



## SARAS PT2 makes maiden flight

THE second prototype PT2 of the 14-seater multi-role Light Transport Aircraft *SARAS* had its successful maiden flight on 18 April 2007 at 09.05 hours. *SARAS* is the first indigenous civilian aircraft of the country, being developed by the National Aerospace Laboratories (NAL), Bangalore. The maiden flight of *SARAS* was conducted by Wg. Cdr. R.S. Makker as the Chief Test Pilot, Wg. Cdr. A. Malik as the Co-pilot and Wg. Cdr. M.S. Ramamohan as the Flight-test Engineer, all belonging to Aircraft Systems and Testing Establishment (ASTE) of the Indian Air Force, which has been the flight testing organization for *SARAS*.

The first prototype (PT-1) of *SARAS* had its maiden flight on 29 May 2004 and its formal inaugural flight on 22 August 2004 in the presence of Shri Kapil Sibal, Minister for Science & Technology and Earth Sciences. Till now, 106 flights of *SARAS* PT1 have been conducted successfully, including the ones in the *Aero India* airshows of February 2005 and February 2007.



Several improvements have been made in design of the second prototype. The most important one among these is the incorporation of two higher power engines PT 6A-67A of 1200 hp each in PT2 in place of PT6A-66 of 850 hp each used in PT1 and new propellers of larger diameter. This is particularly done to meet the stringent climb gradient requirements under one engine failure condition as stipulated by Federal Aviation Regulations 25 (FAR-25) of USA, the certification standard for *SARAS*.



The higher power engines will also improve the other performance characteristics of SARAS. The supporting stubwing structure and the engine nacelle were also modified to suit the new engine. Improvements have also been incorporated in flight control system layout, flap operating system, avionics and electrical system layout etc., taking into account the inputs received from the flight crew and maintenance staff. All these improvements have brought PT2 much closer to the final production standard aircraft.

Parallely, a weight optimization programme has also been taken up for SARAS, with a target of 500 kg weight reduction, through optimization of metallic structures, stringent fabrication control, increased use of composites, etc. An additional prototype will be built to the final production standard and proved through a combination of ground and flight-testing. The FAR-25 standard certification by the Director General of Civil Aviation is targeted for the end of 2009.

Discussions are progressing with the Indian Air Force which is likely to be the launch customer for SARAS for meeting some of their transport and training requirements and also with HAL for productionising the aircraft. The aircraft performance will be

**The SARAS second prototype aircraft VT-XRM with the new, more powerful engines (PT6A-67A), took off from the Bangalore Airport at 09. 05 hrs and the flight lasted about 40 minutes. The aircraft climbed to an altitude of about 9000 ft. and reached a maximum speed of nearly 150 knots. The pilots executed several mild maneuvers to get a feel of aircraft handling qualities. The landing was perfect as indeed were the other phases of flight. The flight crew reported that the aircraft handled as expected and there were no surprises. The flight parameters were normal and as expected. Wg. Cdr. R.S. Makker, Chief Test Pilot, said after the flight that –**

**“The present SARAS with new engines appears to be a very potent and powerful machine, with all the aircraft systems performing precisely in the first flight itself, only goes on to show the professionalism of the entire TEAM SARAS”.**

demonstrated in PT2 to the Indian Air Force by simulating the all up weight of 7100 kg. After some further data is gathered, discussions will also take place with the Ministry of Civil Aviation and various operators for utilization of SARAS in regions like the North East and in other roles like feeder aircraft, light cargo aircraft, air ambulance, etc.

With the present boom in civil

aviation and the recognized need for air-networking different parts of the country including smaller towns, SARAS will have a distinct role to play in establishing air connectivity, bringing people together and in the overall economic development of the country. The maiden flight of PT2 is thus a very important milestone in that direction and in ultimately establishing a viable civil aircraft industry in the country.



## Diversity oriented Synthesis of Tricyclic Compounds

**I**N the era of chemical genetics, small molecules are receiving unprecedented attention in order to understand and eventually modulate various biosynthetic pathways. Increased laboratory automation has improved the efficiency of screening for bioactives thereby demanding diverse chemical libraries for high-throughput screening. Diversity oriented synthesis is a newly proposed algorithm which enables synthesis of diverse molecular scaffolds within the ambit of combinatorial chemistry.

Dr Hotha's group at National Chemical Laboratory (NCL), Pune, has hypothesized that carbohydrate templates enable syntheses of oxygen-rich, chirally homogenous, complex, multi-cyclic and natural

product-like chemical scaffolds exploiting various complexity generating reactions such as Pauson-Khand, Hashmi's, Metathesis and Diels-Alder reactions. A Lewis acid mediated  $S_N2$  addition of alcohols to per O-acetylated glycols is known as the Ferrier reaction and a  $Co_2(CO)_8$  promoted 2+2+1 cyclization of an alkyne and an alkene is the Pauson-Khand reaction. Hotha and his graduate student Tripathi have achieved a natural product-like tricyclic enone library by performing the stereoselective Ferrier reaction to obtain  $\alpha$ -glycosides, introduced a propargylic moiety for the stereoselective Pauson-Khand reaction to obtain tricyclic enones which was further diversified using several mercaptans by Michael's thiolate addition on to the enone.

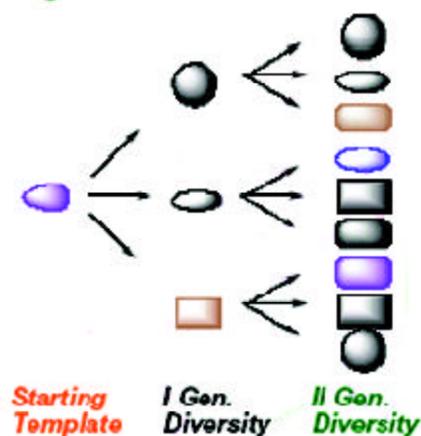
It is pertinent to mention that the complexity generating reactions viz. the Ferrier, Pauson-Khand and the Michael addition reactions were highly diastereoselective thereby enabling chirally pure, oxygen-rich, tricyclic derivatives from easily accessible glycols. Hotha's team is currently engaged in developing diversity oriented pathways for chirally pure, oxygen-rich, multi-cyclic and natural product-like libraries from carbohydrate templates.

