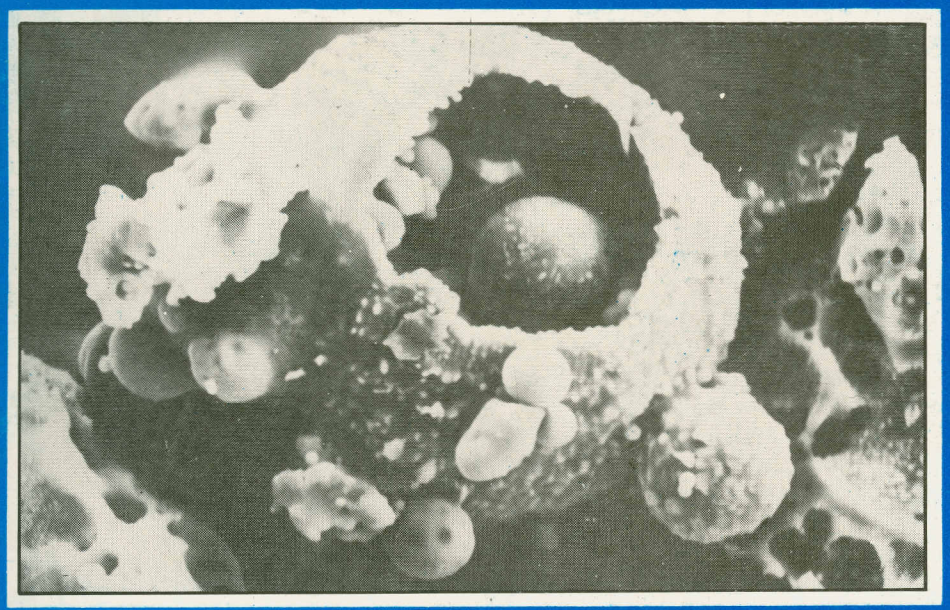
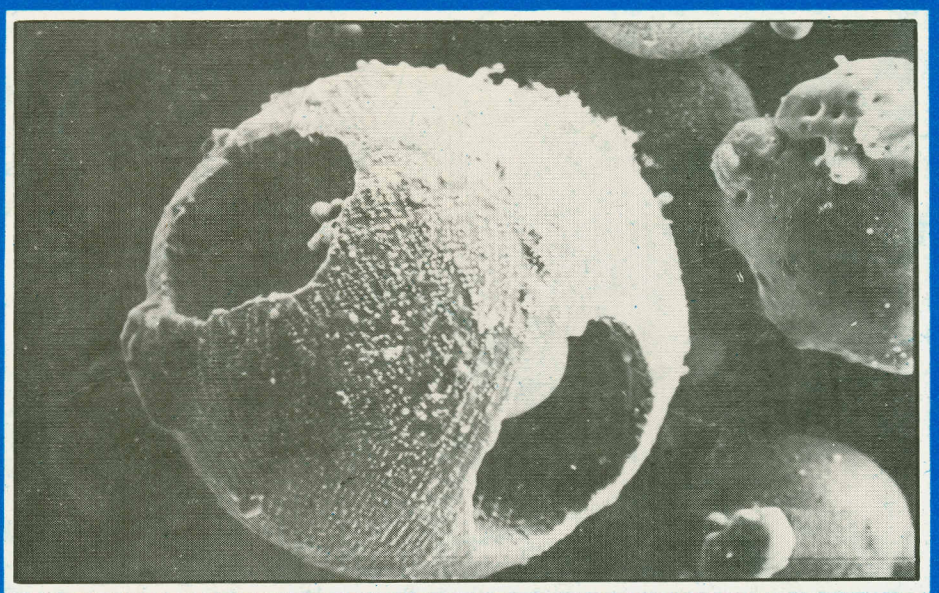
क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल

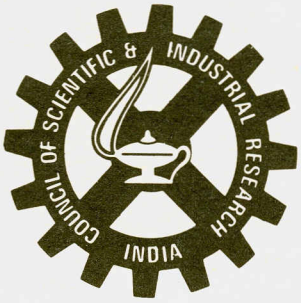
REGIONAL RESEARCH LABORATORY

BHOPAL



REPORT
FOR
CALENDAR YEARS
1987 AND 1988





क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल

REGIONAL RESEARCH LABORATORY

(Council of Scientific & Industrial Research)
HOSHANGABAD ROAD, NEAR HABIBGANJ NAKA, BHOPAL-462 046 (M.P.) INDIA

REPORT
FOR
CALENDAR YEARS
1987 AND 1988

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FROM DIRECTOR's DESK

Dr. Rajendra Kumar, Director.

The last report of the activities of the Regional Research Laboratory, Bhopal of Council of Scientific & Industrial Research covered the period 1985-86. Since then, the Laboratory is seeing a tumultuous period though still in its infant stages. I have great pleasure in presenting the report of its activities for the period of 1986 to 1988 December and the progress report is prepared in the backdrop of the recent measures of organisational and structural reforms initialized in the CSIR as a whole.

Following a series of discussions over five years between the CSIR and the Government of Madhya Pradesh, the decision to establish a Regional Research Laboratory at Bhopal under the Council of Scientific & Industrial Research was finally taken in 1980. Its establishment was perhaps inspired by the fact that there was then no all India level institution in the field of science and technology in the vast central Indian region around the state of Madhya Pradesh. It was hoped that the presence of a national level research laboratory will trigger off scientific activity in the state and also catalyse its industrial development based on its natural resources. The early planners of the laboratory had made ample provision for futuristic orientation of the scope of its R&D work.

The first Director was appointed in 1981. He began to plan for the laboratory from the CSIR head quarters New Delhi and moved over to Bhopal in second half of 1982. A team of three scientists was first appointed in 1981 at Bhopal for the purpose of preparing the ground work for the laboratory. Equipment which began to arrive sometime in 1983 in the absence of its own laboratory buildings, was housed temporarily within the Bhopal University premises, itself then largely under construction. The laboratory moved into its present building in early 1984 with a scientific staff of about 15 persons. This building was acquired with the good offices of the government of Madhya Pradesh through outright purchase of the buildings of a residential college on a 5 acre land. The government of M.P. allocated additional 80 acres of adjoining land for the expansion of the laboratory buildings as well as for the residential complex for the staff. The model plan also included the construction of a central school as well.

On moving to its own but acquired building, the meagre scientific staff faced Herculean ta of arranging for water supply, proper electrification through power lines specifically suited the different sophisticated equipment.

The Bhopal gas tragedy in December 1984 dislocated normal life in the city of Bhopal and no doubt considerably slowed down the building up of the infrastructural facilities. Limited the staff then were, they were hard pressed to provide background support to the scient teams of the CSIR and pratically no additional recruitment of the staff had occured. Even then Director was on periods of long leave during much of 1985 and until 1986, when resignation was accepted by the CSIR. It was against this background that the undersig assumed the Directorship of the laboratory in Dec. 1986 and began to reorganise the R activities in terms of the 10 year profile which was approved by the Research Advis Committee of the laboratory in 1985. The 10 year profile was centred around the developm of the laboratory as a major centre for advanced research in special engineering materi Another major area of emphasis was identified as materials in energy conservation a specially in the transportation sector. Within this general frame work a centre of excelle was envisaged to be developed in the field of light metals. In short, the mandate given to laboratory was to develop itself as a centre for R&D activities in the field of engineer materials. This was subsequently reaffirmed by the Research Advisory Council at its meetig December, 1986. The activities of the laboratory have been reorganised into the follow major disciplines:

1. Building materials
2. Aluminium alloy technology including foundry
3. Tribology (unparalleled facility)
4. Metallograpy and engineering component failure analysis, scanning electr microscopy and x-ray diffraction analysis.
5. Electro chemistry and surface coatings including plasma coatings
6. Mechanical and physical characterisation of materials
7. Computer simulation of engineering processes
8. Natural agro-forest fibre polymer composite group
9. Minerals and ceramics
10. Non-conventional resources and energy conservation

The laboratory has acquired sophisticated and latest equipment for the characterisation engineering materials in terms of mechanical behaviour at room and elevated temperature microstructural and morphological characterisation wit the help of sophisticated optical a scanning electron microscopy and x-ray diffraction analysis. Besides having a die-casting un it has acquired sophisticated equipment for rapid solidification processing of metals and allo and the emerging fields of plasma spray deposition of service coatings to enhance materi performance in aggressive service conditions.

The total strength of the staff of the laboratory is now about 110 inclusive of 36 scientists, 2 scientific assistants and 10 research fellows, in addition three sponsored research scheme are in their terminal phses in the field of biomaterials.

It is a matter of considerable gratification that the industry in the region has recognised th

capacity of the laboratory for solving its problems through sponsoring of several small short term investigations. The R&D receipts per scientist compared favourably with other laboratories during the year 1987-88 and impact factor of our research output as evidenced through research publications in national and international journals of repute is also creditable. While the details of research activities in progress are given in subsequent sections of this report, it will be appropriate to list some of our significant achievements as below:

- our involvement in studying the case of failures of metallic pressure parts at different thermal power stations in the states of M.P., U.P. and Maharashtra.

- our involvement in the characterisation of fly ash from different power stations and its utilization.

- development of energy efficient technology of production of wall tiles from a low cost mineral of M.P. in an advanced stage.

- successful development of organic natural fibre cement composite as a substitute for cement asbestos sheet which has been successfully upscaled through pilot plant facility of CBRI, Roorkee.

- Signing of a Memorandum of Understanding (MOU) with the State owned OPTEL for providing them scientific services, expertise and facilities.

We have started building a coherent interface with the M.P. Council of Science & Technology for R&D studies associated with various facets of socio-industrial growth of Madhya Pradesh. MPCST has already sponsored R&D projects relating to Quality upgradation of re-rolled steel products in the Chhattisgarh and metal base industries in the tribal region of Bastar. During this period the laboratory has organised a symposium on the minerals of M.P., had hosted annual conference of Powder Metallurgy Association of India and entrepreneur development course in Aluminium Technology sponsored by the MPCST. Besides, a lecture course of electro-chemistry jointly with CSIR PTC, Bhopal and CECRI Karaikudi and one on Metallurgy for non-metallurgical engineers was also organised.

Facilities for testing services, and technical advice have been extended to a number of institutions and industries in and around M.P. and the laboratory provided training and research facilities to a large number of young scientists in the region. Distinguished scientists and technologists delivered several lectures at the laboratory which were frequently attended by the community at large. In this sense the laboratory has acted as a promoter of scientific temper in the region. Special mention needs to be made of the visits of eminent scientists, planners, technologists and administrators to this budding institution. Amongst them, Hon'ble Prof. K.M. Chandy, Governor of Madhya Pradesh, His Excellancy Mr. Macioti, Ambassador EEC Countries, Shri C.P. Shekhar, Minister, Industries, M.P., Shri Pratap Bhanu Sharma, Member of Parliament, Shri B.R. Yadav, Minister, Public Works, M.P., Mrs. Manju Rai, Minister Rural Development, M.P., Shri K.N. Pradhan, Member of Parliament, Shri Mahesh Joshi, Minister Environment, M.P., Shri K.L. Puri, Technical Advisor to P.M., Dr. N.C. Nigam, Member, CSIR Governing Body, Dr. S. Varadarajan, Chief Consultant, Planning Commission Shri M.L. Jain,

Vice Chancellor, Bhopal University who visited the laboratory had apreciated the lead ta
R&D activities related to engineering materials.

It was then in early 1987 that the CSIR Review Committee made the foll
recommendations about RRL Bhopal. The following para is quoted from the Report:

> "RRL Bhopal has yet to evolve to an adequate level. The CSIR should explo
> possibility of the State Govt. taking it over and running it as a State Laboratory. C
> Govt. assistance could be considered for its take-over and operation for a limited p
> If this is not possible, then it should be closed down".

The scientists are gratified that the Governing Body of the CSIR differed fro
rcommendations of the Abid Hussain Committee and had recommended that RRL B
should continue under the umbrella of the CSIR with strong linkages built with the ind
However, the CSIR Society in its February 1988 meeting decided as follows:

> "RRL Bhopal has not yet evolved to an adequate level. The laboratory could serve a
> useful purpose if it is linked to a Public Sector Unit in Bhopal, BHEL for instance. C
> to take up with BHEL the question of take over of RRL Bhopal".

Considerable publicity of this decision in the national and state press has perhaps de
many organisations from coming forward to sponsor long term research programmes.

Whilst scientists have all welcomed the assurance given by the Govt. in Rajya Sabha th
intention of the Government is not to close this laboratory, they hope that the decision w
liberally interpreted to mean retention of the Laboratory within CSIR and that the term "
will not be taken as "transfer". The laboratory's R&D activities can however be linked
those of public sector organisations such as the BHEL by having the Chairman/Man
Director of BHEL as Chairman of the Research Council with the understanding tha
industrial organisation would sponsor substantial programmes of R&D activity in the ar
their interst. Other members of the RC could be Chairman cum Managing Dir
BALCO/NALCO, Chairman, MPEB etc. This kind of set up within the CSIR would provi
RRL with the flexibility inherent in the CSIR set up as well as bring its R&D work close
industrial requirements and expectations. RRL Bhopal is an unique laboratory for engine
materials in the country.

I am indeed grateful to Vice President CSIR and the Director General, CSIR for their su
and guidance in building up of the Laboratory into a premier R&D institution for engine
materials. I wish to record my gratitude for the generous support given by the
Government of Madhya Pradesh and its agencies. I record my appreciation of the exc
cooperation and hard work rendered by the scientists and staff of this laboratory,
sometimes very difficult circumstances associated with the establishment of new institu

R Kumar

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RESEARCH & DEVELOPMENT DIVISIONS

	Director	Dr. Rajendra Kumar
	Acting SPA	Mr. T.P. Prasannan
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15.	Secretariat Pool Jr. Hindi Translator	Ms. Manisha Dubey
16.	Jr. Stenographer	Ms. Minimol R.
17.	Jr. Stenographer	Mrs. Sathi Vijayan
18.	Jr. Stenographer	Ms. Sayee Lakshmi V.

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Controller of Administration	—
Section Officer (Est.)	Mr. G.K. Bhatnagar
Section Officer (Gen.)	Mr. B.N. Dikshit
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L.D.C. (Hindi)	Ms. Asha Trivedi
L.D.C.	Mr. Jaipal Kujur
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S/P Assistant Grade-VII	Mr. D.M. Chillbule

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Librarian	Mr. Rishi Kumar Kalra

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Laboratory Supervisor	Mr. H.N. Rao

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	Mr. A.K. Jha, Member

CSIR THRUST AREA PROJECT ON LOW COST ALTERNATE BUILDING MATERIALS AND COMPONENTS

The main objectives of the above project are enumerated below:

1. Development of process technologies and establishment of industries for the manufacture of substitute walling materials, improved quality burnt clay bricks and low cost soil stabilized bricks of adequate durability.

2. Development of process technologies and establishment of industries for the manufacture of cement, low cost cementitious binder and masonry cements

3. Characterisation of inorganic and organic fibres for their suitability and reinforcement in composites and establish their adaptability as substitution for asbestos.

