. The buckling of braces in compression prevents the utilization of their full capacity in compression. The tendency of buckling is influenced by the section property, the compressive force, and the unbraced length of the steel core. The buckling of the steel core results in a severe reduction in the capacity of the braces to resist the earthquake actions and dissipate energy. To overcome this problem, the concept of buckling-resistant braces (BRBs) was proposed in order to obviate the buckling of the braces and to make the bracing system robust in both tension and compression. A BRB is a steel brace that does not buckle in compression; but instead yields in tension as well as in compression. The three principal components of a BRB are a steel core, bond-preventing layer, and the outer casing. The schematic of BRB is shown in Figure 2.

Ductility is strongly affected by the material type and geometry of the yielding steel core segment. The core is encased by a sleeve that is filled with concrete, thus preventing the steel from buckling under compression. The steel core is divided into three segments, i.e., the yielding section, transition segment, and core extension, as shown in Figure 3. The middle portion is designed to yield under tensile and compressive loads.

Advantages of BRB

BRB has the capability to yield both in tensionas well as in compression. The main advantage of BRBs is that they can restrain buckling effectively, and their hysteretic behavior is more stable than other bracing systems. Buckling-restrained bracings provide the rigidity required to satisfy structural drift limits, stable inelastic behavior, and substantial energy absorption capability with symmetric hysteretic behavior in tension and compression. The designer can make the best use of the mechanical properties of a BRB such as strength, ductility, and stiffness, as the cross-sectional area of its steel core, yield stress, and yield length can be defined separately and varied as per the project design demand.Due to the stable hysteretic behavior of BRB, designers can specify the area of steel core, allowing them to meet the capacity demand of each story where BRBs are installed and, hence,the damages in the weak stories can be effectively controlled. As BRBs are effective in restraining lateral buckling, non-structural elements alongside are also free from damage. BRBs can be incorporated into the structural system using welded, bolted, or pinned connections to gusset plates.

Disadvantages of BRB

The major disadvantage of BRB is the absenceof a restoring mechanism. Becausethe yielding core is typically hidden inside the casing, it is usually challenging to detect damages if the brace gets damagedduring an earthquake event. Their considerable weight and large size make BRBs difficultto install in the existing structures.

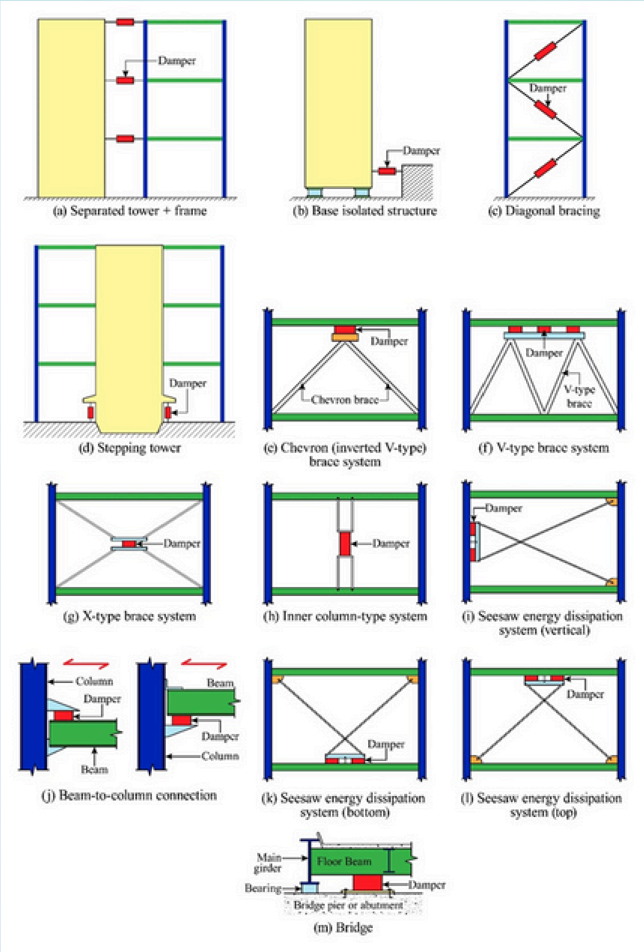


Fig. 1. Different techniques of structural vibration control

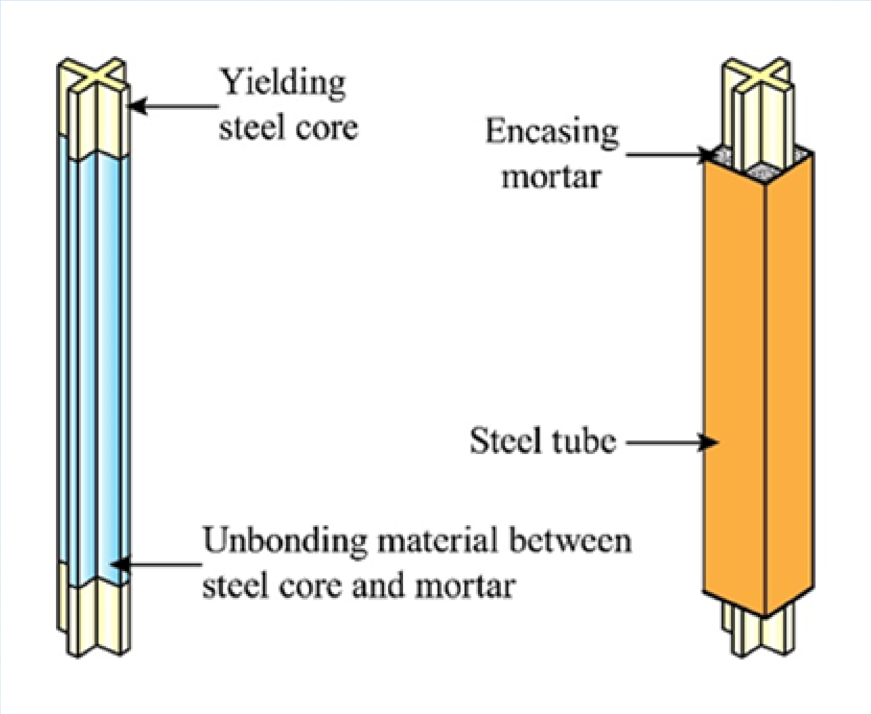
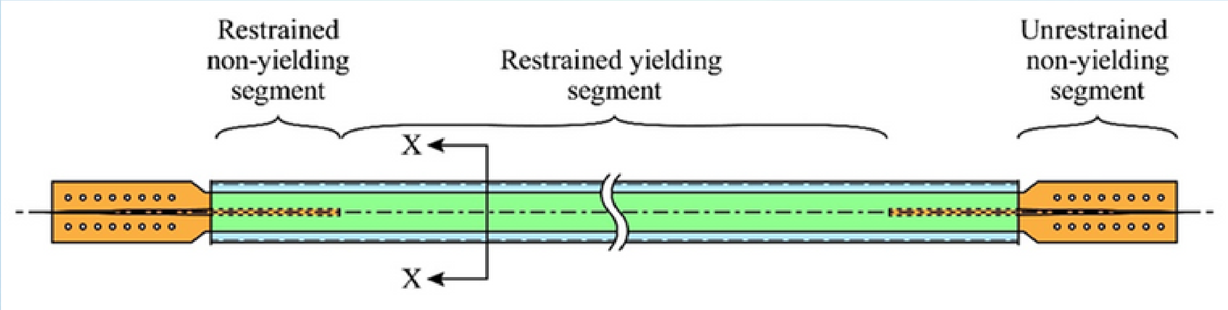
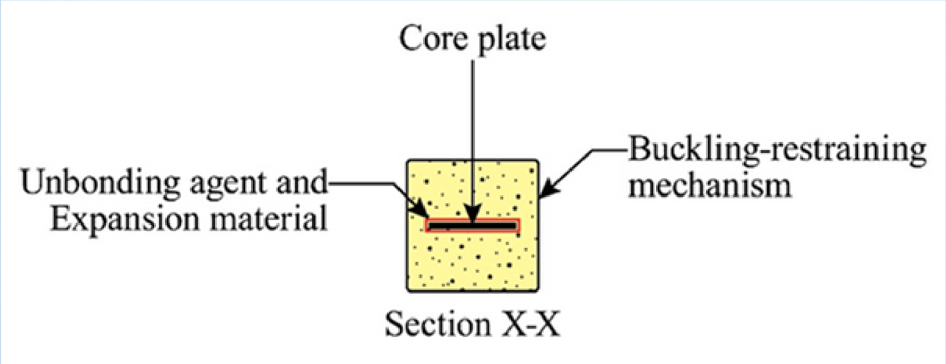