### References

- Hotha, S. and Tripathi, A., *Tetrahedron Lett.* **2005**, 46, 4555-4558.  
 Hotha, S. and Tripathi, A., *J. Comb. Chem.* **2005**, 7, 968-976.

### Diversity Oriented Synthesis

#### Algorithm



#### Synthesis of Natural-product Like Tricyclic Compounds





### Structural Engineering Research Centre

#### R&D HIGHLIGHTS 2005-06

**T**HE Structural Engineering Research Centre (SERC), Chennai, continues to surge ahead with noteworthy progress in all its sponsored, grant-in-aid collaborative and in-house research and development projects, consultancy assignments and technical services. Highlights of 2005-06 are as follows:

##### Sponsored Projects

Four new sponsored research projects were undertaken during the year, apart from continuing the work on existing six sponsored projects. The new projects undertaken are: Studies on ratcheting behaviour of pressurized pipes and elbows; Bimetallic/narrow gap welded pipe fracture tests under cyclic bending load; Analysis, design and evaluation of laced reinforced storage building (IGLOO) including software development and Shaft alignment computer software on Windows platform (SACS-WIN).

##### Grant-in-aid Projects

Seven new grant-in-aid projects were taken up which include: Studies on evaluation of durability of loaded (Pre-cracked) RCC members using fly ash concrete subjected to accelerated corrosion and carbonation; Investigations on the behaviour of laced reinforced concrete members with and without steel fibres; Survivability of plate/shell panel structures/structural

components under impact loads; Experimental investigations on hybrid fiber reinforced concrete; Error estimation and adaptive refinements for fracture analysis of 2-D and 3-D crack problems; Development of distributed memetic algorithms and their applications to multi-criteria design optimization of laminate composite panels and Development of Code and Handbook for design of cold-formed steel members IS:801.

##### NMITLI and Network Projects

SERC is actively participating in the New Millennium Indian Technology Leadership Initiative (NMITLI) project on Development of a 500 kW, *Low Cost Horizontal Axis Wind Turbine*, with NAL, Bangalore and Sangeetha Group of Companies, as collaborating partners.

The Centre has provided leadership as the nodal laboratory for the CSIR Network Project on Design, Analysis and Health Assessment of Special Structures including Bridges. Besides, it has been participating in seven other network projects, viz., Mathematical modelling and computer simulation; Developing capabilities in advanced manufacturing technologies; Technology for engineering critical analysis; Development of new building construction materials and technologies; New and improved road technologies; Upgradation of SI

base units, national standards of measurements and apex calibration facilities and creation of high quality network of testing and calibration laboratories, and preparation of certified reference materials and Development of technology for disaster prevention and management in Jharia coalfields.

##### Consultancy Assignments

Notable among such assignments include: *Fatigue strength evaluation of compound links and pistons used in automobile chasis*, for Wheels India Ltd, Chennai; *Mix design for M60 grade high performance concrete*, for Hindustan Construction Co. Ltd, Orissa; *Testing of 400kV Double "V" suspension string and 400kV triple tension string with hardware*, for Bharat Heavy Electricals Ltd, Bangalore; *Proof checking the design of 120m guyed tower*, for C-WET, Chennai; *Fatigue strength evaluation of alumino-thermit welded rail joint*, for Oberoi Thermit Pvt. Ltd, Uttar Pradesh; *Condition assessment of corrosion affected Head Room area of conveyor roof structure and conveyor supporting structures*, for Madras Fertilizers Ltd, (MFL), Chennai; *Condition assessment of jetty and Intake structures*, for Nuclear Power Corporation of India Ltd, Madras, Atomic Power Station, Kalpakkam; *Evaluation of characteristics of refractory cement used as a bonding material in PSLV/*



*GSLV launch vehicles*, for Liquid Propulsion Systems Centre (LPSC) ISRO, Thiruvananthapuram; *Investigation of ring beam of KGS-1 Reactor Building by ultrasonic scanning and rebound hammer test*, for Nuclear Power Corporation of India Ltd, Karnataka; *Investigation of the concrete quality of the chimney of Aurobindo Agro Energy Private Limited at Kalaiyar Koil*, for Aurobindo Agro Energy Pvt. Ltd, Chennai; *Prototype proof testing of 80m tower*, for Reliance Engineering Associates Pvt Ltd, Mumbai; *Field inspection and analytical studies on the failure of Keeranur MW tower*, Bharath Sanchar Nigam Ltd, Tamil Nadu; *Design of Seismic retrofitting scheme for fly ash storage silo for Suratgarh Thermal Power Station. Stage - III, Unit-V*, for Bharat Heavy Electricals Ltd, Bangalore; *Health assessment of the heavy concrete walls of Calandria Vault of reactor Unit-II, KAPS, Gujarat*, for Nuclear Power Corporation of India Ltd, Mumbai; *Analysis and design of a new profile for an 8' dia gas pipeline in service*, for Gas Authority of India Ltd, Jaipur; and *Condition assessment of concrete in the recast upper brackets of Unit-2 of the upper Sindh Hydro Electric Project at Kangan*, for the Jammu & Kashmir Power Development Corporation, Srinagar.