4. Development of building materials and components as alternatives to timber and also to 'in situ' reinforced cement concrete in building through partially/fully prefabricated components.

In consonance with the above, RRL Bhopal is engaged in the following areas:

* Bricks from inferior soils.
* Fibre reinforced materials including asbestos replacement for roofing sheets and wall panels.
* Building materials from industrial wastes like fly ash and red mud.
* Design of low cost housing units incorporating technologies developed by the laboratory.

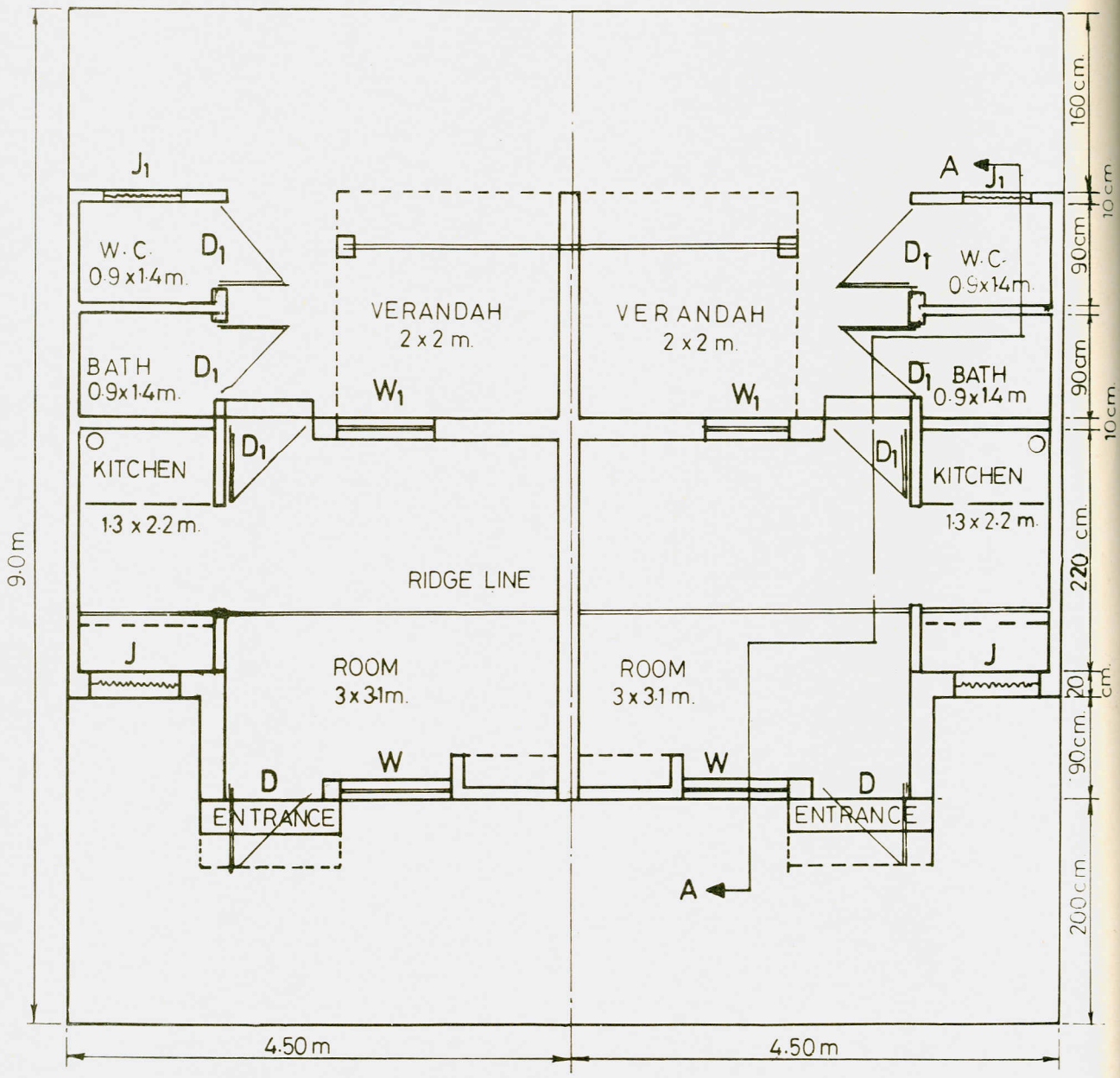
Bricks

In Madhya Pradesh black cotton and lateritic soils are available which are marked by imbalance of various constitutents i.e. clay, silt and sand. Bricks made from these soils have low compressive strength (20-40 Kg/cm^2) and high moisture absorption. The work on characterisation of four typical soil samples was taken up to identify and estimate clay-nonclay minerals by chemical analysis, particle size distribution, Atterberg limits, X-ray and Scanning Electron Microscopy respectively. Besides, conservation of top soil is important from ecological considerations. In this context, enhancement of the quality and productivity of bricks in kilns is a matter of national priority. Anticipating that these objectives can be achieved by blending raw materials with selective additions of other industrial wastes like fly ash, stone dust, the properties of bricks with various blends were studied.

Typical bricks (60% soil and 40% fly ash) showed 15% water absorption and compressive strength 70-90 Kg/cm^2. Similarly samples with stone dust (60% soil and 40% stone dust) showed 13-16% water absorption and compressive strength 50-70 Kg/cm^2.

Roofing sheets and panels

In an attempt to replace the use of asbestos natural organic fibres (sisal, sunhemp) were selected for cement corrugated roofing sheets. Asbestos fibres being carcinogenic in nature, their use in cement asbestos sheets poses serious health hazards for the workers. A large number of 1 m x 1.25 m corrugated roofing sheets with sisal fibre reinforcement were made in the laboratory. Load bearing capacity of 2-3 Kg/cm width for 7 mm - 9 mm thick sheets was obtained; the corresponding moisture absorption being in the range of 12-15%. Pilot plant trials were planned and carried out at CBRI Roorkee. Corrugated roofing sheets of 1 m x 2 m size were made and tested. Load bearing capacity of 3-4 Kg/cm width and 12-15% moisture absorption were obtained. These values are quite adequate for roofing sheets.



PLAN Fig. 1 Proposed plan of low cost house for M.P. Grameen Avas Mandal based on R.R.L. technology.

Industrial wastes

Trial runs of making cementitious binder using red mud, local soil and ground paddy husk as fuel were carried out. Preliminary results indicate that red mud can be a promising material for making lime-pozzolana mixtures for use in construction materials. The red mud cementitious binder showed initial and final setting time of one hour, and three hours respectively. The compressive strength of mortar cube 1:3 (mortor : standerd sand by wt.) at water cement ratio of 0.6 was 1.5 - 2 N/mm^2 (7 days) and 3-4 N/mm^2 (28 days) respectively.

Designs of low cost housing units

Prototype house designs are being worked out incorporating new materials and techniques developed by the laboratory for low cost housing fly ash soil bricks, natural organic fibre strengthened roofing sheets and mud wall panels reinforced with treated Ipomea carnea local plant material.

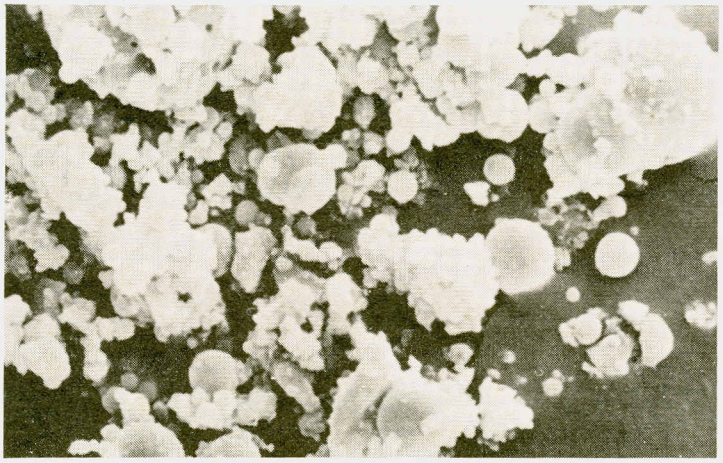


Fig. 2 Microstructure of redmud binder (SEM).

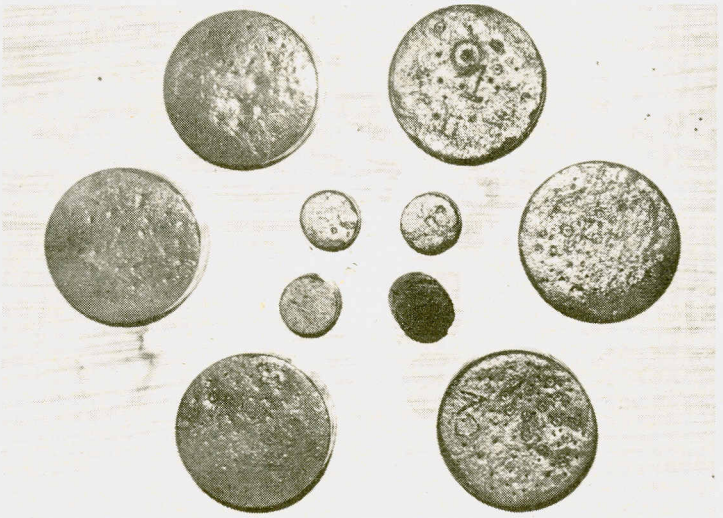


Fig. 3 Test samples for initial and final setting time.

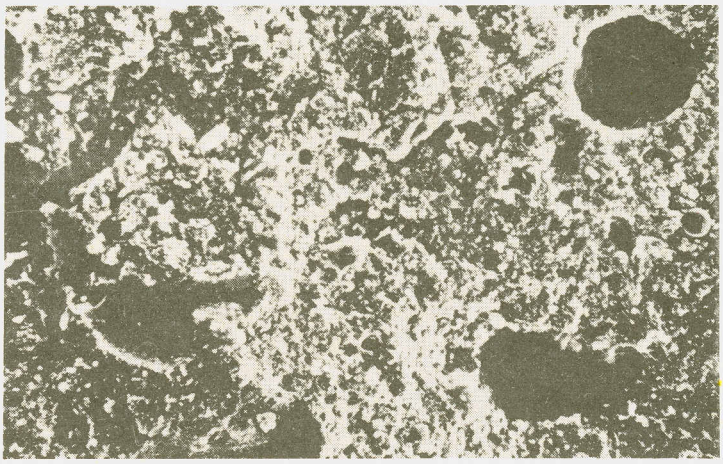


Fig. 4 Microstructure of set-binderpaste (SEM).

Fig. 5 Load testing of fibre-cement roofing sheets.

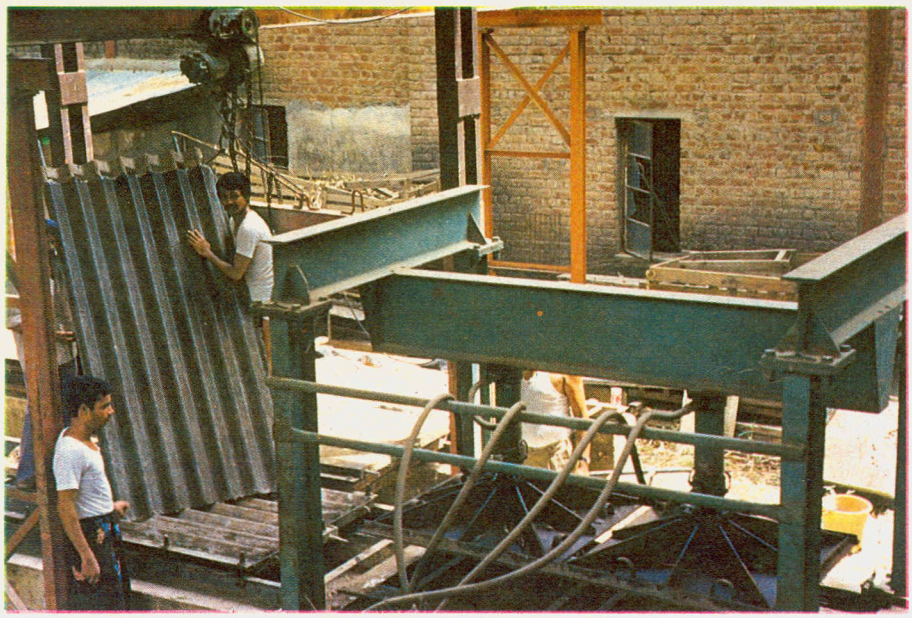


Fig. 6 Casting of fibre-reinforced cement sheets.

Fig. 7 Field weathering test of fibre-reinforced cement sheets.

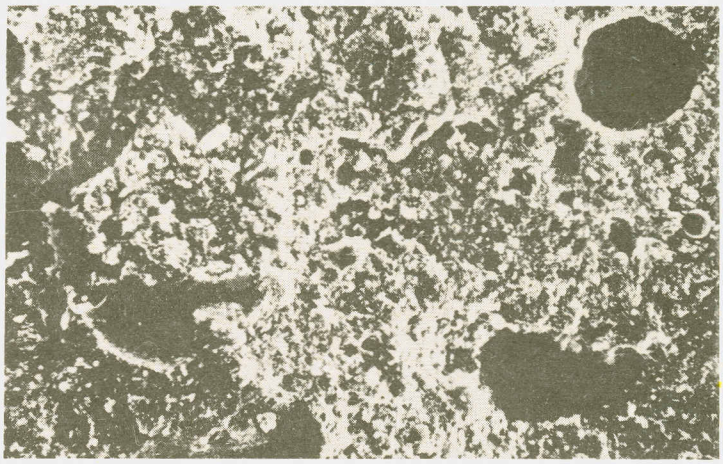


Fig. 4 Microstructure of set-binderpaste (SEM).

Fig. 5 Load testing of fibre-cement roofing sheets.