Fig. 2 Principal components of BRB



(a) Three main segments of BRB



(b) Cross-sectional view of BRB.

Fig. 3. Buckling-restrained brace

3. Diagonal Bracing

The simplest type of bracingused for resisting lateral loads is diagonal bracing. A single diagonal bracing is provided when the bay width is small. The number of diagonal bracing members inserted in the structure determines the overall efficiency of the braced frame. In the single diagonal braced frame, when a lateral load is applied to the braced frame, the diagonal braces are subjected to compression while the horizontal web member (beam) acts as a tension member to maintain the frame structure in equilibrium. Bracings oriented in both directions in the X-bracing type configuration act as tension and com pression members during reversible cyclesof dynamic loading.Broadly, two bays of singlediagonal braced frames are preferred over a single bay of V-brace or inverted V-brace. The slenderness ratio of the braces influences their energy absorption capacity. The braces with a smaller slenderness ratio can dissipate a higher amount of energy. While using diagonal bracing, the designer should check for the possibility of compression buck ling due to the vertical component of the brace force at the tensile yield strength. Considering all tension braces framing to the same column as having yielded at the floor levels above the floor level being checked is the most conservative approach in the design of the diagonal bracing system. Figure 4 (a) shows the yielding of braces in tension, and Figure 4 (b) shows the brace buckling in compression. The latest development in the diagonally braced frame is the Mega X-Bracing (Diagrid). It reduces the lateral drift substantially, minimizes shear deformation, provides maximum resistance againsttorsion, and possesses greater structural flexibility than other bracing systems. Further, there is a substantial saving in the quantity of steel. The diagrid can be configured with some adjustment in modules and angle(s) of diagonals to meet architectural and structural requirements.

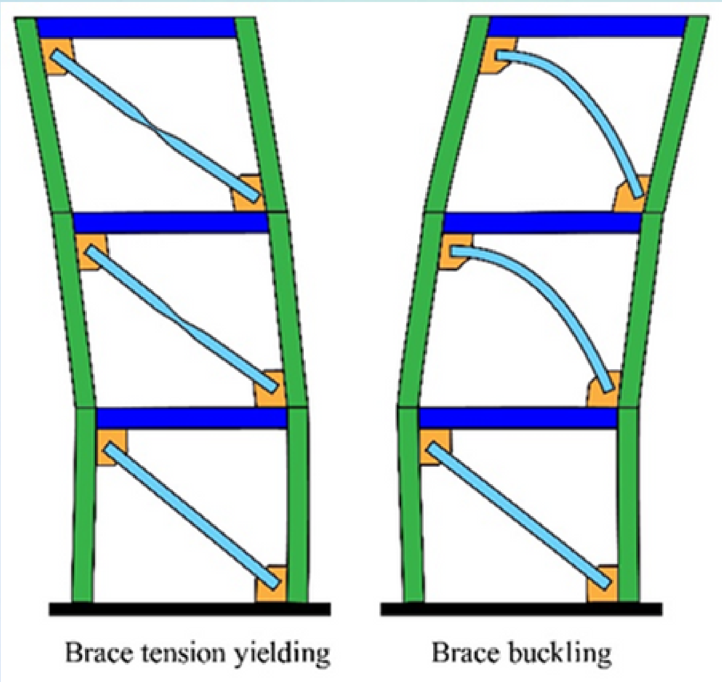


Fig. 4 Yielding and buckling of braces
(a) brace tension yielding and (b) brace buckling under compression

4. Concentrically Braced Frames (CBF)

CBF uses simple connections and a smaller cross-sectional area of beam and columnand can be approximately modeledas a vertical truss. The CBFs are commonly classified into three major types: viz., diagonally braced frames, V-braced frames, and inverted V, i.e., Chevron braced frames. These structures provide stability and lateral stiffness. They resist the lateral seismic acceleration primarily through the axial forces (tension and compression) and deformation of the braces, beams, and columns. The characteristic property of CBF is a low plastic distribution capacity that tendsto cause plasticdeformation in some stories. The seismic performance of the CBF is affected by the slenderness and width-to-thickness ratio of the braces. CBFs generally consist of a lateral load-resisting structural system formed by combining one or more diagonal braces like a concentric truss system. In concentric frames, center lines of all members such as beams, girders, and columns intersect each other at a common joint. Various configurations of CBF include chevron bracing, split chevron bracing, X bracing, single diagonal bracing, V bracing, split V bracing, and K bracing. CBFs increase the natural frequency of the structure by imparting additional stiffness with minimalweight, thus lowering the lateral story drift. The beam, column, and brace are assumed to be pin-connected at a common joint, and hence, there is no bending moment and shear force to be considered between the frame members. Therefore, the axial compression in the column is considerably increased.