### **Thrust Area R&D Projects**

#### **Wind Engineering & Experimentation Structural Dynamics and Earth Engineering**

A detailed investigation has been completed, involving both

experimental and analytical studies on the wind-induced interference effects in prismatic structures having different cross sections. The modal crosswind force spectral coefficient (MCFSC) has been evaluated for isolated as well as different interfering orientations. The results obtained have indicated possible improvement to the recommendations in relevant codes on Wind Loads for Square Buildings. The interference factor varies depending upon the relative interfering positions. The study has brought out recommendations on suitable values to be adopted for the mean drag coefficient under different geometries/configurations of prismatic structures vis-à-vis wind flow direction, an empirical relationship for the modal across-wind force spectrum, including the effects due to vortex shedding, turbulence intensity, and mean velocity and fundamental mode shape profiles.

A project on Development of Fatigue Load Spectrum for Design of Structures/Components subjected to Dynamic Wind Loads has been completed leading to several recommendations related to fatigue design of wind sensitive structures/components. In coastal zones, it is recommended to consider the wind direction reversals during any day (diurnal variation) for fatigue damage accumulation due to the low cycle fatigue with large magnitudes of stress ranges in a structure.

It has been found that the variation of standard deviation of wind speed along the height should be included in the calculation of

dynamic response of slender towers and masts using the stochastic spectral approach. Besides, power and exponential forms of empirical expressions have been recommended for the evaluation of aerodynamic admittance function of lattice frame. It is also recommended to consider the second-order effects of wind speed fluctuations for lattice towers and slender masts with traffic sign boards, in the evaluation of background factor used in the gust response factor of IS 875 (Part 3) code. A generalized gust response factor based bio-modal spectral method for the evaluation of fractional fatigue damage has been formulated for practical fatigue design of slender metallic structures.

Measurement of dynamic pressure fluctuations on a bridge deck enables a better understanding of the flow pattern around the bridge deck in terms of flow separation, etc., and also in evaluation of correlation of pressures across the width of the deck. With the above objective, a section model of a typical bridge deck, measuring 26 cm in width and 98 cm in length has been fabricated to a model scale of 1:50. The model was tested under simulated open terrain conditions, for 0° wind angle and for wind speeds of 9.5 and 11.6 m/s.

Numerical flow simulation studies have been carried out around two 2-D square cylinders positioned in tandem and side-by-side arrangements to study the interference effect on mean drag and lift coefficients on the interfering bodies.



Boundary layer wind tunnel studies have been completed on mapping of mean velocities at different grid points behind the nacelle of a wind mill tower.

A parametric study using finite element method has been completed by including the flexibility of framed buildings of 1-storey, 2-storey and 3-storey. The study also covered the effect of the roof-top tower being directly anchored on the roof slab with concrete pedestals. Static deflections show considerable variation with respect to the building system. When the same tower is placed on pedestals on a simply supported 10 cm thick RCC slab, the bending mode of the roof-top tower is significantly reduced from 1.74 Hz to 0.534 Hz, making it wind sensitive.

Static and dynamic tests were carried out on 0.4 mm and 1.2 mm diameter SMA based nickel titanium alloy wires for evaluating the static and dynamic characteristics such as ultimate tensile strength, frequency dependency and number of cycles to failure. A passive energy dissipation (PED) device using SMA wires as energy dissipation elements was designed and fabricated. The device level test results revealed that SMA based PED devices are more effective in providing energy dissipation to reduce the dynamic or seismic deformations.

A new amplifying mechanism (HyDia) has been developed for the damping amplification of the damper. This leads to significant improvement of energy dissipation in the damper as compared to conventional schemes, e.g., toggle-bracing, scissor-jack, etc.

Experimental studies were carried out on performance evaluation of fiber optic sensors instrumented on a prototype specimen of beam-column joints and subjected to static load. The responses of the embedded and surface mounting fiber optic sensors were monitored and were found to compare well with that of electrical resistance strain gages and the comparison was found to be good.

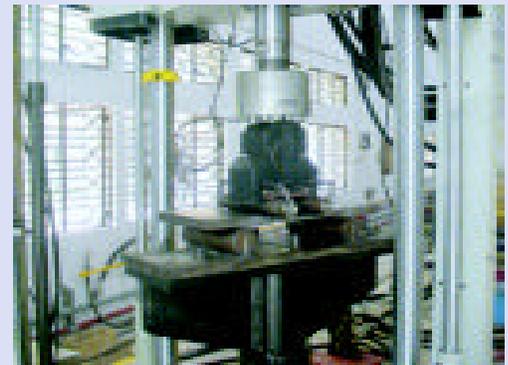
To develop a remote health monitoring scheme, a Multi Channel Real Time Wireless Data Acquisition System has been procured. Experimental studies have been carried out to explore and evaluate different modes of communication for data transfer and apply appropriate technology for remote health monitoring scheme. Studies on using 'pcAnywhere' software for remote transmission of data have been carried out. Its performance in Local Area Network (LAN), for logging data remotely from vibrating wire strain gage data logger has been evaluated and established successfully.

### **Fatigue and Fracture, Experimental Mechanics, Shock & Vibration**

Fatigue crack growth and fracture studies were conducted on piping components and pressure vessels under mechanical loads, pressure and temperature. Study on crack growth behaviour of cracked pipes under cyclic fracture was continued. The experimental results of five pipes of AISI Type



FCG test on a notched rectangular specimen under bending



Close-up view during testing



Close-up view after failure



304LN stainless steel material with circumferential through-wall crack (total crack angle,  $\theta$ , ranging from 66 to 68.5°) under cyclic loading were analysed with respect to crack growth and failure. All the pipes were tested under constant amplitude cyclic bending, fatigue crack growth and ductile failure criterion can be described by using elastic-plastic fracture mechanics parameters  $J_{max}$  and  $\Delta J$ . Based on this, crack growth equation was proposed for stainless steel pipes under cyclic loading.

Limit load analysis of healthy stainless steel (304 LN) elbows was carried out to study the effect of internal pressure on collapse load under opening and closing, bending moments. The limit load was found to increase with increasing elbow factor. With increase in internal pressure, the limit load was found to increase initially and then decrease. Parametric studies were also carried out on defect free elbows to develop closed form expressions for collapse load under in-plane opening and closing modes with internal pressure.