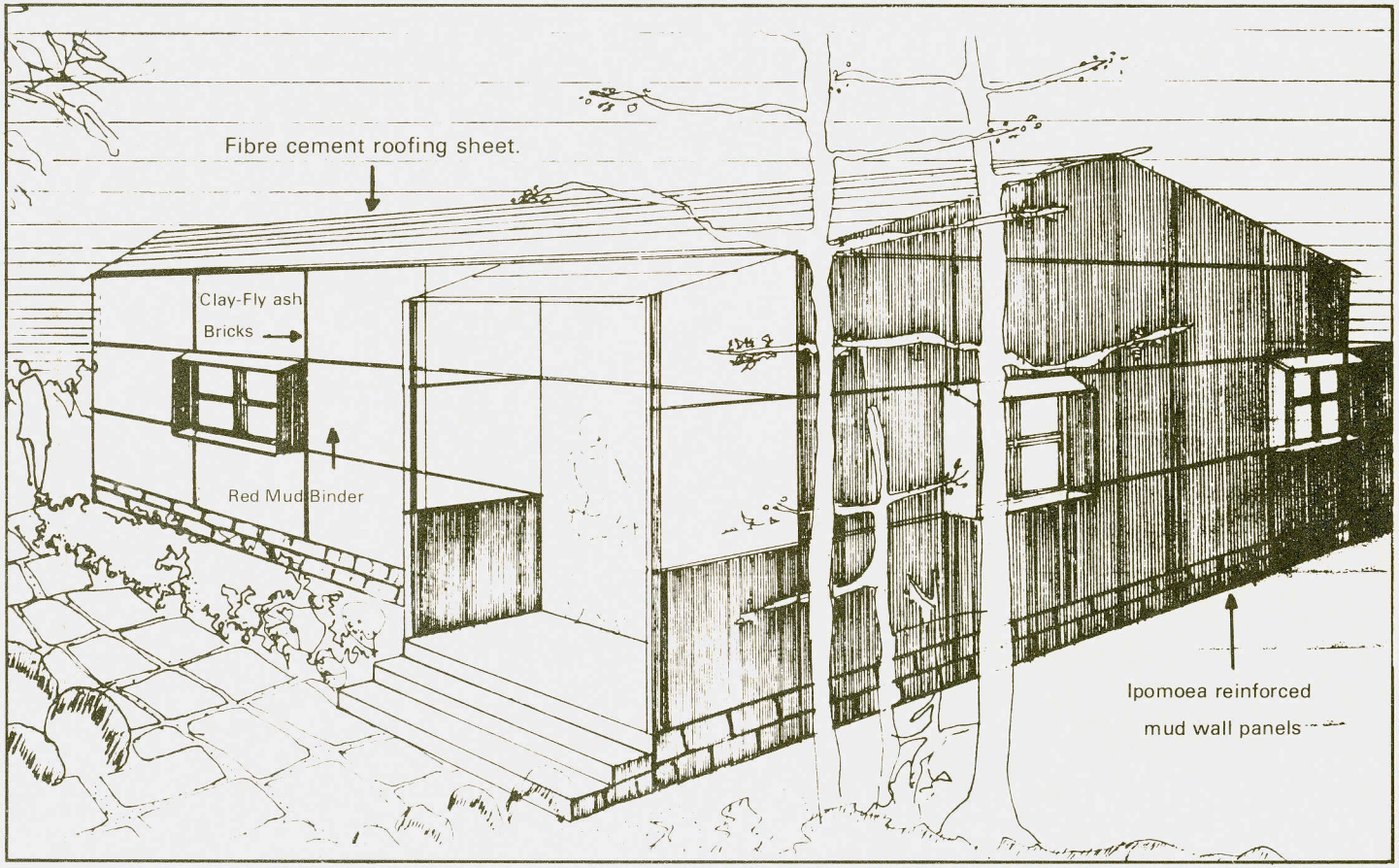


Fig. 8 View of typical low cost house based on materials developed by RRL.

COMPOSITE MATERIALS

Composite material is one of the major areas of R&D at the Regional Research Laboratory, Bhopal. Ongoing programmes range from metal-matrix composite materials to composites based on natural fibres of vegetable origin. The following is the outline of the progress:

Metal matrix Composites (MMCs)

The major emphasis is on aluminium alloy based composites. Composites with dispersions of soft solid lubricants such as graphite and hard ceramic particles like silica sand have been synthesized by inexpensive casting routes. Notable achievements include the development of a process for the manufacture of aluminium alloy graphite particle composites.

The work of Al-graphite composites has evoked considerable interest amongst several parties within the country and abroad. At a special request of an aircraft component manufacturer in the United States, Al alloy-graphite bush bearings have been made to suit the aircraft fuel pumps in the new generation of aircrafts. Simulated tests on Al alloy-graphite bush bearings in aircraft fuel pumps, carried out in the United States, indicate that small bearings possessed the required PV limits for such applications.

Significant progress has been made towards evaluation of pistons and cylinder blocks made out of aluminium alloy graphite composite materials. Pistons for IC engines cast at M/s La Cast Metal Component Pvt. Ltd., Bombay are undergoing endurance tests at ARAI Pune. Five hundred hour tests on Al-3% graphite pistons show substantially less wear. Al-3% graphite cylinder blocks for scooters were made at the facilities of some of the leading auto manufacturers and endurance tests are going on at their facilities. 150 hour tests on these cylinder blocks are completed.

MMCs Through Rapid Solidification and Squeeze Casting:

The microstructure of the matrix in metal matrix composites plays an equally important role in governing the overall properties of the composite. This can be achieved by controlling the process variables e.g. solidification rate, mold configuration, application of pressure during solidification etc. Increasing the freezing rate during solidification (i.e. rapid solodification) minimizes the undesirable floating/settling of the second phase particles due to density differences between the dispersoids and the melt and also refines the matrix microstructure.

A study has been undertaken to produce A1-Si alloy composites with graphite particle dispersions through rapid solidification route in order to achieve the dual advantages of solid lubriocation due to graphite as well as the refined microstructure of the A1-Si alloy matrix (see the microstructure in Fig.9). Similarly, work is initiated to produce A1-Si alloy composites through squeeze casting route wherein pressure is applied during solodification.

Composites Based on Natural Fibres of Vegetable Origin:

Natural fibres such as sisal, sunhemp, jute, banana and coir are grown in many parts of the country. Some of them have aspect ratios (ratio of length to diameter) greater than 1000 and can be easily woven. It is well known that these fibres are extensively used for cordage and twine, sacks, fish-nets, matting and rope and as filling for mattresses and cushions (rubberised coir is an example). Work carried out at the Regional Research Laboratory, Bhopal indicates that plant-based natural fibres may be used as reinforcements in polymer and cement-based

composites, replacing to some extent more expensive and non-renewable synthetic fibres li glass. Studies have also been undertaken to characterize the mechanical and physic properties of various natural fibres grown in and around Madhya Pradesh region. Ceme based composites have been described in earlier sections of this report.

Polymer Based Composites:

The principal advantage of natural fibre-reinforced polymer composites stems from th ability to absorb tremendous amounts of energy during impact fracture. In polyester-mat composite reinforced with unidirectionally aligned sunhemp fibres, the work of fractu showed a linear increase with fibre volume fraction. The work of fracture (Izod) for a 0.24 sunhemp-polyester composite was found to be 21 KJm^{-2}; this is 15 times higher than the wo of fracture for polyester resin alone. The origin of toughness of natural fibre-polyest composites has been studied by SEM examination of fractured surfaces which revelaed th the high toughness is due to the complex fracture mode of natural fibres. Since natural fibr are themselves cellulose fibril-reinforced composite materials, their fracture modes inclu uncoiling of fibrils, fibril pull-out, plastic deformation of fibrils, fibril splitting and diversion the crack at the fibril-fibril interface.

On techno-economic grounds considering particularly specific stiffness per unit cos composites like sunhemp-polyester are found to be far superior to glass reinforced plastic (GFRF). In applications where stiffness is important but strength is not a priority, such as suitcase, a chair or a table top, the advantages of natural fibre-reinforced polymers can b overwhelming. Based on the results of these basic studies, a project is being undertaken (wit sponsorship from KVIC) to develop some such products.

The untreated sunhemp and sisal fibres do not have good bonding with polymer. With a vie to achieve good bonding, treatment of the surface of the fibres with alkali and sodium silicat was tried. The acetylation of the sunhemp fibres was found to reduce their hygroscopicity fro 8.04% to 4.41%. Attempts are being made to prepare boards using less expensive polymers an sunhemp fibre.

A technique has been developed to achieve optimum conditions of improvement of strengt of sisal fibre and of bonding between fibre and polymer matrix. Sisal fibres of differen diameters ranging from 0.15 to 0.3 mm obtained from local sources of M.P. were soaked in a aqueous solution of NaOH (5 wt.%) for various periods of time. After a particular interval, th fibres were removed from the solution, washed with fresh water several times and rinsed wit distilled water containing a few drops of HCl to remove any excess of NaOH adhering to the fibr surface.

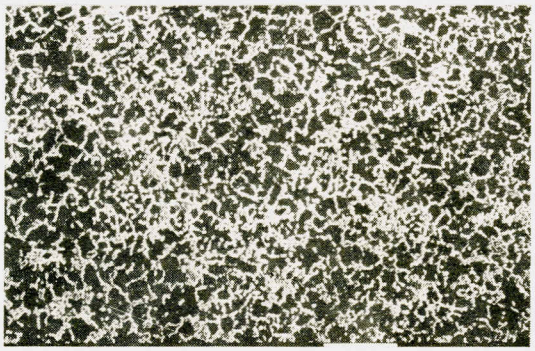


Fig. 9a Microstructure of rapidly solidified (LM6) alloy.

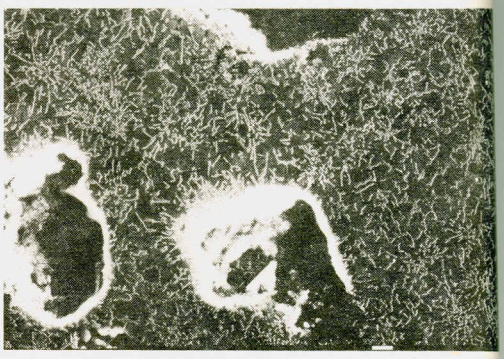


Fig. 9b LM6-graphite composite.

TRIBOLOGY

Ongoing programmes include: (i) erosion resistance of materials used in thermal power plants, (ii) evaluation of the abrasion resistance of Al aloy-hard ceramic particle composites and (iii) friction and wear studies on Al alloy-graphite composites.

RRL Bhopal is equipped with the most modern facilities to carry out tribological studies of materials. These include:

(i) a pin-on-disc wear test machine to study the sliding (adhesive) wear of materials, (ii) a rubber wheel abrasion test (RWAT) apparatus to generate the abrasion resistance of materials as per ASTM standard test procedure (iii) a gas-jet erosion system to evaluate the erosion-resistance of materials (iv) a bearing test rig to evaluate the pressure-velocity (PV), limits of plain bearings and (v) a four-ball tester to evaluate the strength of lubricants. RRL Bhopal is also equipped with the most modern facilities required for characterizing the worn surfaces, debris and the materials removal mechanisms. These include JEOL SEM with EDXS WDXS spectroscopes, X-ray diffraction unit, Optical Microscrope with computerised image analyser and microprocessor controlled profilometer-Talysurf.

(i) Erosion Studies:

Erosion is the removal of material from the surface due to the impingement of erodent particles carried by a fluid medium (air or liquid). It is encountered by many materials; thermal and hydro power plants, mining and mineral dressing equipment, chemical and metallurgical industries and so on. A programme has been initiated to study the erosion behaviour of materials used in thermal power plants, by fly ash particles. The objective is to work out the right composition and heat treatment procedure that will enhance the resistance to erosion.

(ii) Abrasion Resistance of Al Alloy-Ceramic Particle Composites:

Aluminium alloy composites with very high volume fractions (upto 0.35 Vf) of hard particles such as silica sand and zircon have been synthesized by casting route for potential applications which involve high resistance to abrasion. Abrasion resistance of these composites have been evaluated according to ASTM test procedure. The abrasion rate (inverse of abrasion resistance) of Al alloys decreased by a factor of five due to the dispersion of 0.35 volume fraction zircon. Interstingly, the abrasion rates of these composites (hardness: 144 VHN) are lower than that of the 1020 steel and comparable to 1045 steel that was heat treated to a much high hardness of 467 VHN.

SEM studies of abraded surfaces showed hardly any zircon particle pullouts. If the bonding between the hard particles and the matrix is strong enough, and if the particle size and the volume fractions are carefully designed, it is possible to conceive of a situation wherein the hard filler particles will completely protect the softer Al alloy from the action of the abrasion. The role of Al alloy matrix is to impart toughness to the composite while the resistance to abrasion is provided by the hard particle dispersions. Thus, the Al-alloy hard particle composites can be tailor-made to give rise to inexpensive, light weight abrasion resistant materials.

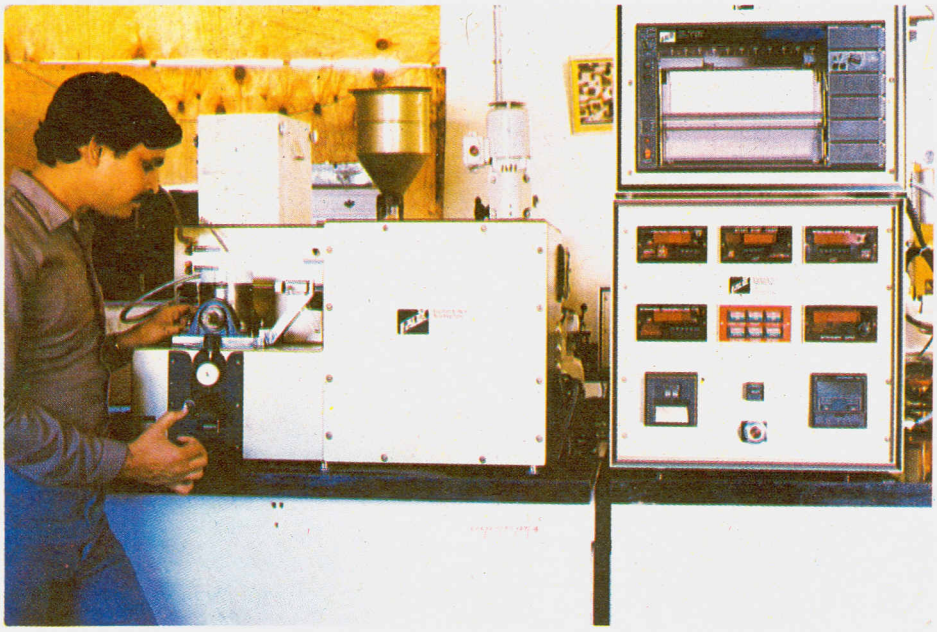


Fig. 10 Bearing test rig.

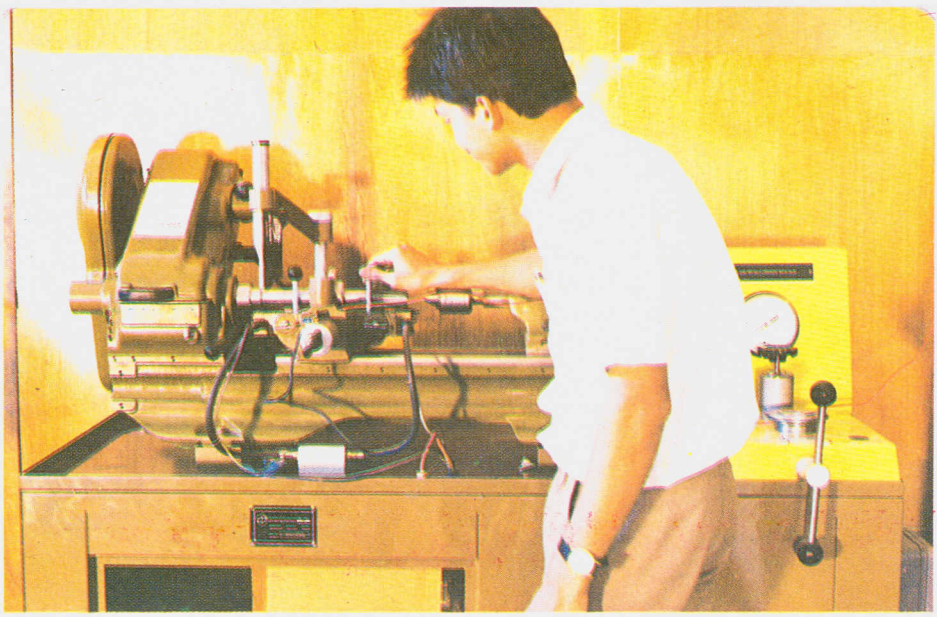


Fig. 11 Cameron-plint pin-on-disc showing wear test machine.