5. Eccentrically Braced Frames (EBF)

The main idea in the design of an EBF is to integrate the advantages of both the MRF (Moment resisting frames) and CBF lateral load-resisting systems, into a single structural system. The EBF system originated from Japan in the 1970s to achieve a structure with high elastic stiffness and high energy dissipation during severe earthquakes. Eccentric bracing is a unique structural system that attempts to combine the strength and stiffness of a CBF with the inelastic behavior and energy dissipation characteristics of an MRF. In an eccentric bracing system, the connection of the diagonal brace is deliberately offset from the connection between the beam and the column. By keeping the beam to brace connections close to the columns, the stiffness of the system can be made very close to that of concentric bracing. This offset or eccentricity promotes the formation of energy-absorbing hinges in the portion of the bean between the two connections

Figure 5 presents the comparison of ductility and stiffness of MRF, CBF, and EBF. EBFs are made of two short diagonalbraces connecting the column to the middlespan of the beam with a short segment of the beam to increasethe lateral load resistance to seismic forces.EBFs provide architectural functionally, similar to the chevronbraced frames. The lateral stiffness of eccentric braces is lower than that of the CBFs, especially the diagonal bracing, because the eccentric braceshave a more ductile characteristic. The safety of the occupants in the buildingis ensured, as eccentric bracesdelay the structural response toward the earthquake by dissipating a large amount of energy. It gives sufficient time to the occupants to escape from the building.

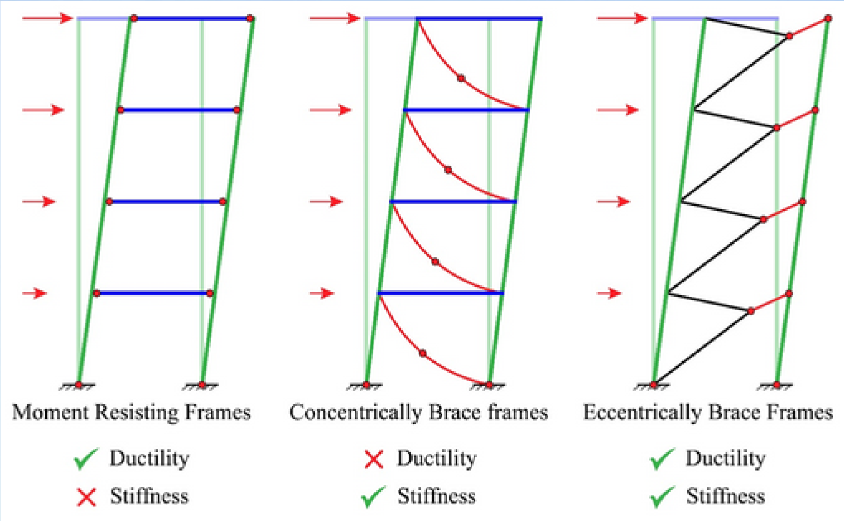


Fig. 5 Comparison of ductility and stiffness of MRF, CBF, and EBF bracing

EBF is a framingsystem in which the axial forces induced in the braces are transferred either to a column or anotherbrace through shear and bendingin a small horizontal segmentin between the connections of two bracing members called link element. Yielding is concentrated only at link segments, and all other members of the frame are proportioned to remain essentially elastic. The links in EBFs act as structural fuses to dissipate earthquake-induced energy in a stable manner and control plastic deformations. A link needs to be properly detailed such that it has adequate strength and stable energy dissipation characteristics to achieve the aforementioned objectives. All other structural components such as beam segments other than the link, braces, columns, and connections are proportioned following capacity design provisions to remain essentially elastic during the design earthquake. There are many variations in terms of the placement of the link beam in the EBF. Different placements or locations of the link in the structure lead to diversestructural response due to the impact of lateral load. The primary function of the link beam is energy dissipation under dynamic excitation. The link is used to control plastic deformation and maintain structural stability through seismic energy dissipation due to its ductile behavior. Moreover, the resistance to lateral movement in the eccentric braces is through the bending of the beam and column. The strength, stability, and ductility of the EBF are influenced by the length of the horizontal links.

A shorter horizontal length of links leads to higher shear-yielding efficiency, as the shear in thestory directly influences the shear in the links. It is reported that the short links have better performance in terms of rotation capacities compared to long and intermediate-length links. Further, the short links have greater strength and exhibit ductile performance under several cyclic loading cycles. In shear yielding,the web of beam yields along the entire length.Hence, a sufficient number of web stiffeners must be provided to control inelastic web buckling. The ultimate failure mode is web fracture. Bending may occur in the longer links that contribute more to the flexural yielding. The longer links provide the architecture freedom, especially in the placement of the window and door openings. Flexural yielding occurs near the beam ends. Hence, width-to-thickness limits of web stiffeners are important to control local flange and web deformation. If an intermediate length of the horizontal links is used in the eccentrically braced system, a combination of shear and flexural yielding would be experienced. If damaged during the seismicexcitation, it is time-consuming and expensive to replace or repair the horizontal link beam.

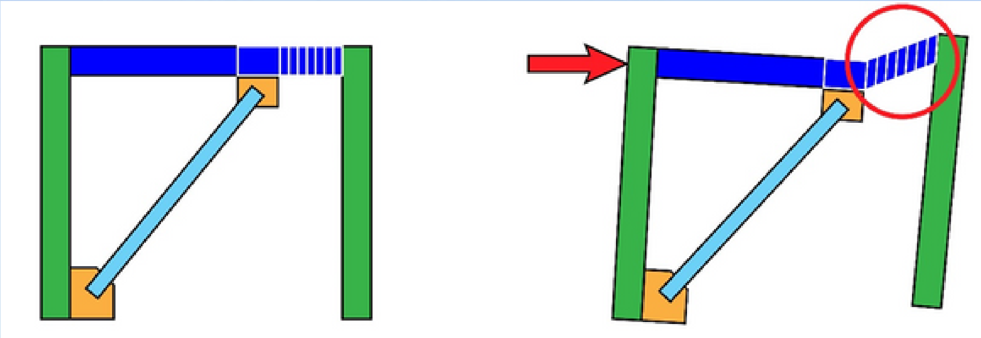


Fig. 6 Eccentrically located link element in a single-story frame
(a) link element at beam column joint and (b) deformed link element