Leak-before-break analysis was carried out for carbon steel shell nozzle junction of steam generator at cold end with postulated crack at the highly stressed region to study the behaviour under cyclic loading and collapse using FEM.

In the studies on Corrosion Fatigue in Steels, in all the three corrosion fatigue tests using salt spray method, crack initiation life was reduced drastically in comparison to similar specimens tested in air; a reduction of about 63% was observed.

### **Steel Structures — Transmission Line Towers and other Skeletal Structures**

In a project on Advanced Analysis and Design Methods for Steel Frames and Experimental Investigation of Steel Frame Connections, a 7-storey steel building plane frame was designed in four ways: (1) manually using IS: 800 provisions for representative loadings; (2) using the frame design computer program developed under this project; (3) using STAAD Pro software and working stress approach; and (4) by the advanced analysis program, in order to compare the various approaches of design of the steel building frame.

Structural configuration of various guyed transmission line towers have been studied based on the power conductor orientations. Analytical studies on two commonly used configurations, i.e. V-type and portal type have been carried out for voltage class of 400 kV and 765 kV transmissions. The guy wire was modeled as link 10 element in ANSYS and as cable element in NE-NASTRAN. However, the lattice mast members were modeled as 3D-Beam element in both programs.

Advanced studies have indicated that nonlinear spectral dynamic analysis may be useful to understand the progressive collapse of guyed structural systems when they are subjected to severe loading conditions.

Advanced analysis software for steel frames has been used to design a few practical cases of multi-storey steel building frames. The software developed is capable

of considering sway as well as non-sway frames including flexibility of connections. The plane frame design program based on limit state design methods has been further validated with example problems given in AISC-LRFD procedure for industrial trusses and framed buildings. Three design procedures from the literature were chosen for detailed evaluation and then based on this study a simple design method using the revised IS: 800 code was evolved.

Various models for pounding and separation distance have been explored in depth. Inclusion of parameters such as participation of mass and the period of the structures has been found to be necessary in the numeral model for pounding. The studies have revealed that the same earthquake excitation can produce different magnitudes of pounding force for still and flexible structures.

In an investigation involving condition assessment and rating of bridges, the concept of residual force vectors has been used to specify and objective function for an optimization procedure using genetic algorithms. In this study, Modal Assurance Criterion (MAC) in conjunction with fractional change in frequency has been used to identify the damage accurately. Also, a simple and efficient procedure has been developed for characterization and localization of damage using transfer matrix method and vibration characteristics.

A refinement has been proposed to improve the analytical load rating procedure as specified by IRS: SP37 (1991). A methodology has been



developed for deriving capacity reduction factors using fuzzy mathematics and fuzzy logic.

Instrumentation and response measurements were carried on the railway bridge No. 42 near Tiruttani. Data on shear and axial force, the bending moment and dynamic displacement and acceleration at mid span locations, have been acquired for a number of test cases. Response of the bridge to the test train running at different speeds, braking ahead of the bridge, on the bridge, fully loaded goods train loading, etc., have all been recorded. This is the first ever detailed study of this kind in India.

For developing Parallel Computing Methodologies for Damage Detection of Large Structures using Wavelet Theory, a mathematical model of the cracked beam has been derived. The stiffness matrix of the cracked beam element has been formulated for elements with rectangular cross section and coded using the finite element to model the crack-like damage in frame structures. A program was developed in MATLAB for dynamic analysis of beam to extract the mode shape and natural frequencies. Iterative algorithms, viz. Lanczos method, sub-space iteration, for calculating a few eigen values, and eigen vectors of a Hermitian matrix were coded. Numerical examples with single bay beam structure were tested with the standard program. Tests were carried out to see the changes in the eigen values and vectors by changing the stiffness of the selective element to simulate the damaged condition in the beam element.

Towards the development of structural system identification methodologies using parallel processing technique, from recent works on meta-heuristic algorithms in various disciplines, it is observed that the particle swarm optimisation (PSO) algorithm and ant colony optimisation (ACO) algorithm are emerging as powerful alternatives to the well researched algorithms like evolutionary algorithms and simulated annealing. Based on these detailed analyses, a new formulation for PSO algorithm has been proposed which makes the algorithm adaptive by maintaining an excellent balance between exploitation and exploration. In the proposed algorithm, the cognitive and social parameters in PSO, which are crucial for accuracy as well as faster convergence, are automatically set through a single new parameter introduced into the formulation.

Formulation of displacement extrapolation technique to compute stress intensity factor (SIF) for 3-D surface cracks has been completed. Based on this technique, a program

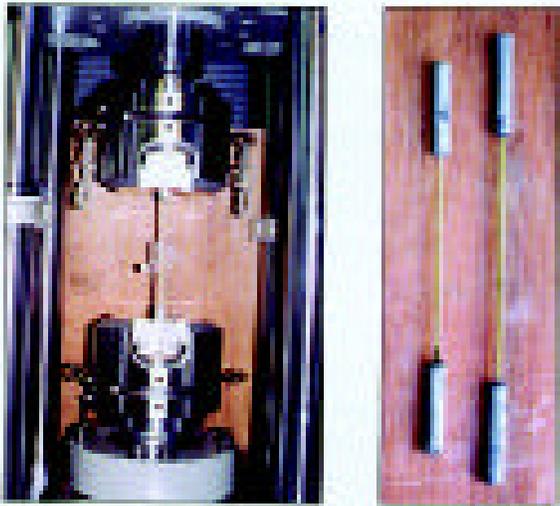
module has been developed, implemented and integrated with FINEART. In addition, twenty-noded regular and quarter-point solid finite elements, which are required to model surface cracks, have been also implemented in FINEART program.

A program module based on MVCCI technique for 3-D surface crack problems has been developed for computation of strain energy release rate and stress intensity factor. This module has been validated by conducting fracture analysis of a plate with a centre crack subjected to uniaxial tensile stress.