Tribology Lab-A Unique facility at RRL.

(iii) Friction and Wear of Al-alloy Graphite Composites:

It is well known that aluminium alloys particularly aluminium-silicon alloys are extensively used for some tribological applications. Techniques to produce aluminium alloy graphite composites by conventional poweder metallurgy as well as casting route have been established. Sliding wear, friction and temperature rise during the test have been evaluated for aluminium alloy graphite composites. Effects of the heat treatment and surface finishing techniques and mechanism of graphite film formation during sliding wear have been established. Studies also indicated that the desired improvements in tribological behaviour of aluminium alloy-solid lubricant can be achieved only if there is such a tribo-induced graphite film formation on the mating surface which will prevent metal to metal contact. A typical worn surface of composite with tribo induced graphite film is shown if Fig.13.

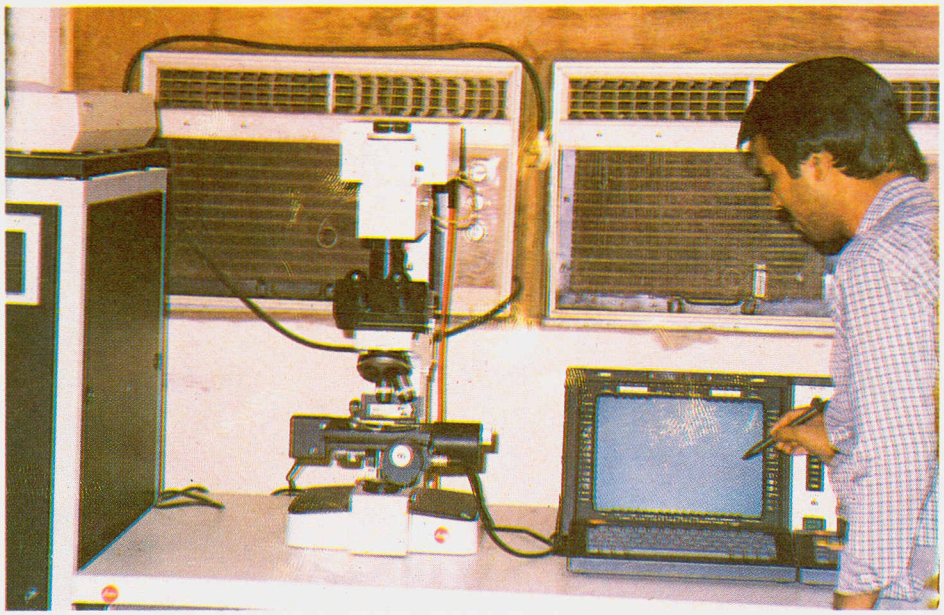


Fig. 12 Tas Plus Image Analyser for quantitative metallography.

Worn Surface.

X-Ray dot mapping for Carbon LM30-Graphite (H.T.).

Fig. 13 Worn surface of LM 30-graphite composite with triboinduced graphite film.

INTERACTION WITH THERMAL POWER SECTOR AND ENGINEERING INDUSTRIES
THROUGH METALLURGICAL CONDITION MONITORING

R&D Support to Thermal Power Sector:

The average PLANT LOAD FACTOR (PLF) is adjudged as a true measure of the performance of a thermal power generation unit. The PLF is influenced by unscheduled outages of the plant. This in turn depends upon the premature failure of vital power plant components such as boiler tubes, turbine blades, turbine rotors, coal mill shafts and so on.

A group and facilities have been created in the laboratory for metallurgical failure analysis with a view to take up studies related to materials problems in thermal power generation systems.

During this period a large number of failed components received from several thermal power plants; Korba, Satpura, Hasdeo (MPEB), Nasik (MSEB), Parichha, Obra (UPSEB), Batinda (Punjab EB), Kothagudam (APEB), DESU etc. were examined/analysed (list of some investigations enclosed).

It has been observed that about 60% of the forced outages were due to high temperature/high pressure boiler tube failures. The reasons for failure include:

(i) Overheating:

These failures result from

- combustion imbalances arising out of situations such as flame impingement on the boiler tubes from damaged burner nozzles, deposition of unburnt soot, secondary combustion etc.

- departure from thermal regimes of design values resulting in higher flue gas temperatures originally envisaged/higher metal skin temperatures due to insufficient water/steam flow through the boiler tubes eventually leading to a particular tube bank to attain high temperatures in a particular zone, higher thermal stresses and consequent failure,

- scales, deposits, corrosion products at the tube bends or at the excessive weld protrusions causing improper flow of the medium leading to localised overheating,

- poor water chemistry with inadequate pH, high O2 and CO2 contents.

(ii) Creep:

Creep phenomenon of low alloy steels due to prolonged overheating.

(iii) Erosion:

Erosion of boiler tubes due to impactation of abrasive particulate matter of the fly ash coals having in consistent ash contents varying from 35-50%.

(iv) Electrostatic Precipitator (ESP):

Most of the thermal power plants have been depending upon the use of ESP in the ar emission of fly ash into the atmosphere in their pollution abatement programmes. Pre failure of the ESP from Nasik, Satpura, Kothagudam, Desu power plants have been studi the principal cause has been found to be substandard stainless steel materials an susceptibility to stress corrosion cracking. A programme of indigenous manufacture of s quality stainless steel ESP electrodes with improved metal working/drawing operati RRL's supervision is underway.

Residual life estimation:

A programme for residual life estimation of high temperature high pressure comp such as boiler tubes for modernisation and renovation of thermal power plants and r tubes in petro-chemical industries is underway through micro-structural characterisa accelerated stress rupture tests; installation of the latter equipment is in the offing.

Thus our exposure to the problems of thermal stations includes a broad spectrum the following aspects in particular:

- Diagnosis of failures of vital components such as boiler tubes, turbo generator blades and condenser tubes.

- Computer aided analysis of operational data in relation to heat transfer and drop for the prediction of several operating conditions.

- Characterisation of fly ash and suggestion of steps for converting the fly ash in made resource material for the building industry.

- Pollution abatement through indigenous development of better ESP mate improved fabrication techniques.

- Analysis of coals/ashes for trace metals from the point of view of envir protection - residual life estimations through either in-situ micro-s characterisation or through accelerated stress-rupture testing.

- Orientation training to operation and maintenance people.

R&D support to Industrial sector:

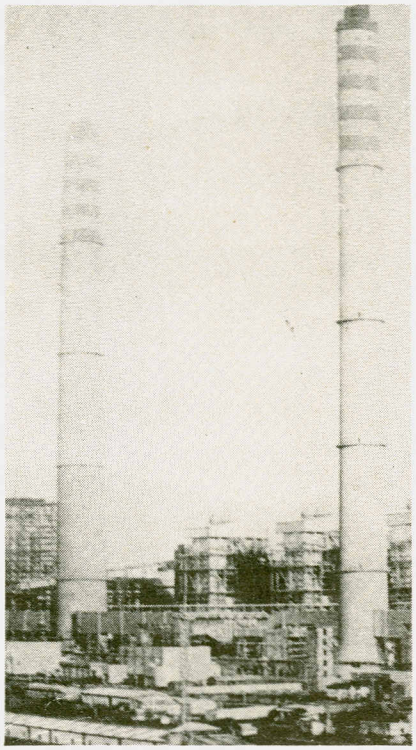
Microstructural characterization of metallic products of small/medium scale indu carried out to estimate the metallurgical integrity for quality assessment as per int standards.

List of some important sponsored Metallurgical Investigations.

S.No	Name of Investigations	Sponsoring Agency
1.	Metallurgical investigation on the failure of superheater tubes and control valve spindle	Ennore Thermal Power Station, Tamil Nadu
2.	Metallurgical investigation on the failure of: - Vertical coal mill shaft - boiler tubes - turbine rotor	Parichha Thermal Power Station, Jhansi, UPSEB
3.	Metallurgical investigation on the failure of platen super heater tubes	HASDEO Thermal Power Station, MPEB
4.	Metallurgical investigation on the failure of super heater tubes	Korba Thermal Power Station, MPEB
5.	Metallurgical investigation on the failure of ESR Electrodes	Satpura Thermal Power Station, MSEB
6.	- do -	Nasik Thermal Power Station, MSEB
7.	Metallurgical investigation on the failure of super heater tube	Obra Thermal Power Station, UPSEB
8.	Metallurgical characterisation of coal pipes	Nasik Thermal Power Station, MSEB
9.	Metallographic characterisation of high speed tool steel sample	MEPCO, Indore
10.	Galvanisation/porosity test on 11 KV/45 KN insulating disc.	Insulators & Electricals Co., Bhopal
11.	Metallurgical investigation on the failure of boiler tubes	Satpura Thermal Power Station, MPEB
12.	Metallographic characterisation of serrated sickles	M.P. State Agro Industries, Bhopal
13.	Metallographic characterisation of RCC Steel rods	Gujrat Engineering Research Institute, Vadodara
14.	Metallurgical investigation on the failure of grinding balls.	Bhatinda Thermal Power Station,
15.	Metallurgical investigation on the failure of: - coal mill shaft - boiler tubes	Parichha Thermal Power Station, UPSEB
16.	Metallurgical investigation on the failure of thermal power plant components.	Nasik Thermal Power Station, MSEB

R&D SUPPORT TO THERMAL POWER GENERATION SECTOR

FAILURE ANALYSIS OF VITAL POWER PLANT COMPONENTS



◀ Fig. 14 A view of thermal power plant.

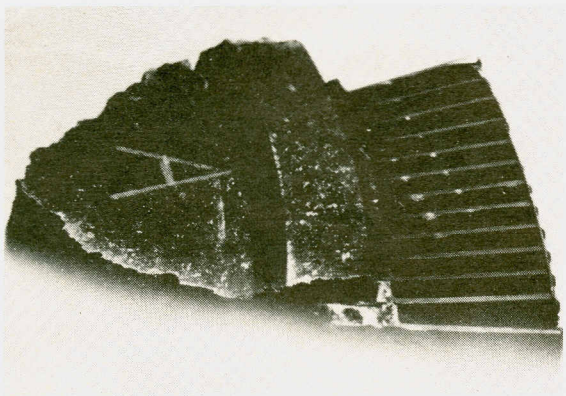


Fig. 15 Failure of turbine blades.

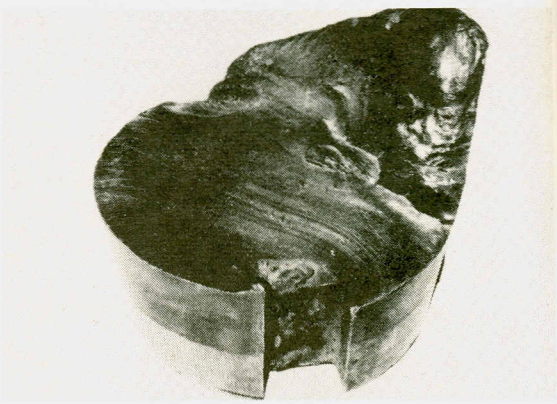


Fig. 16 Failure of coal mill shafts.

Fig. 17 Failure of blades on account of stress corrosion cracks.

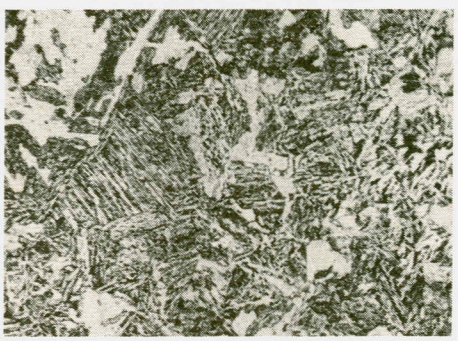
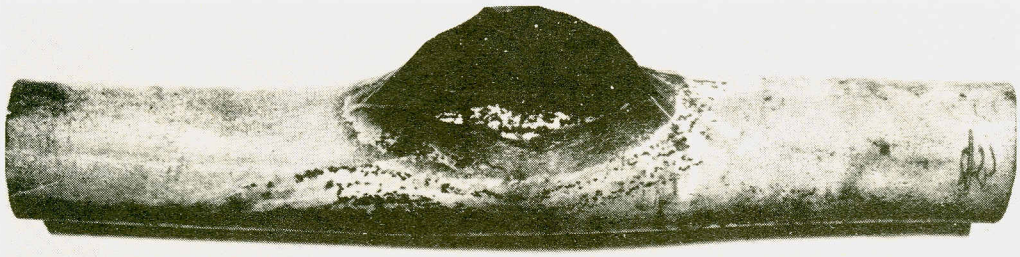
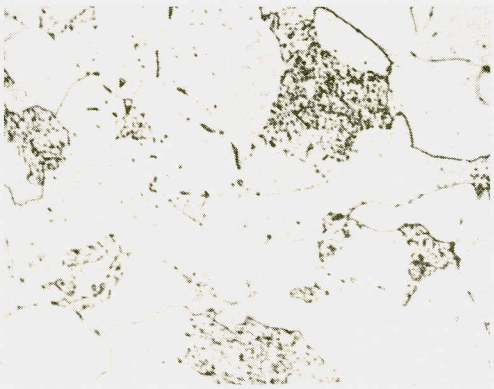
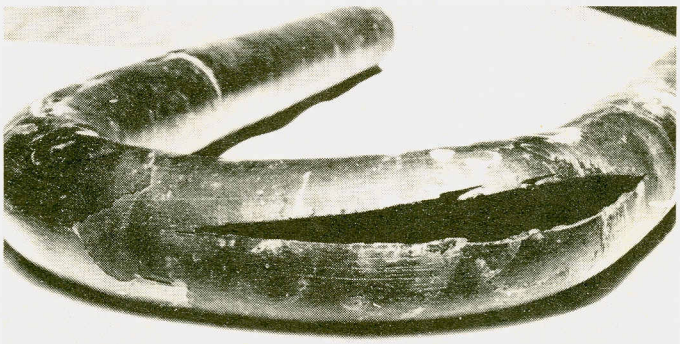


Fig. 18 Fatigue failure arising from faulty microstructure on account of inadequate heat treatment of the shaft.