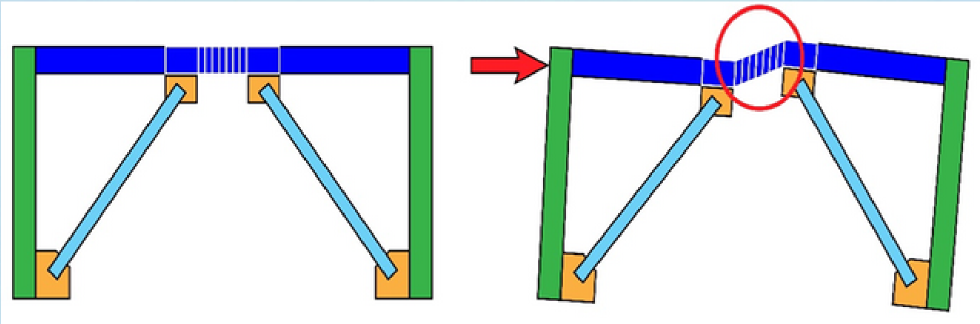


Fig. 7 Centrally located link element in a single-story frame
(a) link element at center and (b) deformed link element

Figure 6 and Figure 7 show a single-story frame with a link element located at the corner and center, respectively. It is seen that yielding occurs within the links, whereas all other members remain essentially elastic. Figures 8 (a) and (b) show the three-story frame with link elements located at the center and the corner, respectively.

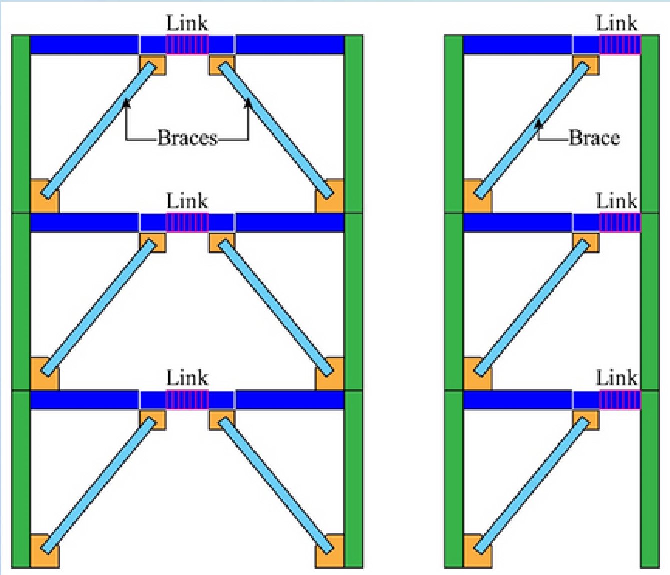


Fig. 8 Link element in a three-story frame
(a) link element at center and (b) link element at beam column joint

Attaching vertical links to the story beam is an alternative proposal to overcome the limitations of horizontal links. The vertical links act as fuses and are similar to the horizontal links, which providethe required ductility and energy dissipation capacity, and withstand most of the shear duringthe dynamic excitation by deforming plastically. There is no rotational restraint at the lower end of the vertical link. The floor beam does not suffer significant damage because the internal energy dissipation and inelastic deformation are accumulated in the link. Hence, the replacement of the vertical links is efficient and easier than horizontal links after dynamic excitation. Figure 9 shows the bracing type energy dissipation devices, viz., CBF, buckling-restrained brace, and link beam with their deformation patterns under lateral loading.

6. X-Type Brace

A single-story X-type brace is made of two diagonals. It may sometimes be challenging to employ X-type braces practically because the doorways and other openings may conflict with the X braces. It is required to provide additional splicing for the diagonal members where they cross each other. The behavior of the single-story X brace and two-story X brace is like a truss. Therefore, it is essential to check the columns for axial compression, as they have to resist the gravity loads and the vertical component of the brace tension. The two-story X brace requires special considerations of gravity loads and seismic forces compared to the single-story X brace. Particular attention should be given to columns as they have to resist the vertical component of the brace tensile yield force without buckling

7. K-Type Brace

K bracing allows for circulations through the middle of the bay, unlike X bracing that virtually eliminates the possibility of circulation. Many studies have reported that K braces should not be used in areas of moderate-to-high seismicity. The braces' unequal buckling and tension-yielding strengths create an unbalanced horizontal force at the mid-height of the columns, jeopardizing the ability of the column to carry gravity loads if a plastic hinge forms at its mid-height.

8. V- Brace and Inverted V- Brace (Chevron Brace)

High elasticstiffness and strengthare the characteristics of the chevron braces.Chevron braces are most effective in the architectural functionality, as they allow the positioning of windows and doorways at bay of the braces. In chevron braced frames, compression and tension are exerted on each side of braces. Both braces distribute the lateral load equally in the elasticrange, prior to buck- ling. The compression braces buckle and the tension braces sustain tensile forces. Large bending moments are created at the intersection of beam and braces. The unbalanced distributed force has major influence of the tension and compression braces that can cause large deflections. Since the chevron bracinghas a non-ductile behavior, using a deep beam or heavy beam which is able to pro- vide adequate strength, the undesirable deterioration of frame can be prevented. The strong beam mechanism is highly ductile and can dissipate considerable energy; thus, delaying the failure of braces in fracture. Superior hysteretic response can be achieved from the strong beam mechanism, wherein the ductile braces distribute damages over the height of the building. The most efficient architectural bracing configuration is the V type or inverted V type. In the V bracing, the beams are designed for the unbalanced loading; that occurs when the compression brace buckles and the tension brace pulls the beam down. This potential failure mode is largely present in V bracing as compared to in other brace configurations. When V-braces are used, the ends of the SCBF beams are generally assumed as pinned-pinned.

However, this is a very conservative assumption that may lead to large beam size because most of the beam bending momentresults from the unbalanced load. Gusset plateprovided at the beam ends provides partialor full fixity, thus reducing the moment.