In the analytical cum experimental work on developing methodologies for improved performance of structures using Passive and Semi-active dampers, experiments were conducted to measure the dynamic response of the Magneto Rheological (MR) damper under wide range of prescribed displacements as sinusoidal and triangular wave forms. The force-time relationship, force-velocity relationship, force-



GFRP reinforced slab under flexural loading



GFRP rebar under tension test

## Concrete Composites and Materials

### Reinforced Concrete Structures

In the R&D work on risk consistent design and risk management of structural systems and assemblages, the stochastic modelling of the evolution of strains with loading in a reinforced concrete beam using homo-

geneous Gaussian Markov Chain (HGMC) has been studied. A bi-level HGMC model has been proposed for modelling the strains at different stages of loading.

Several recommendations have been proposed to Bureau of Indian Standards with respect to durability- and serviceability-related provisions in IS 456 for the design of reinforced concrete structural elements. These recommendations include a revised classification of exposure conditions based on the major environmental parameters influencing the different

deterioration mechanisms related to durability of reinforced concrete, separate values of minimum cover thickness for reinforced concrete slabs, explicit specification of service life for structures, equations for characteristic crackwidth for reinforced concrete flexural members under static and fatigue loading, and procedure for durability-based service life design of reinforced concrete flexural members.

The addition of fly ash to binder was found to increase the resistance of SFAA concretes to acid, sulphate and alkali attacks. Tests were conducted to understand the utility of addition of steel fibres to the lightweight aggregate concretes containing 'sintered fly ash aggregate' (SFAA). In case of SFAA concrete (SFAAC) with fly ash based binder, the increase in compressive strength due to addition of fibres ranged from 1 to 15%. Geopolymeric concretes (GPCs) from industrial wastes such as fly ash and blast furnace slag were developed.

The exposure of GPCs to 10% sulphuric attack was found to have only marginal effect even after about 100 days of exposure indicating that

displacement relationship were obtained from the experimental observations.

A methodology for optimum distribution of damping with dampers has been established, which can be effectively used during retrofitting of existing buildings or for performance based design of new ones subjected to earthquake loads.

### Safety in Power Plants

A reliability analysis procedure has been developed by integrating a standard finite element software with Monte Carlo simulation and AFOSM method of reliability analysis, to ascertain the safety of the power plant piping components. Using this procedure, reliability analysis of a typical elbow component of a pipeline layout in Nuclear Power Plant, designed according to the relevant clauses of ASME, and operating at different conditions indicative of in-service conditions, against erosion-corrosion, was carried out.



Experimental set-up for MR damper calibration



alkaline catalyst residue is utilized almost completely during geopolymerisation reactions and the GPC is highly acid resistant compared to FAA concrete having only cement as binder system.

Towards the development of Advanced Composites and Techniques for Retrofitting of Reinforced and Prestressed Concrete Structural Elements, tests were conducted to study the bond between the concrete surface and CFRP and GFRP wraps. It was found that the average bond strength was 0.8-1.2 Mpa. Tests were also conducted to study the tensile characteristics of CFRP and GFRP coupons.

The effectiveness of FRP wrapping as a retrofitting measure was studied on the reinforced concrete beam column joint specimens, retrofitted with CFRP, GFRP wraps and microconcrete jacketing with lacing. Investigations were carried out to study the flexural behaviour of reinforced concrete slabs using FRP bars. Control RC slabs were also cast with HSD bars to compare their performance with the FRP bars.

A series of concrete and mortar specimens were cast and tested to



Upper toggle brace mechanism with MR damper fitted to a 3 storey steel moment resistant frame



develop a concrete mix design procedure using the fly ash aggregates (FAAs). Based on the test results, a Modified Bolomey Equation to estimate the compressive strength of Light Weight Aggregate Concrete (LWCs) has been developed.

Finite element formulation has been developed based on lumped damage mechanics for analysis of RC framed structural elements. In the formulation, the force-

displacement relation of a frame element is modified to account for material damage under extreme loads. Plastic hinges are included at member ends to model energy dissipation under hysteretic response. In addition, damage variables have been introduced on generalized forces based on the principles of continuum damage mechanics (CDM). The formulation addressed methodologies to analyze RC frames subjected to low cycle fatigue loading of extreme magnitude due to earthquake excitations.

Experimental studies were carried out on rebar corrosion in different types and grades of concrete with different voltages such as 5, 10, 20 and 30V. Concrete grades of M40, M60 and M75

with mineral admixtures such as Fly ash and GGBS were considered. For comparison, OPC concretes of same grades were also studied. To study the effect of cover thickness on rebar corrosion, two cover thicknesses of 29.5 mm and 42 mm have been chosen. The studies indicate that the concrete resistivity is increased with the higher grade of concrete and further enhanced for the concretes with mineral admixtures.

To study the diffusion

characteristics of high performance concrete with GGBS and fly ash, diffusion experiments were taken up. Accelerated diffusion test was conducted to determine the chloride ion diffusion on high performance concrete. The chloride concentration profile was much lower and the concrete with mineral admixture and lowest for the M75 grade concrete using fly ash.

### **Publications & ECF**

During the year, 135 research papers were published in journals/conference proceedings and 86 technical reports were prepared. The ECF (External Cash Flow) from the contract R&D, grant-in-aid, consultancy, etc. amounted to around Rs 5.08 crore.

## **Establishment of a National Test Facility for Rolling Element Bearings**

**A**S a part of a major National initiative towards the development of Aerospace Quality Rolling Element Bearings, the National Aerospace Laboratories, Bangalore, has established a National Test Facility for Rolling Element Bearings. This facility has been established in accordance with the Joint Service Specifications (JSS) prepared by the Centre for Military Airworthiness and Certification (CEMILAC), Bangalore, so that it could act as a Centralized Certifying Agency for testing indigenously developed aerospace quality bearings.