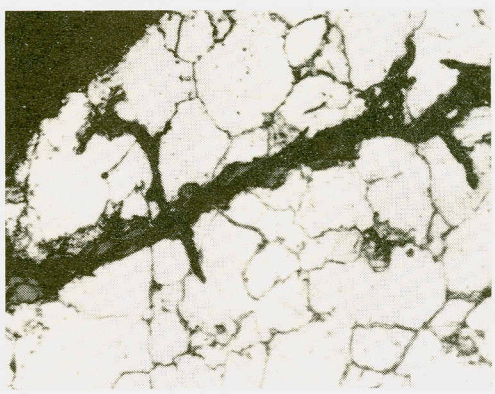
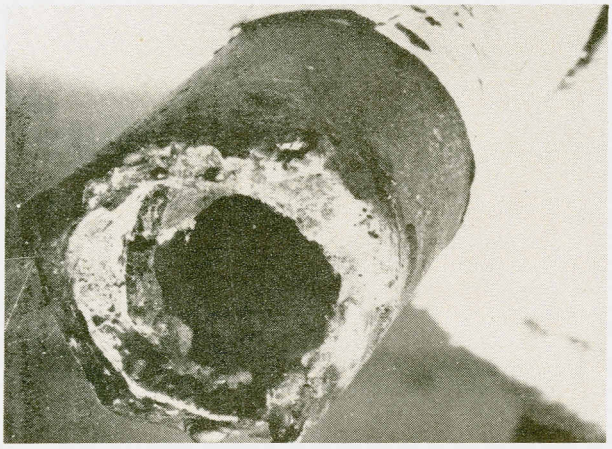


Fig. 19 Failure of super heater tubes on account of overheating resulting in degenerated microstructure.



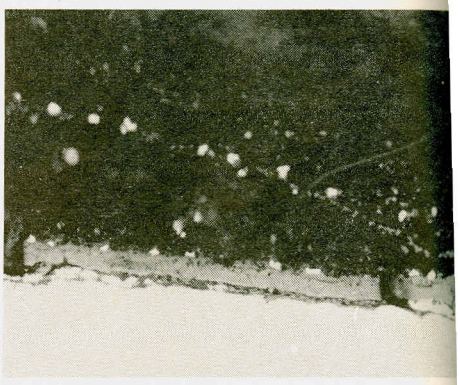
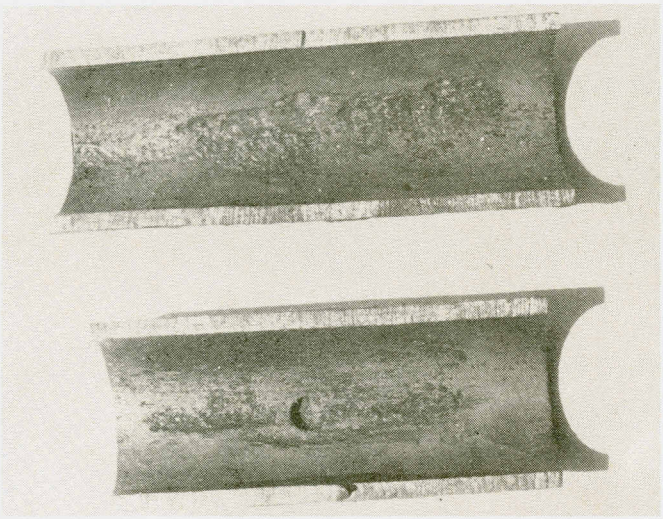


Fig. 20 Failure of water wall tubes on account of poor water chemistry resulting in deposits on the inner surface of the tubes.



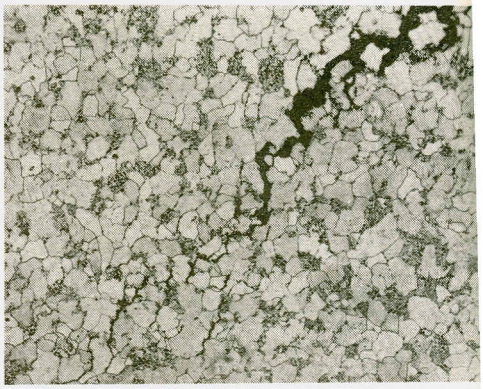


Fig. 21 Failure of Boiler Tubes on account of caustic gouging.

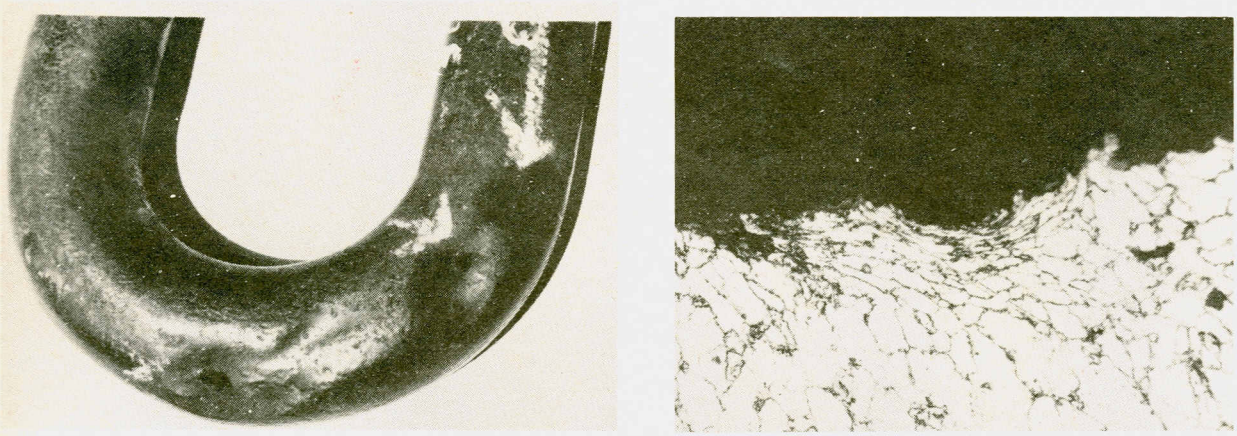


Fig. 22 Failure of boiler tubes on account of excessive erosion by the impactation of abrasives in flyash.

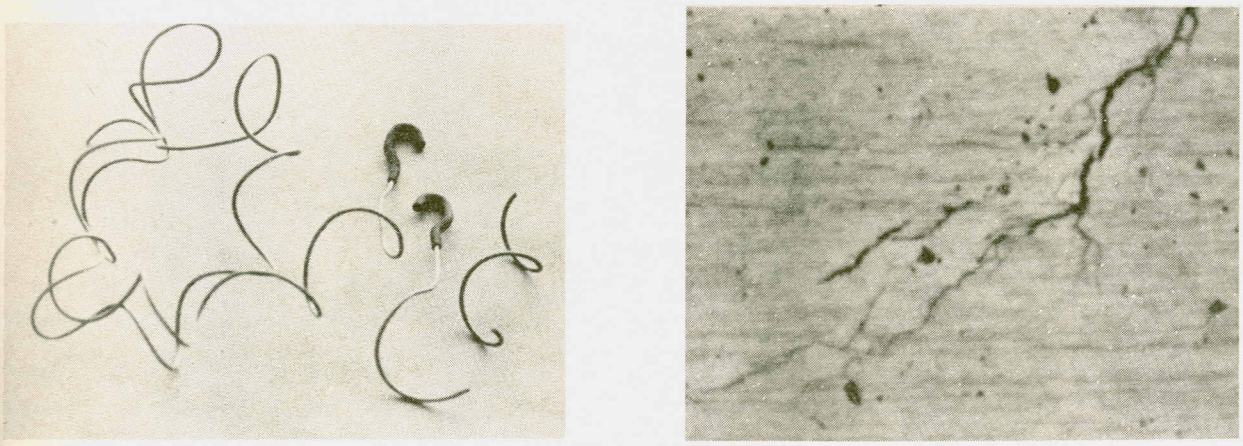
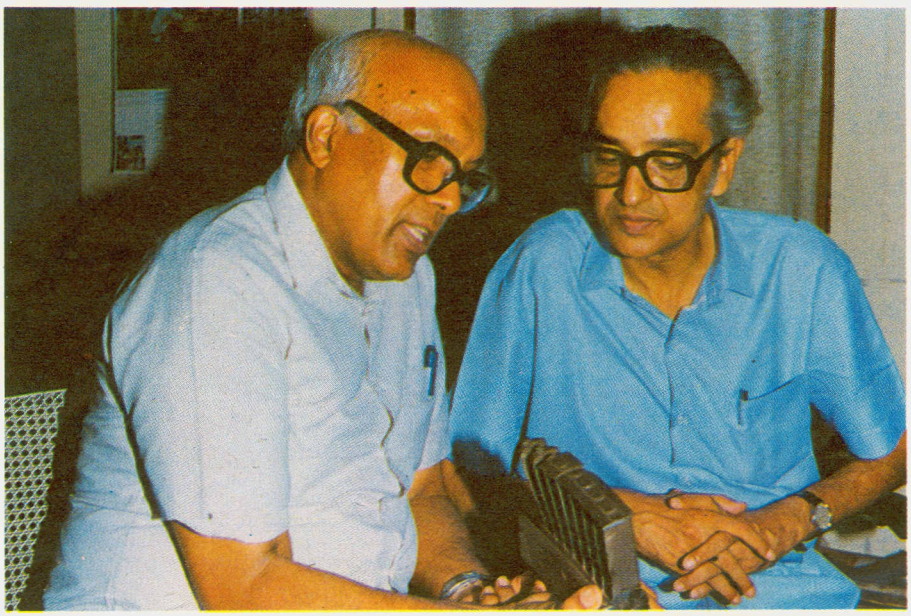


Fig. 23 Failure of electrostatic precipitators on account of stress corrosion cracking.



Director, RRL discussing the mechainsm of failure of turbine blades of a thermal power plant to Dr. D.N. Mishra, Director General, Madhya Pradesh Council of Science & Technology.

Scientists explaining the R&D projects on electrostatic precipitators and flyash of Thermal Power Stations of M.P. to the Hon'ble Mr. C.P. Shekhar, Minister of Industries, M.P.

CHARACTERISATION AND UTILISATION OF FLY ASH

Indian coals and their fly ashes are notorious respectively for their high ash contents and erosive character resulting in severe erosion of boiler tubes leading to unscheduled outages and low PLF of pulverised coal fired thermal power plants. Studies are undertaken to minerologically characterise the fly ashes from several thermal power plants with a view to:

- design systems to avert discharge in to the environment through chimneys
- use the waste product suitably

Since beneficiated coal is not presently used in India for firing power boilers, studies are undertaken to characterise the fly ash samples obtained from run of mine coal fired boilers in comparison with that obtained from a beneficiated coal fired experimental power station in M.P.

The fly ash samples were subjected to:

- particle size analysis
- X-ray diffraction
- Scanning Electron Microscopy

Results are briefly discussed below:

Chemical Analysis

Elemental Analysis	Fly ash from run-of-mine coal	Fly ash from beneficiated coal
SiO_2	54.0 - 63.8	56.4 - 64.7
Al_2O_3	27.7 - 37.4	20.5 - 31.8
Fe_2O_3	07.2 - 09.0	10.3 - 12.2
CaO	00.28 - 00.45	00.25 - 00.42
MgO	00.15 - 00.20	00.10 - 00.18

Particle size analysis

Particle size varies from less than 1 micron to 60 microns. Fig. 24 ab show respectively the accumulated weight percent vs. particle size curve of the fly ash from run-of-mine coal and that of beneficiated coal.

X-ray diffraction analysis

Phase analysis both qualitative and relatively quantitative has been carried out. Presence of -quartz together with mullite has been estimated using classical internal standard techniques taking into account, the absorption corrections. Results are depicted in Fig (25) and (26) on a fly ash sample received from one of the thermal power stations. Apart from α -quartz and mullite Fig. 26 gives additional information about the relative variation in amounts of hemetite and rutile. Further work is in progress.

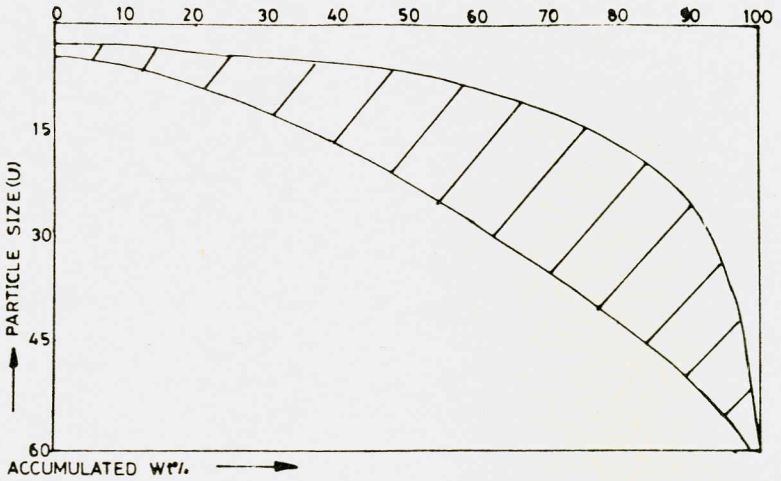


Fig. 24a Particle size analysis of flyash from run-of-mine coal.

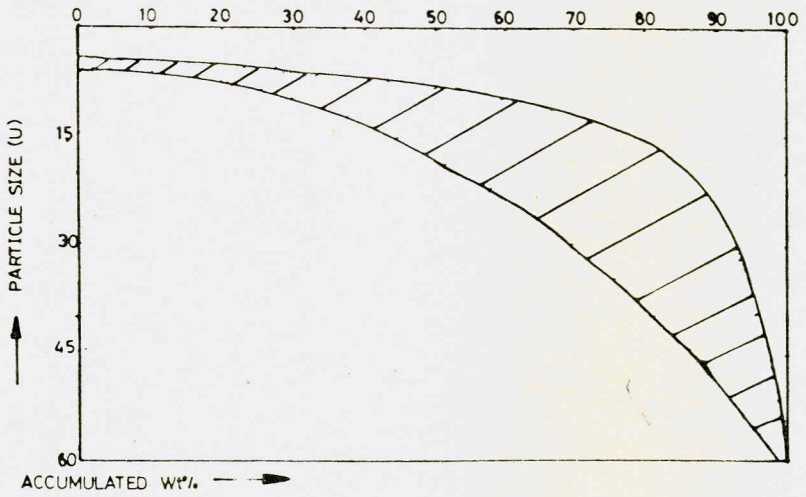


Fig. 24b Particle size analysis of flyash from washed coal.

Scanning Electron Microscopy

Morphological observation through SEM showed:

- most of the fly ash particles are spherical
- surfaces showed mechanical damage through impact
- small size particles stick to bigger ones
- some of the particles are cenosphere in nature.

Fig. 27 abcd-Scanning electron micrographs illustrating respectively the above features

M.P. State Electricity Board has sponsored a Rs. 2.00 lakhs project on the characterisation of fly ashes from their thermal power plants.