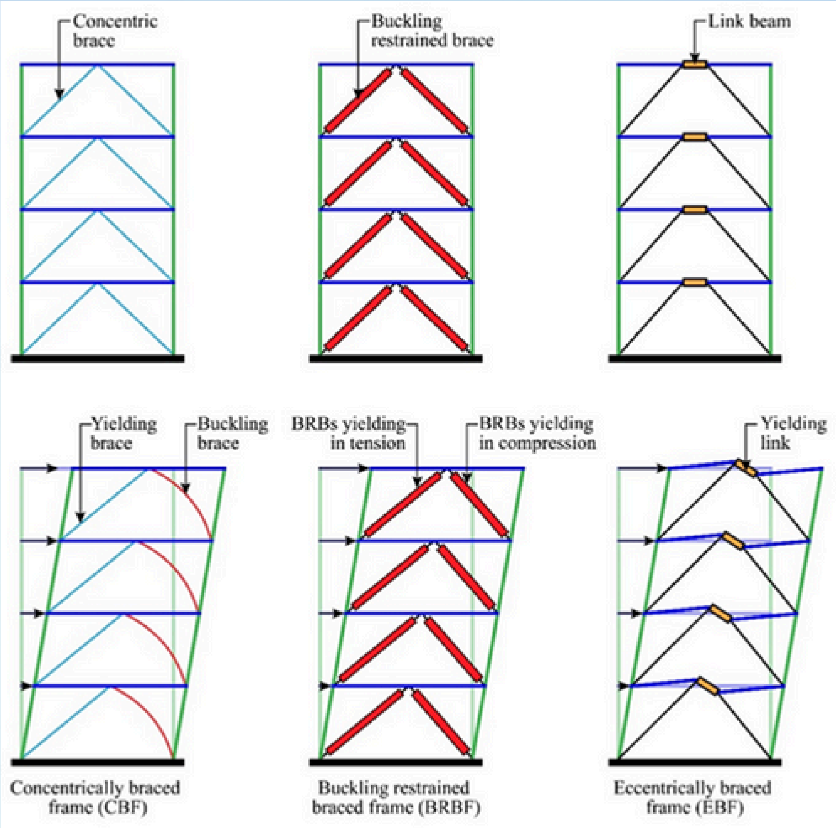
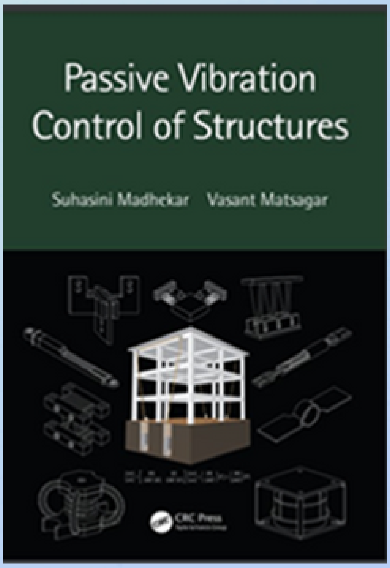


Fig. 9 Bracing type energy dissipation devices

Editor's Note : This article is a preview of Chapter-3 of the Authors' book entitled "Passive Vibration Control of Structures" (CRC Press). Chapter-1 was covered in the previous issue of "amplitude". We plan to present the previews of subsequent Chapters of the book in future issues of this Newsletter



Neural Network Method for Predicting Modal Frequencies of Composite Plates

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Abstract

This article presents a neural network approach to predict the modal frequencies of a composite plate in a fixed- fixed condition, aiming to enhance the efficiency and accuracy of Experimental Modal Analysis (EMA). An 8- channel DAQ system and accelerometer were used to acquire vibration response data. The neural network was trained with modal frequencies from the fundamental mode to the 20th mode and then used to predict the 12th and 23rd modes within and beyond the dataset, respectively. The model showed strong accuracy for within-dataset predictions after sufficient training epochs, but struggled to achieve similar precision for beyond-dataset predictions, highlighting the need for additional strategies or more diverse training data to improve generalization capabilities.

Introduction

Experimental Modal Analysis (EMA) is a technique used to determine the dynamic characteristics of a structure, such as natural frequencies, mode shapes, and damping ratios. This process involves exciting the structure using a known input force and measuring the resulting response, typically using accelerometers or other sensors. By analyzing these input-output relationships, EMA identifies the inherent vibrational properties of the structure. This information is critical for understanding how the structure will behave under different operational conditions, optimizing designs, and diagnosing potential issues in mechanical systems.

Neural networks are a class of machine learning models inspired by the human brain's structure and function. They consist of interconnected layersof nodes (neurons) that process data and learn patterns. The most basictype is the feedforward neural network, where data moves in one direction from input to output layers.More complex architectures, like convolutional neural networks (CNNs)and recurrent neural networks (RNNs),are designed for specific tasks such as image processing and sequence prediction. Neural networks are trained using algorithms like backpropagation, where the network adjusts its weights based on the error of its predictions compared to actual outcomes. This training process allows neural networks to model complex, non-linear relationships and make accurate predictions or classifications.

Abdolrasol et al. [1] provide a comprehensive review of optimization techniques based on artificial neural networks (ANN), discussing methodologies to find optimal parameters along with the associated challenges and motivations. Kusiak et al. [2] emphasize the importance of neural networksin contemporary approaches, arguing that future products may need to be designed for manufacturing processes not known at the design phase, highlighting the significance of prediction-based methods.Silva et al. [3] presenta prediction modelfor electrical terminals in the automotive industry, showing that correlations between mechanical properties like strength and hardness can enhance model performance. Kloch et al. [4] highlight the importance of prediction-based approaches and numerical modeling on both micro and macro scales. Jeong et al. [5] validate that an FEA-ANN modeling approach is highly robust and capable of accurately capturing properties under consideration. Iqbal et al. [6] offer an ANN-based approach for understanding Stress Concentration Factors under complex loading, providing a regression analysis with controllable error. Barbosa et al. [7] study the mean stress effects for predicting fatigue life using neuralnetworks, providing a reference procedurefor similar problems. Bolandi et al. [8] suggest a deep learning method that embeds physics functions into loss functions to drive model training. Isleem et al. [9] study the axial compressive behaviorin columns using ANN modelsto predict structural behavior, noting the gap in studies related to connector and terminal applications, which are emerging technologies.

Neural networks can be integrated into experimental modal analysis to enhance the prediction and analysis of dynamic characteristics of structures. First, collect vibration response data from the structure using sensors. This data includesthe input excitation forces and the corresponding outputresponses at variouspoints on the structure. Preprocess this data by normalizing it and possibly extracting relevant features to feed into the neural network. Train a neural network on this preprocessed data. The input layer of the neural network could represent the excitation force and measurement points,while the output layer represents the predicted dynamicproperties, such as natural frequencies and mode shapes. The network learns the complex relationships between input forces and the resulting vibrational responses through iterative training. Once trained, the neural network can predict the dynamic characteristics of new, unseen data. This capability allows for rapid analysis without the need for extensive physical testing.The predictions can then be validated againstactual measurements to ensure accuracy.

Implementing neural networks in EMA offers several advantages. Neural networks can quickly predict dynamic characteristics once trained, significantly reducing the time required for analysis comparedto traditional methods. Neural networks are adept at modeling non-linear relationships, making them well-suited for complex structures where traditional linear assumptions may not hold. Neural network models can automate the analysis process, allowing for scalable solutions that can handle large datasets and complex structures. By learning from vast amounts of data, neural networks can improve the accuracy of modal predictions, leading to better-informed decisions in design and diagnostics.