This facility has been established with a view to meeting all the different tests as listed in the JSS, prepared by CEMILAC. The facility comprises a Fatigue Bay for testing bearings up to 300 mm outer diameter and speeds up to 25,000 rpm and a 10,000 Class clean room housing all the necessary metrology equipment. Other test set-ups that have been established in the facility, include rigs for estimating static load capacities of rolling element bearing assemblies and bearing components, frictional coefficients in the bearings, sphericity of the balls, wobble in the bearings, and dimensional stabilities. Equipment for evaluation of shear stability, extreme pressure of oil and an atomic absorption spectrophotometer have also been commissioned. This facility has been established under the project related to the development of Synthetic Aviation Lubricants (SAL), which is funded by CHT, CSIR, IOC (R & D), DRDO and HAL. It will act as a nodal agency for testing, indigenously developed

Aerospace Quality Rolling Element Bearings using proven SAL or indigenously developed SAL using proven aerospace quality rolling element bearings, under real life situations, defined in terms of loads, speeds and temperatures as experienced in aircraft gas turbines.

Apart from the above, this facility can also be utilized for testing and certifying rolling element bearings procured from secondary sources for aerospace applications.

The facility was inaugurated by Shri M. Natarajan, SA to RM. He expressed that the facility will be extremely useful towards the development of aerospace quality rolling element bearings and synthetic aviation lubricants in the country. Dr K. V. Raghavan, Chairman, RAB, DRDO, who was the guest of honour, while reiterating the importance of development of aerospace quality bearings and synthetic aviation lubricants stated that the NAL facility will be first of its kind in the country and one of the very few such facilities in the world. The facility details were presented by Dr V. Arun Kumar, Scientist, NAL. Dr K. S. Balaraman, Executive Director, Centre for High Technology, was the other guest of honour. While Dr A. R. Upadhy, Director, NAL, welcomed the gathering, Dr J. J. Isaac, Head, Propulsion Division, NAL, proposed a vote of thanks.

Dr M. N. Sathyanarayana, Jt Head, KTMD, Shri Somanarayanan, Scientist, KTMD, organized the programme in co-ordination with Shri V. Munirathnam, Scientist, Propulsion Division, NAL.



### Prof. Dobson delivers the second Innovation and Technology Enterprise Lecture at NCL

**P**ROFESSOR Peter Dobson, Academic Director, Oxford University's Begbroke Science Park, delivered the Second Innovation and Technology Enterprise Lecture titled "The journey from science to technology" at the National Chemical Laboratory (NCL), Pune, on 2 April 2007. The talk, which was open to the public, was attended by a large audience comprising people from industry, academia, and research institutions in Pune, besides the representatives of British Council in India.

Prof. Dobson, an Oxford Nanotechnologist and Entrepreneur, used the forum to describe the issues surrounding science-based innovations. He used the examples of the companies founded by him to highlight challenges and lessons learnt for taking laboratory research to technology and finally to commercial products as efficiently as possible.

In his talk, Prof. Dobson highlighted the "time gap" between emergence of the first scientific publications / patents on a concept and eventual commercialisation of a product based on the concept – a gap that needs to be understood and overcome if products based on scientific innovation are to successfully reach the market. He gave the examples of some of the products and companies he has been associated with to illustrate the "time gap" and further showed how it could be shortened through a clear market orientation, timely financing and



Prof. Dobson delivering his lecture

partnerships. He advised the audience to look for market-led solutions rather than "push technology" when it comes to taking scientific ideas to commercialisation. He opined that one needs to cultivate a problem solving ethos and orientation amongst scientists if one wants to focus on commercially viable technology. Oxonica PLC, one of the earliest nanotechnology companies, was founded by Prof. Dobson in 1999. A company which is now listed on the AIM exchange, and is generating substantial revenues on two product lines trade named Optisol and Envirox. Optisol is a broad spectrum UV absorber for personal care products – one of the earliest nanotechnology applications taken to the market. Optisol UV

absorber is now being sold in 27 formulations by 14 companies in nine countries and incorporated into "Boots Soltan Once" and "Tesco Finest" suncare product lines. The other product Envirox is based on cerium oxide nanoparticles that significantly improves efficiency and environmental performance of diesel engines, especially two-stroke diesel engines found in many developing economies. Prof. Dobson illustrated how Oxonica has been able to narrow the science to product gap significantly by bringing in a sharp market and solution-focus, building balanced teams and partnerships, striving for early revenue generation and forging strategic alliances to save time and money. Prof. Dobson then used the case of his company Oxford Biosensors Ltd that makes a hand-held device based on enzyme-functionalized microelectrode arrays to illustrate how start-up companies can be a better way to commercialize technologies than licensing when the technology is disruptive and not an incremental improvement.

Earlier, Dr V. Premnath, Scientist, NCL, welcomed the audience and briefly mentioned the idea behind organizing the Innovation and Technology Enterprise Lecture series. He also introduced Prof. Dobson to the audience. Dr S. Sivaram, Director, NCL, offered a memento to Prof. Dobson. The public lecture was sponsored by the generous support of the British Council and the NCL Research Foundation.



## A.V. Rama Rao Research Foundation Award Lecture-2007



Dr A. P. Mitra, former Director General, CSIR, is delivering A.V. Rama Rao Research Foundation Award Lecture-2007

**T**HE Indian Institute of Chemical Technology (IICT), Hyderabad, in collaboration with A. V. Rama Rao Research Foundation and AVRA Laboratories Pvt. Ltd, Hyderabad, jointly organized the A. V. Rama Rao Research Foundation Award Lecture on 2 April 2007 at the IICT Auditorium.