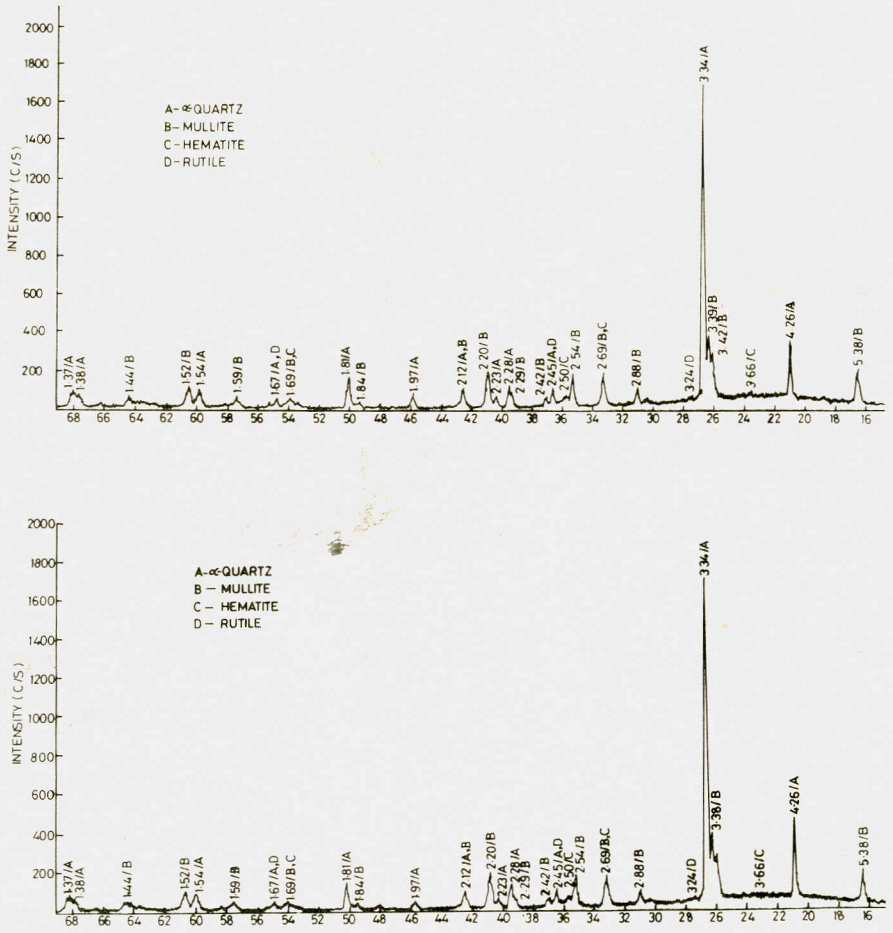


Fig. 25 X-ray diffractograms of fly ash showing phase constituents.

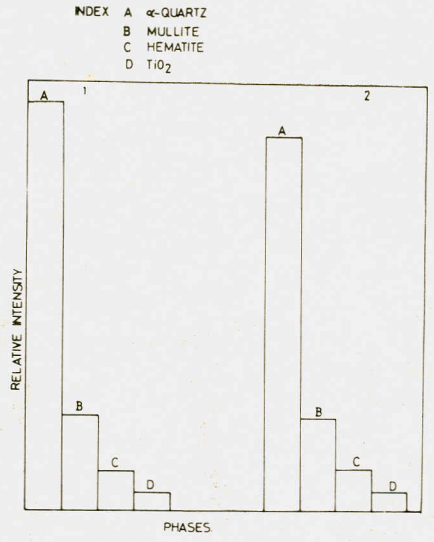
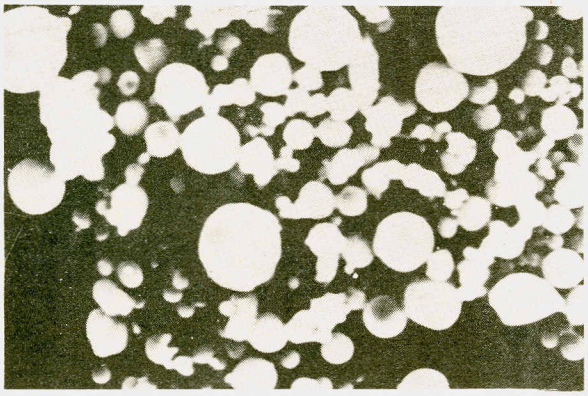
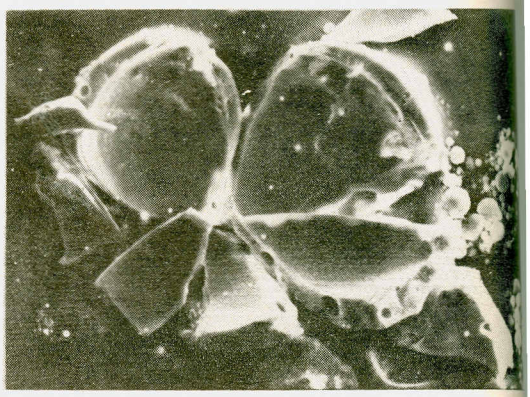


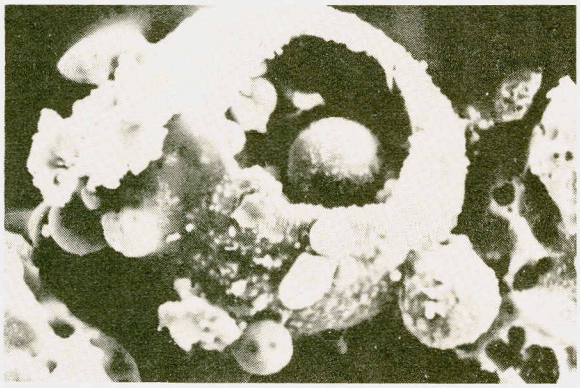
Fig. 26 Histogram showing relative variation in the amount of phase constituents.



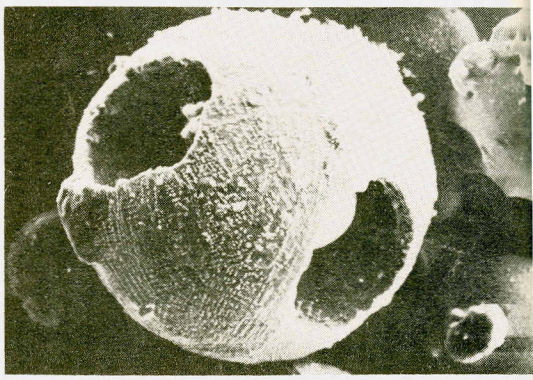
(a)



(b)



(c)



(d)

Fig. 27 abcd: SE micrographs of fly ash.

ALUMINIUM TECHNOLOGY AND FOUNDRY

Evaluation of Al conductors in coastal and industrial areas

Metallurgical evaluation of Aluminium conductors exposed in coastal and industrial areas has been undertaken. NMLPM 215 AAAC and ACSR conductors received from Tamil Nadu exposed for different durations were evaluated. Similar investigations on samples of NMLPM 215 and ACSR conductors received from Kerala State Electricity Board was also carried out. Investigation on NMLPM 215 AAAC and ACSR conductors received from Gujarat Electricity Board, Karnataka Electricity Board are in progress. Samples at regular intervals are being received from different State Electricity Boards.

The properties evaluation showed that:

(1) The NML PM 215 AAAC stranded conductors are superior to ACSR, when installed in coastal areas.

(2) The gradual increase in power loss in ACSR conductors, ultimately leads to huge loss of power with time.

(3) from the safety point of view also NML PM 215 AAAC conductors are superior to ACSR as failures due to over heating can be avoided.

Surface modification for improved materials performance

For the protection of tube well pipes from corrosion, aluminium based anodes are under development. Al, Al-Zn-In castings were made by conventional methods. The electrochemical

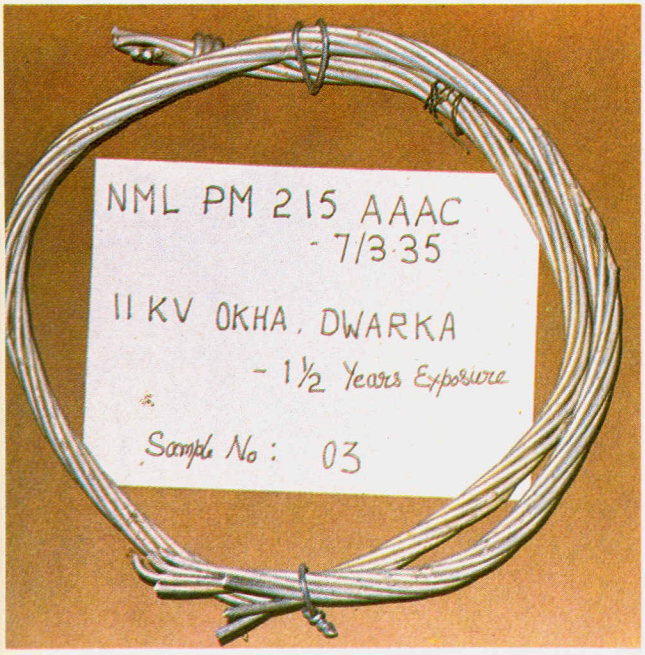


Fig. 28a NML PM 215 AAAC exposed in Coastal regions of Gujarat showing no Corrosion after 1½ years.

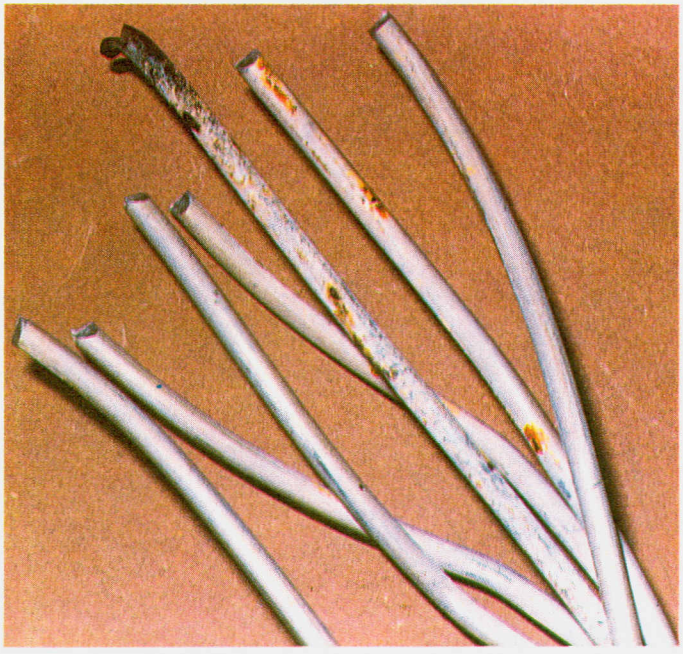


Fig. 28b Corrosion after 1½ years of exposure of a ACSR conductro.

behaviour of mild steel, Al, Al-Zn and Al-Zn-In samples was studied in 3% NaCl solution by Ta plot, potentiodynamic polarization and impedance measurement techniques. The corros rates obtained by weight loss method and Tafel plots have been found to agree well in aera NaCl solutions. On galvanic coupling of mild steel with aluminium based alloys, the corros rate of mild steel was found to decrease substantially. The corrosion behaviour of super pu aluminium was studied in different mineral acids by Tafel and impedance methods.

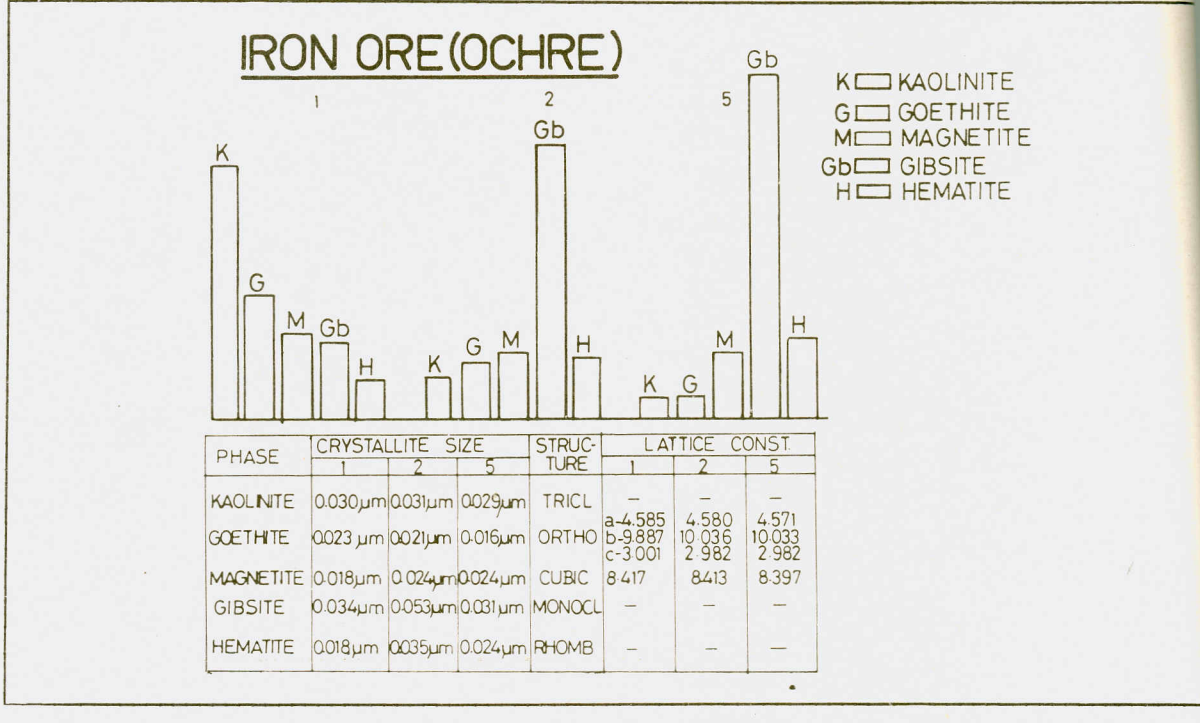
Squeeze casting:

It is generally known that castings, produced by conventional methods like sand a permanent mould, have many defects such as porosity, coring, blow holes, shrinkage cavit etc. Further these are processed by forging/rolling into different shapes and sizes. Squee casting offers the advantages of casting and forging in a single step, sometimes near n shaped components are produced. In this process, pressure is applied on the melt immediat after pouring the melt into the die.

Initial work on squeeze casting carried out using hypoeutectic Pb-Sn alloys show promis results. The work is now extended to aluminium alloys. Optimisation of processing parame is now in progress. Microstructural investigations and mechanical properties of castings a being studied further.

X—RAY AND RAPID SOLIDIFICATION

X-ray diffractometric technique is used for phase analysis (both qualitiative and relativ quantitative) in addition to crystal structure and crystallite sizes of selected (hkl) Planes metals and meterials in the internal research programmes as well in sponsored projects.



PHASE	CRYSTALLITE SIZE			STRUC-TURE	LATTICE CONST.		
	1	2	5		1	2	5
KAOLINITE	0.030μm	0.031μm	0.029μm	TRICL	–	–	–
GOETHITE	0.023 μm	0.021μm	0.016μm	ORTHO	a-4.585 b-9.887 c-3.001	4.580 10.036 2.982	4.571 10.033 2.982
MAGNETITE	0.018μm	0.024μm	0.024μm	CUBIC	8.417	8.413	8.397
GIBSITE	0.034μm	0.053μm	0.031μm	MONOCL	–	–	–
HEMATITE	0.018μm	0.035μm	0.024μm	RHOMB	–	–	–

Fig. 29 Shows relative amount of phase constituents in OCHRE SAMPLES represented in form of histograms an lattice parameters, structure and crystallite sizes.