Experimental Setup

The experimental setup has been depicted in Fig 1. An 8-channel DAQ system was used for the data acquisition fromthe composite sample in fixed-fixed condition in an in-house developed fixture.An excitation hammerwas used to strike at various locations and the accelerometer was appended at the surface to obtain the response.

Fig 1. Experimental setup

Results and Discussions

Based on the experimentation, the first 25 modes were determined and the same have been tabulated below in Table 1.

Neural networks were trained with the modal frequencies from the fundamental mode to the 20th mode and used to carry out predictions of twotypes. Firstly, to predict the modal frequencies within the training datasetand then the modal frequencies beyond the dataset. For within the dataset, randomly the frequency corresponding to 12th mode was considered and for beyond the dataset,the frequency corresponding to the 23rd mode was considered at random. The aim is to find out how accurately can the neural network predictthe modal frequencies as close as possible to the experimental values so that it can be used as a faithful replacement to the process if sufficient experimental data is available for the training of the neural network.

Table 2 shows a comparison of the experimental modal frequencies and neural networkpredictions along with the performance metric in terms of mean absolute error (MAE) and the percentage deviation.

The Table presentsan in-depth analysisof the predictive model's performance in estimating frequencies for Modes 12 and 23, both within and beyond the provideddataset. The data is evaluatedacross various epochs—100, 250, 500, and 1000—considering experimental frequencies, predicted frequencies, Mean Absolute Error (MEA), and percentage error.

Table 1. Modal frequencies and damping ratio values

Mode. No.	Damping Ratio	Modal Frequency (Hz)
1	0.1068	86.417
2	0.041573	181.31
3	0.0082345	211.03
4	0.57941	230.91
5	0.0089312	286.35
6	0.0023497	335.17
7	0.013493	411.54
8	0.037762	437.16
9	0.02203	539.13
10	0.013758	599.48
11	0.026162	647.7
12	0.00028266	704.7
13	0.019743	748.21
14	0.0101	792.4
15	0.00096218	824.69
16	0.035702	873.97
17	0.026455	881.06
18	0.010045	987.74
19	0.019855	1089.1
20	0.014419	1307.1
21	0.0025795	1344.7
22	0.00858	1531.3
23	0.00573	1751
24	0.00951	1855.2
25	0.00735	1942.5

Table 2. Summary of predictions

	Epoch	Experimental Frequency (Hz)	Predicted Frequency (Hz)	MEA	% error
Within Dataset Mode 12	100	704.7	61.192	354.761	91.31659
	250	704.7	600.3745	57.711	14.80424
	500	704.7	693.5192	13.156	1.586604
	1000	704.7	693.50464	14.989	1.58867
Beyond Dataset Mode 23	100	1751	154.1504	343.54	91.19644
	250	1751	1147.478	48.0293	34.46728
	500	1751	1292.7155	12.1323	26.17273
	1000	1751	1298.9197	14.501	25.81841

The results have been depicted pictorially in Fig 2, 3 and 4.