The lecture was delivered by Dr A. P. Mitra, former Director General, CSIR on the topic 'The Near Space: Milestones, Changes, Challenges', where he made an interesting presentation on earth's near-space, specifically global changes owing to human activities, acid rain, ozone problem and green house gases in India. He highlighted the importance of research in lower atmosphere which is very much needed to understand the global change process. According to Dr Mitra, developing countries like India should make such efforts in more comprehensive manner. Prof. S.K. Joshi, former Director General, CSIR and newly appointed Chairman of the AVRA Foundation, chaired the programme .

Welcoming a huge gathering of IICT staff members, scientists from sister laboratories, participants from the Industry and employees of the AVRA laboratories in a glittering function, Dr J. S. Yadav, Director, IICT, who is also the Secretary of the AVRA Foundation, explained in detail the genesis of the AVRA Foundation and its aims and objects.

## Prof. S. E. Hasnain delivers Fifteenth S. S. Bhatnagar Lecture -2007



Prof. S. E. Hasnain is receiving the memento from Dr S. Varadarajan former Director General, CSIR. Dr J. S. Yadav, Director, IICT (extreme left) is also seen

**T**HE Indian Institute of Chemical Technology (IICT), Hyderabad, organized the fifteenth S.S. Bhatnagar Lecture on 2 April 2007 at its Auditorium. Prof. S. E. Hasnain, VC, University of Hyderabad and former Director, Centre for DNA Fingerprinting and Diagnostics, Hyderabad, delivered the Bhatnagar Lecture on the topic 'War against TB: Is it going to be a long drawn battle'.

Prof. Hasnain, whose research interests include understanding of the mechanisms of baculovirus very late gene transcription and apoptosis, and pathogenesis of *Mycobacterium tuberculosis*, said that about 30% population of the Indian subcontinent was infected with *M. tuberculosis*, out of which 5-10% end up with the actual TB disease. In view of the disease raising its head again in India, especially amongst the poor and the undernourished, greater attention was desired for control of this disease instead of diverting the Government resources and the aids from the national and international agencies are diverted towards new health hazards like AIDS and SARS, mainly prevalent in Africa, Europe and South East



Asia. Prof. Hasnain was of the view that drug companies should not relax in their fight against TB lest it should raise its head again in India. Newer and cheaper drugs should be introduced in the market. The lecture was very informative and was acclaimed by one and all.

Earlier, Dr J. S. Yadav, Director, IICT, welcomed a huge gathering of IICT staff members, scientists from sister laboratories and participants from the Industry in a glittering function and said that S. S. Bhatnagar Lecture was started by Dr A. V. Rama Rao, former Director, IICT & CMD of AVRA Labs, in the memory of Dr S. S. Bhatnagar, who was one of the founder members & a father figure in CSIR, on the occasion of renaming of RRL, Hyderabad to Indian Institute of Chemical Technology on 1 April 1989.

### National Mineral Award to Dr Kalachand Sain

**D**R Kalachand Sain, Scientist EII and In-charge of Gas-hydrates Group, National Geophysical Research Institute, Hyderabad, has been honoured with the National Mineral Award-2005 by the Ministry of Mines, Government of India, in recognition of his significant contribution to the field of Earth Sciences. The award carries a cash prize, trophy, certificate and citation.

Dr Sain has proposed several techniques based on comprehensive inversion algorithms for the exploration of hydrocarbons including the gas-hydrates and crustal dynamics. Prominent among these are (i) solution to the (a) hidden and (b) velocity inversion problems of seismic refraction work using wide-angle seismic data; (ii) new approach for interpreting first arrival seismic data; (iii) methods of directly (a) calculating interval velocities (b) estimating depth to any reflector from wide-angle seismic data; (iv) assessing structures required by the seismic data based on traveltime tomography; (v) delineating fine-scale structures or stratigraphic horizons of sub-volcanic sediments using 2-D waveform inversion.

Dr Sain has made a commendable job in (i) investigating gas-hydrates (future potential energy resources) along the continental margins of India using the state-of-the-art seismic data processing



Dr Kalachand Sain receiving the National Mineral Award from Union Minister of Mines Shri Sisram Ola. Also seen in the picture Shri Subbarami Reddy, Minister of State for Mines

and sophisticated full-waveform inversion; (ii) imaging hydrocarbon-prospective Mesozoic sediments in the Saurashtra peninsula and Gondwana sediments in the Mahanadi delta using the modern traveltime tomography of wide-angle seismic data.

He has shed light to understand the probable causes for the occurrences of Jabalpur (1997) and Bhuj (2001) earthquakes, and evolutionary processes of various geological/tectonic units like the Narmada-Son lineament, Bengal basin, Mahanadi delta, southern Granulite terrain, western Dharwar craton, etc. based on the analysis of wide-angle seismic data.

He has proposed methods of (i) estimating Q-factor, (ii) joint inversion of traveltime and amplitudes from BSR, (iii) performing AVO attribute analysis with a view to identifying and quantifying the resource potential of gas-hydrates. His recent work on Effective Medium Theory to understand the microstructure and



hence quantitative assessment of gas-hydrates is praiseworthy.

Dr Sain has published 48 research papers in national and international journals and 10 technical reports. He is a highly motivated and well-recognized young scientist with various decorations like (i) Young Scientist Award and Raman Fellowship by CSIR, (ii) BOYSCAST Fellowship and Swaranajayanti Award by the DST, (iii) Krishnan Gold Medal and Life Fellow by the Indian Geophysical Union, (iv) Associate Fellow and Best Paper Medal by the AP Akademi of Sciences, (v) Best Paper Presenter Award by the PETROTECH-2007 at the International Conference on Oil & Gas, etc. He is a member of a number of Scientific Societies/bodies, Technical Committees and Editorial Boards of scientific journals.

## Dr D.C. Goswami honoured for his Children's Literature

**D**R D.C. Goswami, Scientist G of the North-East Institute of Science and Technology (NEIST) (erstwhile Regional Research Laboratory), Jorhat, was invited by the President of India to a reception at the Rashtrapati Bhavan on this year's Republic Day, in recognition of his eminence as a writer of children's literature.