Results of XRD on ochre samples are given in Fig.29.

R&D programme on the following projects are in progress.

- processing of advanced Al-base alloys through rapid solidification and evaluation of mechanical properties.

- Structure, high temperature stability and phase transformation studies of rapidly solidified supersaturated solid solution of aluminium base alloys.

Extruded Al-Mn alloy powder samples produced through rapid solidification processing had shown high alloying constitutents and enhanced physical and mechanical properties than conventionally produced ingot cast alloys. Wear properties of these alloys have been found to be superior, enabling them eminently suited for applications in automobile, aerospace and many enineering systems involving motion.

Scientists explaining programme on RSP Project to Hon'ble Shri B.R. Yadava, Minister, M.P.

CHARACTERISATION AND UTILISATION OF MINERAL RESOURCES OF M.P.

Zeolites:

Zeolites are known to possess an ion exchange and reversible hydration properties. Madhy Pradesh has a deposit of natural zeolite in Khargaon district. With an objective of developin inexpensive ceramic water filters for providing bacteria and suspended particles free potabl water the characterisation of zeolite found in M.P. was undertaken using XRD,IR and DTA/TG methods. The samples collected from three different locations were found to be stilbit natrolite and mesolite variety respectively.

The ceramic filters were prepared by mixing appropriate proportions of zeolite powder an inorganic binder followed by compression in the form of disc and sintering at temperatures upt 1000°C. The SEM studies of the filters showed that the pore size varied btween 2 and 5 u, th average pore size was estimated to be between 5 and 6 u. For removal of bacteria from wate dispersion of noble metal catalyst in the filter was tried. The bacteriological testing of th filtered water is presently being carried out at Military Hospital, Bairagarh. This project ha been sponsored by Madhya Pradesh Council of Science & Technology (MPCST)

Pyrophyllite:

This mineral is available in large quantities in M.P. and over a third of its total production i the country is reported from this state. Studies on characterisation of pyrophyllite fro Tikamgarh district were carried out by Chemical analysis, XRD,IR and DTA/TGA. Its plasticit PCE value and firing properties including shrinkage have been determined.

With a view to develop ceramic wall tiles from phyrophyllite, the powdered mineral wa appropriately prepared, compressed and sintered at temperatures less than conventionall used. It was found that despite the use of lower temperatures and shorter firing times, the tile passed the specifications laid down in ISI specification No. 777/1970. Further conventiona tiles are based on the use of feldspar, quartz and high quality clay and are required to be fired temperatures in the range of 1200-1300°C for prolonged period. This lowering in firin temperature leads to considerable saving in the fuel cost.

Talc, soapstone and mica:

These minerals occur in Jhabua, Narsingarh and Dhar Districts of M.P. The minerals wer collected from these places and characterised by chemical analysis, XRD, IR and DTA/TG The beneficiation of mica schist samples was carried out by grinding followed by wat elutriation method. Different cavitising aids and dispersion medium have been used delaminate mica schist flakes using ultrasonic method. The process for making porous therm insulation bricks from soapstone has been developed.

Lepidolite and Glauconite:

These are micaceous minerals and contain lithium and potassium sodium respectively. Bo lithium and potassium have great demand and at present are imorted in our country. Wit view to develop Indian resources the lepidolite and glauconite minerals were characterised chemical analysis, XRD and IR. The work on leaching of lithium and potassium on the minerals, is in progress.

His Excellency Prof. K.M. Chandy, Governor of M.P. going round the different R&D sections of the laboratory.

Director, RRL explaining the project on ceramic wall tiles developed fyom phyrophyllite mineral available adundantly in M.P. to Shri B.R. Yadav, Minister, Public Works, M.P.

Bauxite:

The low grade bauxite of Bastar district and overburden of metallurgical grade bauxite in markantak and Phutkapahar of M.P. were analysed through XRD,IR and DTA in addition to chemical analysis. The bauxites of Phutkapahar and Amarkantak contain only 28-32% Al^2o^3. X-ray and IR spectral analysis have confirmed the presence of gibbsite, kaolinite, diaspore.

Ochres:

The ochres occurring in M.P. were characterised by XRD, IR DTA/TGA and chemical analysis methods. They consist of two varieties having red and yellow colours. Yellow ochre has goethite along with variable amounts of alumina bearing minerals i.e. kaolinite. The red variety has hematite as the major iron phase along with small amounts of both gibbsite and kaolinite. Yellow ochres have iron oxide. 21-22% whereas red ochres have iron oxide to the extent of 47-48%.

In order to know the presence of various consituents in ochre samples together with crystallite size, structure and relative amounts of phase constituents complete x-ray diffraction ayalysis has been done. (Fig. 28)

SYSTEMS PLANNING AND RESEARCH MONITORING

The Systems Planning & Research Monitoring Division continued its activities in planning, liaison, information, research monitoring and computer applications. Computational support was extended to various R&D activities as well as management functions. Software packages for simulation of dispersion emissions from tall stacks from thermal power stations and cement plants are being developed. Computerisation of library accession registers and search has also been taken up. An analysis has been carried out on operational data from thermal power stations with a view to develop predictive capabilities on plant performance through mathematical modelling.

The division liaisoned with the industrial sector in and around the region on matters related to consultancy, technical and analytical services, know-how and technology transfer. A MOU has been made with the State Government undertaking on raw materials characterisation.

TECHNOLOGY TRANSFER

(i) The process for manufacture of aluminium alloy graphite particle composites was assigned to NRDC for technology transfer. The process was released to M/s Diamond Auto Industries Ltd, Ghaziabad in early 1987. Successful factory production trials were carried out and their staff was trained in making the Al-graphite material heats.

(ii) As mentioned in earlier annual reports, the work on aluminium graphite composite has evoked considerable interest amongst several parties within the country and abroad. Formal arrangements have been worked out through NRDC for overseas technology transfer.

The details of the terms of technology transfer through NRDC are mentioned below:

	Within India	**Overseas**
Lumpsum Premium	Rs. 15,000	US$ 25,000
Recurring Royalty	5%	2½ %
Period of Licence	7 years	7 years
Nature of Licence	Non exclusive	Non exclusive

(iii) The technology of making unglazed ceramic wall tiles (CTW-1) is ready to release. Salient features of this process are:

(a) Energy effectiveness
(b) Distortion free products leading to high productivity
(c) Obviates use of quartz/china clay which are otherwise used
(d) Minimizes pollution

GENERAL INFORMATION

13th National P/M Conference

The laboratory organised the 13th National P/M Conference with the Powder Metallurgy Association of India (PMAI) and the Department of Science & Technology on March 2-3, 1987. Dr. R.V. Tamhankar, Chairman, Research Advisory Council (RAC) of RRL Bhopal inaugurated the Conference devoted to the theme "Powder Metallurgy: Today and Tommorrow".

Seminar on "Development of Mineral Resources of M.P.

RRL Bhopal organised a two day Seminar on the "Development for Mineral Resources of Madhya Pradesh" during 19-20 March, 1987. The seminar was co-sponsored by the M.P. Council of Science & Technology and was inaugurated by Prof. P.K. Jena, Director, RRL Bhubaneswar. Spread over two key note sessions and four technical sessions the seminar addressed itself to topics related to the mineral resources of Madhya Pradesh, modern beneficiation techniques for low grade ores, prospects of the mineral based industries and environmental issues related to mining areas. The seminar was largely attended by experts from various organisations like GSI, IBM, SAIL, Mineral Development Board, MECL, Indian School of Mines, M.P. State Mining Corporation Ltd., CSIR Laboratories and academic institutions in the region.

Course on Industrial Metal Finishing

The laboratory jointly organised a course on "Industrial Metal Finishing" from 3rd to 5th June, 1988 with CECRI Karaikudi and PTC Bhopal. The training was designed for shopfloor staff dealing with metal finishing in the industries.

CSIR Foundation Day Celebrations

Regional Research Laboratory, Bhopal celebrated the CSIR Foundation Day on 26th September, 1987 coinciding with the 40th anniversary of independence. Inaugurating the celebrations, Shri Pratap Bhanu Sharma, M.P. made a fervent appeal to scientists and technologists to give their mite to provide the much needed S&T inputs to the development of the region. He appreciated the lead taken by the RRL Bhopal in R&D in natural resources including materials development. Dr. Rajendra Kumar, Director RRL Bhopal, gave a brief account of the history of CSIR and mentioned that the Regional Research Laboratory at Bhopal has developed a strong infrastructural base for advanced engineering materials ranging from low cost building materials to the sophisticated composite materials in advanced technologies.

On this occasion, a seminar on 'Research Facilities in M.P.' was jointly organised by the RRL Bhopal, SISI Indore, CSIR Polytechnology Transfer Centre, Bhopal, Bureau of Indian Standards and Association of Industries, Govindpura to highlight the potential S&T needs of the state of Madhya Pradesh. A science essay competition and science quiz was held for the children of staff of RRL Bhopal and prizes were distributed.

Foundation Day celebrations of 1988 were inaugurated by Shri Hasnat Siddiqui, Minister for Energy, Madhya Pradesh. Dr. D.N. Mishra, Director General of M.P. Council of Science & Technology delivered a special lecture in which he recalled the role of CSIR S&T growth of the country.

Shri Pratap Bhanu Sharma, M.P. inaugurating the CSIR Foundation Day.

Science Students of Jawaharlal Nehru School at the Metallography division.

CSIR has started an award scheme to promote scientific studies amongst SC/ST students. Three high school students each from SC and ST categories from Madhya Pradesh region were selected by RRL, Bhopal. These students were awarded at the hands of Mr. Siddiqui on the occasion of CSIR Foundation Day. The award carries a cash prize of Rs. 3000/-. The students also made a one week visit at RRL Bhopal for acquaintance with scientific studies. The following students received the awards: Dalpratap Singh and Ajmer Singh of Govt. Model School, Churhat, Chain Singh JLN Navin, Adarsh Tribal Govt. School, Barwani in the ST category and Yogesh Kumar Prajapati SP HSS, Alirajpur, Jhabua, Jagdish Prasad, Govt BHSS Thandla, Jhabua and Rajdhar Saket, Govt. Model School Churhat in the SC category.

Mementoes were presented to Mr. O.P. Juneja, Sr. FAO, Mr. GG Nair and Mr. S.P. Mukherjee, scientists of RRL Bhopal on the completion of thirty years of service in CSIR.

Entrepreneuership Awareness Camp

The laboratory organised an Entreprenuership Awareness Camp (EAC) on 'Aluminium alloy foundries for production of Castings' from March 14-16, 1988. The EAC was sponsored by the M.P. Council of Science & Technology and meant for interaction with twenty prospective entrepreneuers. It was designed to cover the essentials of entrepreneurship like project formulation, systems of financial assistance, labour laws and taxation for small industries in addition to expert technical lectures on various facets of aluminium foundries.

Quality Maintenance and Improvement Month

RRL Bhopal arranged a series of lectures on various aspects of "Quality Assurance" in connection with the "Quality Maintenance and Improvement month" on 24th Nov. 1986. The deliberations related specifically to the role of materials and scientists in quality control. Also problems of quality control in ferrous and non-ferrous foundries were discussed. Open day was also observed in which industrialists, engineers and technologists from Bhopal and around were invited.

National Science Day - 1987 & 1988.

The laboratory observed the Annual National Science Day on Feb. 28th 1987, Shri Mahesh Joshi, M.P. Minister of Environment inaugurated the celebrations. Students from local high schools spoke on the topic "Indian Scientists, Society and Technology". On the eve of the National Science Day 1988, the Laboratory arranged a meet of officials from various State Govt. agencies related to Science & Technology.

Exhibition-CSIR in the service of Nation

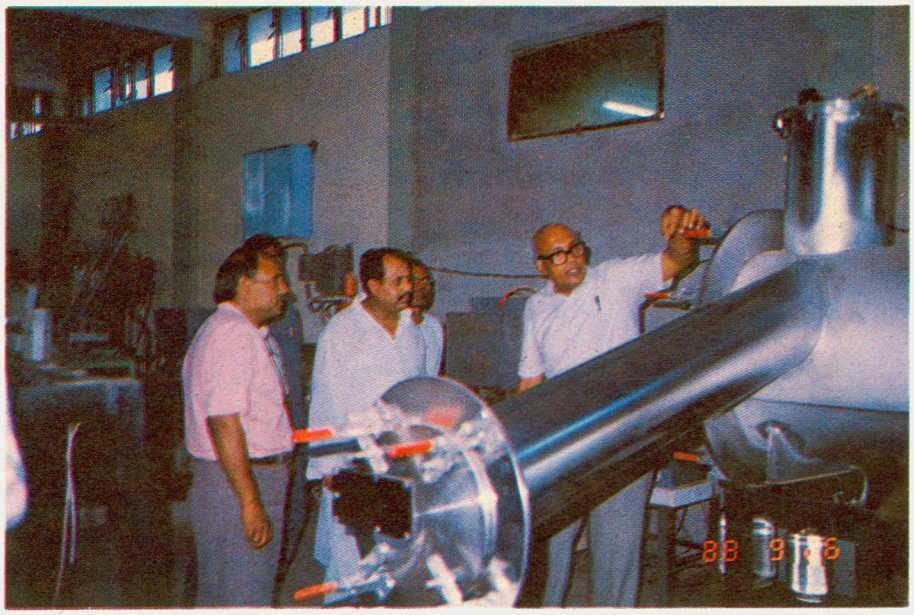
The laboratory participated in the exhibition held in the parliament annexe New Delhi, for the members of parliament during May, 1987. Exhibits on the aluminium based composites were on display and evoked encouraging responses.