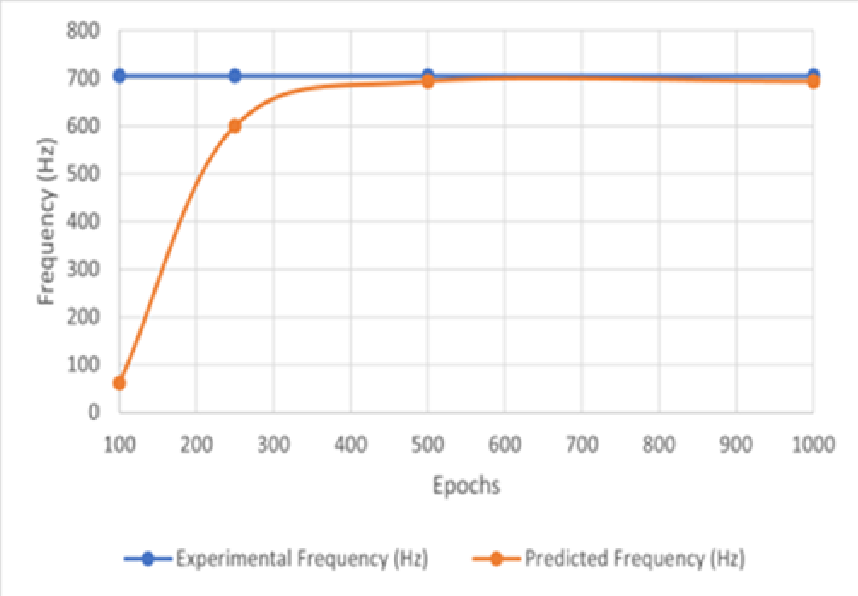

Fig 2. Frequency vs. Epochs – within the dataset

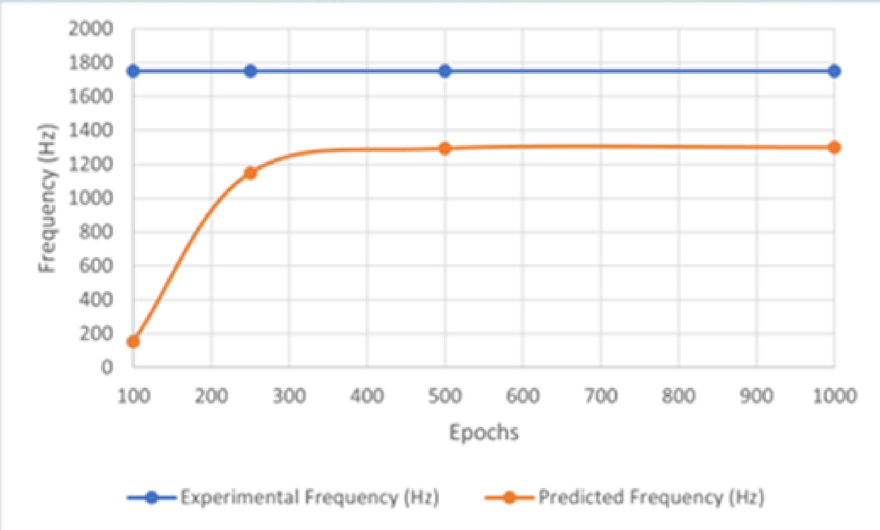

Fig 3. Frequency vs. Epochs – beyond the dataset

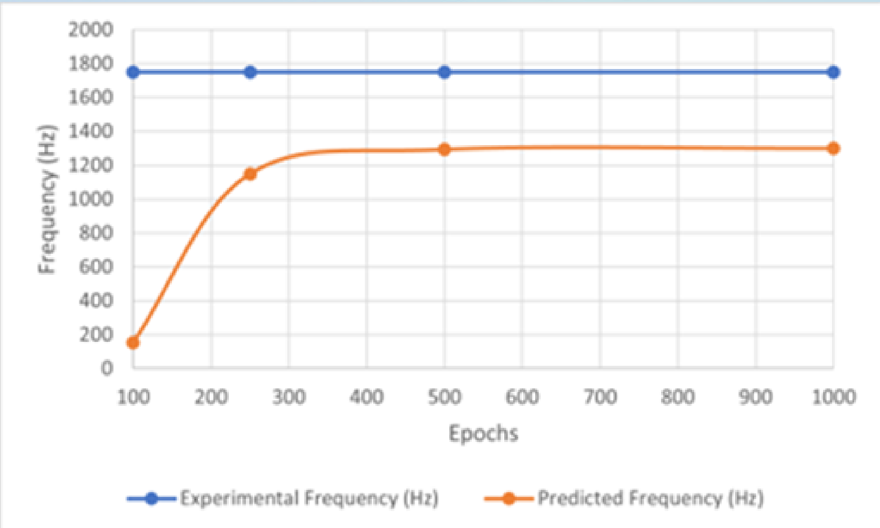

Fig 4. Mean Absolute Error (MAE) vs. Epochs

For Mode 12 within the dataset, at epoch 100, the experimental frequency is 704.7 Hz while the predicted frequency is 61.192 Hz, resulting in a high MEA of 354.761 and a percentage error of 91.32%. This indicates that the model significantly underpredicts the frequency, demonstrating poor initial performance. However, by epoch 250, there is a notable improvement with the predicted frequency increasing to 600.3745 Hz. The MEA drops to 57.711 and the percentage error reduces to 14.80%, reflecting better accuracy as the model trains further. At epoch 500, the predicted frequency nearly matches the experimental frequency, reaching 693.5192 Hz, with a significantly lower MEA of 13.156 and a percentage error of 1.59%. This suggests that the model has effectively learned the pattern. By epoch 1000, the predicted frequency is 693.50464 Hz, with an MEA of 14.989 and a percentage error of 1.59%, indicating stable and accurate predictions as the model does not show significant improvement beyond epoch 500.

In contrast, for Mode 23 beyond the dataset, the model initiallystruggles more with prediction accuracy.At epoch 100, the experimental frequency is 1751 Hz, but the predicted frequency is only 154.1504 Hz, resulting in an MEA of 343.54 and a percentage error of 91.20%. This indicates a substantial underprediction and high inaccuracy. By epoch 250, there is considerable improvement with the predictedfrequency rising to 1147.478 Hz. TheMEA reduces to 48.0293 and the percentage error to 34.47%,showing progress but still not achieving reliable accuracy. At epoch 500, the predicted frequency further improvesto 1292.7155 Hz, with a lower MEA of 12.1323 and a percentage error of 26.17%, indicating enhanced learning. However, even at epoch 1000, the predicted frequency of 1298.9197 Hz with an MEA of 14.501and a percentage error of 25.82% reflectsthat while the model has stabilized, it does not achieve the same level of accuracyas within the dataset, suggesting continued challenges in generalizing to new data.

Thus, the model demonstrates effectivelearning and high accuracy withinthe dataset for Mode 12, achieving low error rates after sufficient training epochs. However, for Mode 23 beyond the dataset, the model requires more epochs to improve and still does not reach the same level of precision. The higher error rates and MEA in predictions beyond the dataset indicate a need for additional strategies or more diverse training data to enhance the model's generalization capabilities

Conclusion

The predictive model shows strong accuracy within the dataset for Mode 12, achieving low MEA and percentage errors after sufficient training epochs. In contrast, for Mode 23 beyond the dataset, the model struggles to achieve the same level of accuracy, with higher MEA and percentage errors indicating challenges in generalizing to new data. This suggests that while the model performs well within known data, it requires further refinement and possibly more diverse training data to improve its predictions for unseen data.

References

[1] Abdolrasol, M.G., Hussain, S.S., Ustun, T.S., Sarker, M.R., Hannan, M.A., Mohamed, R., Ali, J.A., Mekhilef, S. and Milad, A. Artificial neuralnetworks based optimization techniques: A review. 10(21), Electronics, 2021

[2] Kusiak, A. Extreme engineering: Polarization in productdevelopment and manufacturing., 7(3), Engineering, 2021

[3] Silva, F.J.G., Morgado, L., Teixeira, A., Sá, J.C., Ferreira, L.P. and de Almeida, F., Analysis and Development of a Failure Prediction Model for Electrical Terminals Used in the Automotive Industry. 51, Procedia Manufacturing, 2020

[4] Kloch, K.T., Kozak, P. and Mlyniec, A.,. A review and perspectives on predicting the performance and durability of electrical contacts in automotive applications. 121, Engineering Failure Analysis, 2021

[5] Jeong, K., Lee, H., Kwon, O.M., Jung, J., Kwon, D. and Han, H.N.. Prediction of uniaxial tensile flow using finite element-based indentation and optimized artificial neural networks. 196, Materials & Design, 2020

[6] Iqbal, M., Karuppanan, S., Perumal, V., Ovinis, M., Khan, A. and Faizan, M.,. Stress Concentration Factors in KT-Joints Subjectedto Complex Bending Loads Using Artificial Neural Networks. 10(4), Civil Engineering Journal,2024

[7] Barbosa, J.F., Correia,J.A., Júnior, R.F. and De Jesus, A.M.,Fatigue life prediction of metallic materials considering mean stress effects by means of an artificial neural network. 135. International Journal of fatigue, 2020

[8] Bolandi, H., Li, X., Salem, T., Boddeti, V.N. and Lajnef, N. Deep learning paradigm for prediction of stress distribution in damaged structural components with stress concentrations, 173, Advances in Engineering Software, 2022

[9] Isleem, H.F., Tayeh,B.A., Alaloul, W.S.,Musarat, M.A. and Raza, A.. Artificial neuralnetwork (ANN) and finite element (FEM) models for GFRP-reinforced concretecolumns under axial compression, 14(23), Materials, 2021

Contributed by Dr Arun Jalan, FCVS

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Word Search Game 4: Come be a member