A dedicated science writer and communicator in Assamese, Dr Goswami has been writing popular science and science fiction for children and general readers and has more than 50 books to his credit. He has also translated sixteen books into Assamese. He has coordinated and edited a series of about 70 translated classics for children. The Chief Editor of a three-volume science encyclopaedia, a translated encyclopaedia for children, and a national science popularization award winner, Dr Goswami was one of the 50-odd children's literature whom the President met in an informal interaction programme at the Rashtrapati Bhavan.



## Best Poster Award from MRSI

**D**R Anjana Jain and Shri S. Kalyan Sundaram, Materials Science Division, National Aerospace laboratories (NAL), Bangalore, along with Shri V. Vedha Prakash and Shri H. H. Kumar were conferred with the Best Poster Award for the paper titled 'Preparation and characterization of  $\beta$ -PVDF films' at the 18th Annual General Meeting (AGM) of the Materials Research Society of India (MRSI) held during 12-14 February 2007 at the National Physical Laboratory (NPL), New Delhi.



## Corrigendum

### Dr K. Thangaraj and Dr D. Kar Chowdhuri bag UKIERI Major Research Awards

In the above news item published in *CSIR News* 57 (2007) 124, please note that the amount of the research grant for the project awarded to Dr K. Thangaraj, Scientist, Centre for Cellular and Molecular Biology (CCMB), Hyderabad, is Rs 2.5 crore and that for the project awarded to Dr D. Kar Chowdhuri, Scientist, Industrial Toxicology Research Centre (ITRC), Lucknow, is ₹500,000 and not \$ 500,000 as published. The error is regretted.

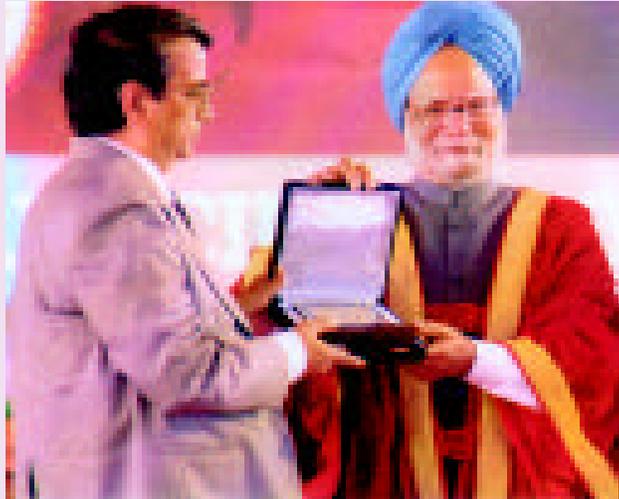


### Dr V.P. Dimri honoured with G.P. Chatterjee Award of ISCA

DR Manmohan Singh, Prime Minister of India, honoured Dr V.P. Dimri, Director, National Geophysical Research Institute (NGRI), Hyderabad, with G.P. Chatterjee Award during the 94<sup>th</sup> Indian Science Congress (ISC) at Chidambaram. Dr Dimri received the award for his achievement in the field of geophysics. The Indian Science Congress Association instituted this award in 1981 to honour every year a distinguished scientist for his/her outstanding contribution related to some aspects of Science and Man.

Dr Dimri was also elected as President of the section of Earth System Sciences for 95<sup>th</sup> session of Indian Science Congress Association to be held at Visakhapatnam in January 2008.

A Fellow of Indian National Science Academy, Dr Dimri is an internationally known geophysicist for his pioneering work in the field of exploration of oil, mineral and groundwater and seismology using mathematical modeling and fractal theory, which he has summed up in three books published by international publishers. He has published 150 scientific and technical papers in various national and international journals.



Dr V.P. Dimri, Director, NGRI, receiving the prestigious Prof. G.P. Chatterjee Award from Dr Manmohan Singh, Prime Minister of India,

Dr Dimri, was elevated to the exalted position of the Director of NGRI on 17 October 2001 and since then NGRI has been surging ahead under his leadership. The institute has been awarded ISO 9001:2000 certification, and the FICCI award

(2001-02) for outstanding contributions to S&T. Today NGRI is ranked No 1 laboratory among 38 laboratories of CSIR in earning external cash flow and has earned 1/10<sup>th</sup> of the total external cash flow of the CSIR, after holding the second position for the last two financial years. Dr Dimri is also an Adjunct Professor at University of Hyderabad and Honorary Professor at Department of Geo-physics, Andhra University. He is Chairman of Research Advisory Council of Indian

Institute of Geomagnetism, Mumbai and Member of Research Council of several earth science institutions. He is National Chairman of International Union of Geodesy and Geophysics and President of Indian Geophysical Union.

### Dr V. Kasirao

DR V. Kasirao, Head, Documentation Department; Central Leather Research Institute (CLRI), Chennai, presented a paper titled 'Electronic Knowledge Organisation Management (E-KOM): A tool for Leather Industrial Development' at the International Conference on 'Information Technology and Management (ICITM-2007)' held at Hong Kong Polytechnic University, Hong Kong, during 3-5 January 2007. He also delivered a lecture on 'IT Strategies in Information Management' at ICITM-2007.



Printed and Published by S.K. Rastogi on behalf of National Institute of Science Communication and Information Resources (CSIR), Dr K.S. Krishnan Marg, New Delhi -110 012 and printed at NISCAIR Press, Dr K.S. Krishnan Marg, New Delhi -110 012  
Editor: Dr B.C.Kashyap; Associate Editors: Meenakshi; Vineeta Singhal; Editorial Assistant: Neelima Handoo;  
Design: Pradip Banerjee; Sarla Dutta; Production: Kaushal Kishore

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For subscription: The Sales & Distribution Officer, NISCAIR; E-mail: sales@niscair.res.in Annual Subscription: Rs 300 Single Copy: Rs 15.00  
Subscription Complaint No 25843359