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B	E	A	I	N	S	T	R	U	M	E	N	T	A	T	I	O	N	I	O
A	C	M	I	S	S	I	O	N	S	R	T	U	X	A	V	E	R	A	M
A	S	E	T	O	P	N	I	A	G	O	N	A	T	Y	K	O	R	B	A
C	A	U	T	I	O	N	A	V	U	O	B	P	I	T	A	R	A	A	N
L	O	T	B	T	E	C	H	N	I	C	I	A	N	S	C	O	P	P	E
A	S	T	M	J	E	T	E	T	D	B	I	R	D	S	P	I	C	E	S
D	R	I	V	E	E	R	A	T	A	I	R	O	U	M	E	N	D	E	R
A	N	P	M	O	T	C	H	A	N	O	O	A	S	U	B	J	E	C	R
B	B	R	O	U	U	A	T	I	C	O	N	U	T	I	N	T	M	I	C
R	A	A	T	D	L	O	P	S	E	T	A	D	R	I	V	E	O	G	O
E	T	C	E	P	A	A	N	S	W	E	R	I	I	V	O	E	N	D	A
A	R	T	A	P	L	A	T	F	O	R	M	E	E	P	O	N	S	A	R
D	N	I	R	D	R	R	P	I	N	T	I	N	S	T	A	G	T	O	N
T	O	C	B	A	E	A	T	I	O	N	I	C	O	M	M	I	R	E	A
A	B	A	N	P	I	M	C	O	U	N	T	E	C	O	I	N	A	C	L
X	I	L	X	O	X	N	I	T	E	X	R	E	T	O	B	E	T	I	N
A	P	E	N	T	H	O	I	A	I	M	P	U	L	S	O	E	I	N	K
S	E	R	V	O	C	E	I	N	M	C	A	T	I	E	R	R	O	T	A
E	R	O	S	T	E	E	R	I	G	I	A	N	N	T	E	S	N	U	T

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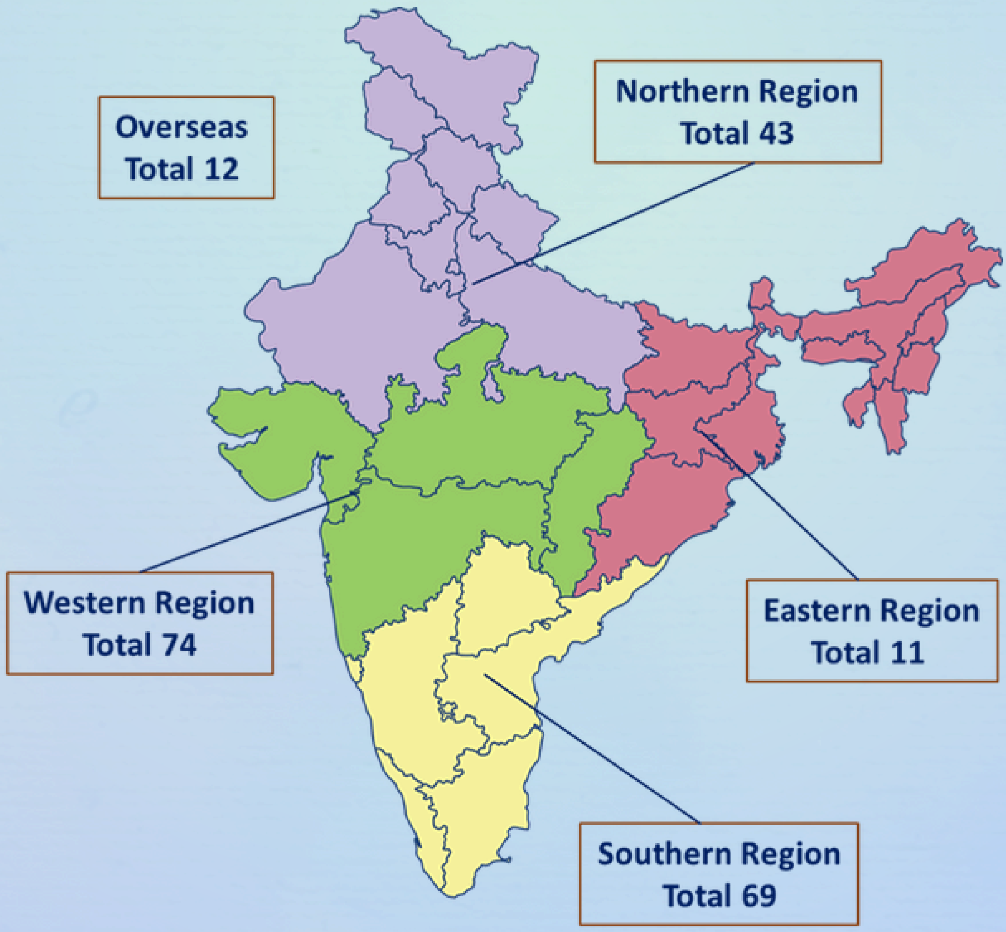
Total	74	69	11	43	12



Solution to the CVS Crossword

A	X	E	G	O	N	E	Y	E	S	S	E	R	V	I	C	E	T	A	N
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A	C	M	I	S	S	I	O	N	S	R	T	U	X	A	V	E	R	A	M
A	S	E	T	O	P	N	I	A	G	O	N	A	T	Y	K	O	R	B	A
C	A	U	T	I	O	N	A	V	U	O	B	P	I	T	A	R	A	A	N
L	O	T	B	T	E	C	H	N	I	C	I	A	N	S	C	O	P	P	E
A	S	T	M	J	E	T	E	T	D	B	I	R	D	S	P	I	C	E	S
D	R	I	V	E	E	R	A	T	A	I	R	O	U	M	E	N	D	E	R
A	N	P	M	O	T	C	H	A	N	O	O	A	S	U	B	J	E	C	R
B	B	R	O	U	U	A	T	I	C	O	N	U	T	I	N	T	M	I	C
R	A	A	T	D	L	O	P	S	E	T	A	D	R	I	V	E	O	G	O
E	T	C	E	P	A	A	N	S	W	E	R	I	I	V	O	E	N	D	A
A	R	T	A	P	L	A	T	F	O	R	M	E	E	P	O	N	S	A	R
D	N	I	R	D	R	R	P	I	N	T	I	N	S	T	A	G	T	O	N
T	O	C	B	A	E	A	T	I	O	N	I	C	O	M	M	I	R	E	A
A	B	A	N	P	I	M	C	O	U	N	T	E	C	O	I	N	A	C	L
X	I	L	X	O	X	N	I	T	E	X	R	E	T	O	B	E	T	I	N
A	P	E	N	T	H	O	I	A	I	M	P	U	L	S	O	E	I	N	K
S	E	R	V	O	C	E	I	N	M	C	A	T	I	E	R	R	O	T	A
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