Distinguished Visitors

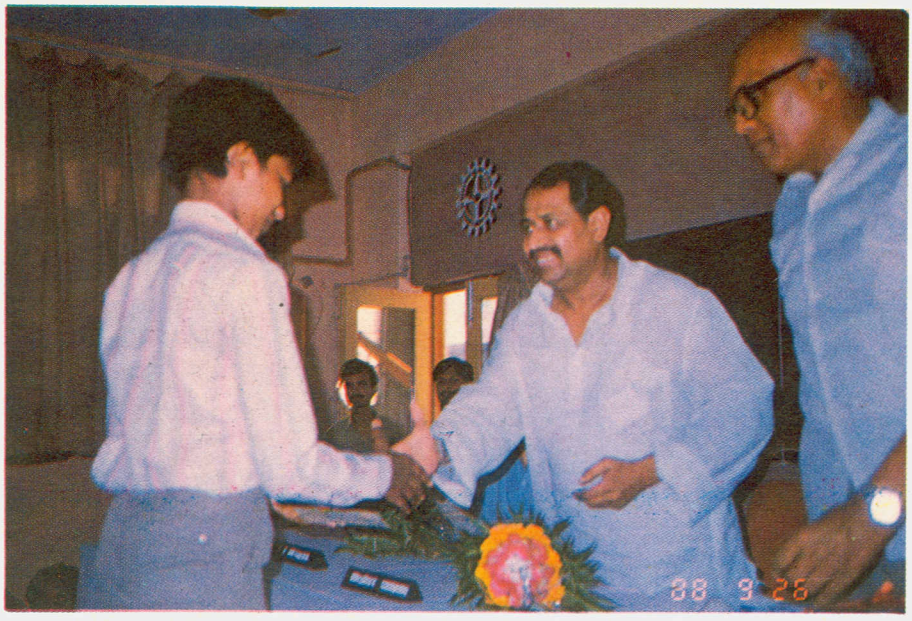
During these years the Laboratory had the privilege of visits by several distinguished Scientists, Administrators, Planners and other dignitaries. Amongst them were Shri K.L. Puri Advisor to Prime Minister, Hon'ble Shri K.M. Chandy, Governor of Madhya Pradesh, Shri Mahesh Joshi, Shri CP Shekhar and Smt. Manju Rai, Shri HN Siddiqui, Ministers MP, Shri

Pratap Bhanu Sharma and Shri KN Pradhan, Members of Parliament, Dr. S Varadarajan, Chief Consultant, Planning Commission, H.E. Manfied Macioti Ambassador EEC countries, Dr. DC Nigam, Member CSIR Governing Body, Shri M.L. Singhal, Member MPEB.

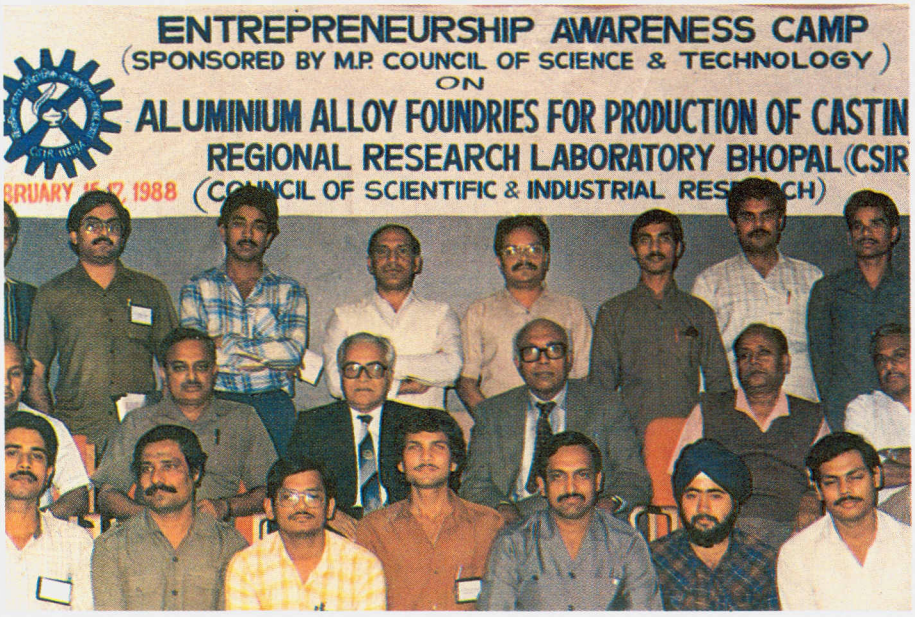
The laboratory received the International delegation of attending Regional Workshop on Design and Development of Harvesting and Threshing equipment at the Central Institute of Agricultural Engineering (ICAR) Bhopal. In its Science Popularisation Drives, an overwhelming response was received on the open days when Students, Engineers, Scientists and Industrialists participated in large numbers.



Hon'ble Mr. H.N. Siddiqui, Minister of Power, M.P. examining new melt spinner equipment.



Hon'ble Mr. H.N. Siddiqui, Minister of Power distributing prizes to the SC/ST students on the SCIR Foundation Day.



Seminar/Symposia at RRL, Bhopal.

Honours and Awards

Dr. Rajendra Kumar, Director was conferred the prestigious research award by the Central Board of Irrigation and Power (CBIP) in recognition of his distinguished work in the vital area of energy sector, particularly that concerning thermal power generation. Dr. Rajendra Kumar has also been nominated on the Aluminium Development Council.

Shri B.K. Saxena elected Fellow of the Institution of Engineers of India, Calcutta.

Dr. R. Kumar and Shri S.K. Bose have been awarded the prestigious gold medal of the Metallurgy & Materials Division, Institute of Engineers India for the year 1987-1988 on their paper entitled Decomposition of Supersaturated Al-Mn solid solution"

Shri R.K. Chauhan, GTA has been awarded the certificate for the first place in order of merit for his paper "Cementitions binder from Al-Industrial wastes" by the Institution of Engineers (3rd Engineering Congress).

Visits and exchange programme

Prof. A.A. Das, University of Laughburogh visited the Laboratory under CSIR British Council exchange programme in Dec. 1987. During his stay in the Laboratory, delivered special lectures on Squeeze Casting, Composite Materials and metal processing. Scientists of the laboratory interacted with him on the projects in above areas.

Prof. Dr. ing. Wingfried Reif Technische Universitat Berlin visited the laboratory in Sept. 1988. During his stay he interacted with the scientists on recent advances in metallurgy and materials.

Visits Abroad

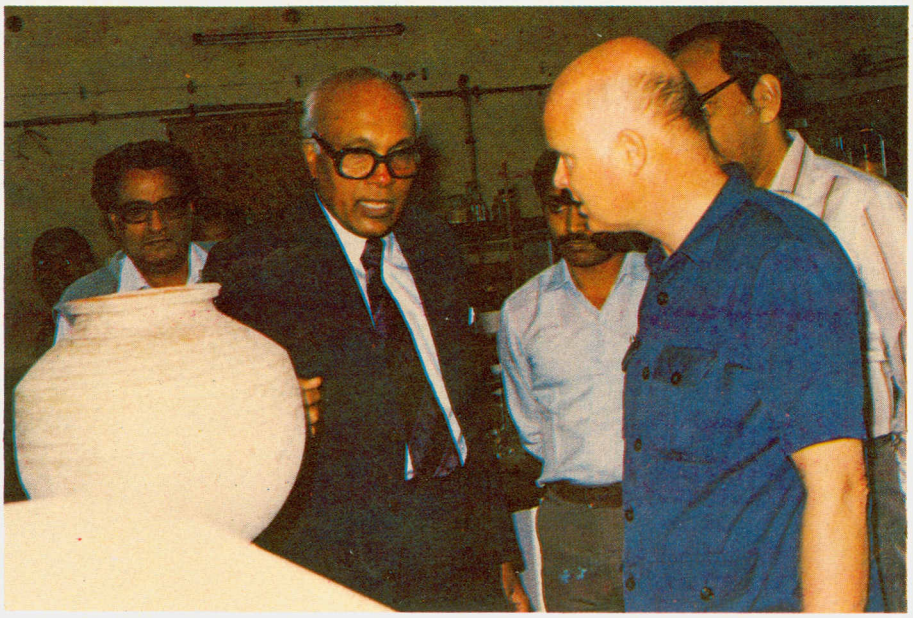
Dr. Rajendra Kumar, RRL Bhopal visited Moscow (Oct. 1988) at the invitation of UN Centre for Science and Technology for Development to participate at the International Workship on "New Energy Technologies for 2000-2020 AD" He made powerful plea to initiate to advanced action to plant energy forests to capture solar energy and to store it in the form of wood only to be used at a later date for the generation of electric power, in his paper.

Dr. SV Prasad, Asstt. Director attended the ASM Materials Congress at Cincinnate (USA) in Oct. 1987 and presented two technical papers. He was also elected member of the wear Resistant Material Group of the ASH.

Dr. Navin Chand, Scientist visited Sheffield, Unviersity Sheffield (UK) in July 1986 to attend International Conference on fibre reinforced composites.

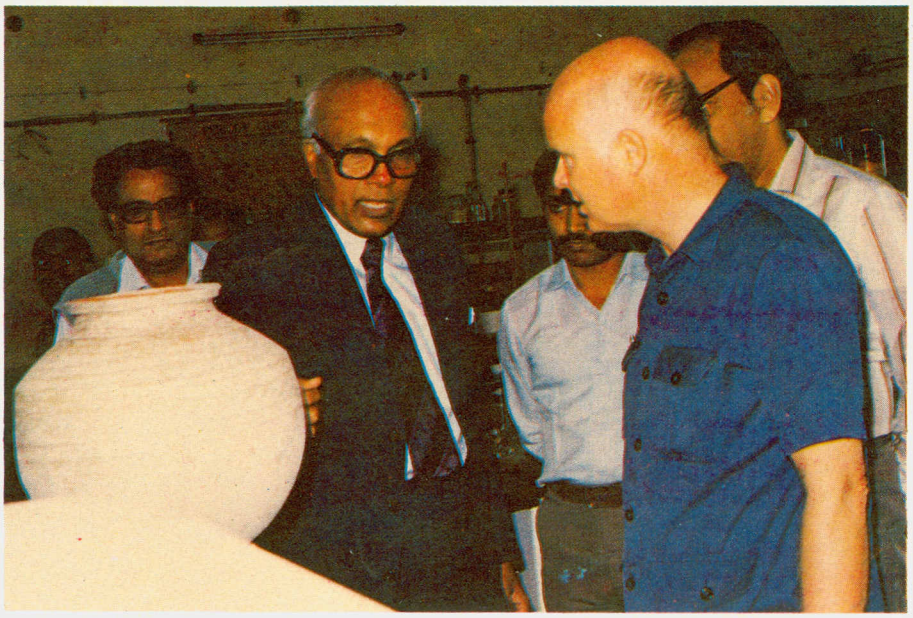
Institutional Linkages

Useful links establihsed earlier with different institutions engaged in development of science, technology and industrial potential of MP have been further nurtured during this period. This has earned a reputation for the Laboratory and several agencies, industries and institutions have requisitioned expert opinion from the laboratory. Scientists of the laboratory were invited on the faculty of special courses by Bhopal University. Dr R.N. Yadava, Head, Systems Planning and Research management and Computer Applications delivered full course lecture on Composite oriented numerical methods in 1987-88. Dr. Navin Chand, Scientist, similarly delivered full course lectures in Materials Science in the Bhopal University.



Director, RRL explaining to His Excellency Shri Macioti, Ambassador EEC Countries the project on Ceramic filters for the purification of drinking water under tribal develpoment programme.

Prof. Reif of Technische Universitat, Berlin going round the various divisions.



Director, RRL explaining to His Excellency Shri Macioti, Ambassador EEC Countries the project on Ceramic filters for the purification of drinking water under tribal develpoment programme.

Prof. Reif of Technische Universitat, Berlin going round the various divisions.

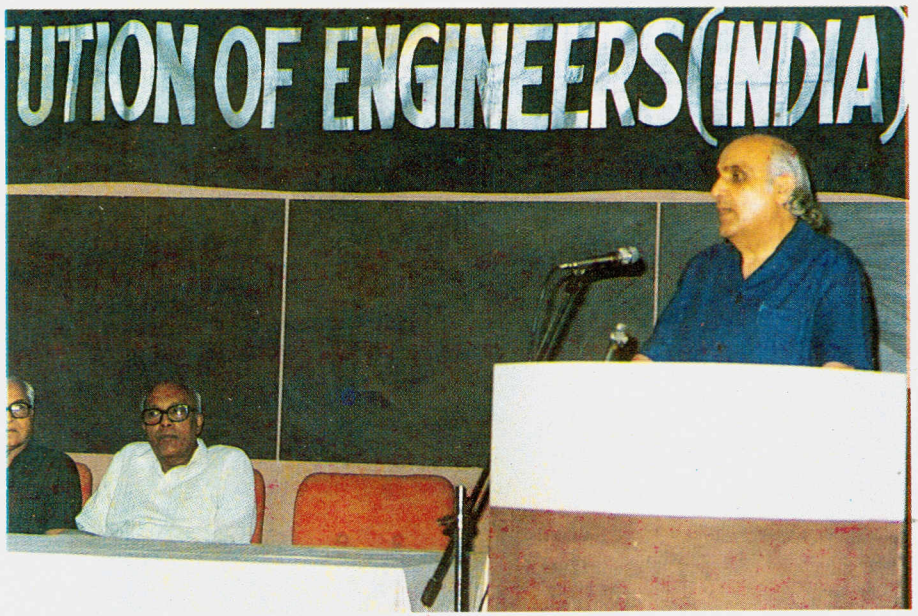
Campus Site Development & Welfare

Considerable progress has been achieved on campus and site development programmes. Barbed wire fencing has been put demarking the RRL Bhopal site. A new heavy equipment shed (30m x 10m) has been constructed.

Several functional modifications and renovations have been carried out in the existing buildings and a new conference room has been made. A separate site in the existent building blocks has been provided for the Computer Centre and the work is in progress.

Administration and Account wings have been newly housed in the remodelled wing within the premises and similarly the Stores and Purchase units have been reallocated to provide the much needed space for laboratory activities. A major tree plantation and campus beautification drive has been launched in association with Nari Pragati Parishad of RRL and AIWC of Bhopal. Tiffin room facilities have been created for the first time in the Laboratory. The activities of RRL staff club have been geard up and RRL teams participated in Central Govt. employees sports tournaments and came out with flying colours. Cultural activities received a filip and a Kavi Sammelan was organised.

A new staff car has been added and the existing Standard-20 van has been renovated.



Shri K.L. Puri Advisor to Prime Minister (Energy) addressing scientists of RRL under the auspicous of Institution of Engineers. Prof. T.S. Murthy the than Director General M.P. CST presided.

Prize distribution to the winners by Smt. Kusum Kumar, Chairperson, Ladies' Club, RRL.

Ladies' Tea Stall at RRL on the Foundation Day.

RESEARCH FACILITIES AVAILABLE

FOUNDRY:

Melting facilties including Pit Furnaces (Electrical Resistance and Coal Fired); Wesman Oil fired furnace, Induction Melting Unit for 25 Kg Aluminium Melts; Centrifugal Casting Machine; Pressure Die-casting Machine; 150T Hydraulic Press, Melt Spinner, Heat Treatmnt Furnaces; Vacuum Heating Furnace; Plasma Spray Coating machine, Fast hydrogen determinator HYMAT-200, Sand testing equipment, and AFS fluidity spiral Test mould.

MICROSCOPY:

Lietz Optical Microscope with Computerised Tas Image Analyser and a Heating Stage; JEOL (JSM 35CF) Scanning Electron Microscope with Double Dispersive Wavelength Spectroscope and an Energy Dispersive Spectroscope with a 512 K Byte Computer.

MECHANICAL TESTING:

Instron Universal Testing Machiner with High Temp. Tensile Testing Facility; Impact Tester; Hardness testers including Microhardness Tester, Fatigue Testing Machine.

PHYSICAL TESTING:

Moisture balance, Conductivity Meter, Electrical Resistivity Measuring Unit.

TRIBOLOGICAL TESTING:

Cameron Plint make Friction and Wear Testing Machine; Rubber Wheel Abrasion Tester, Gas Jet Eroder; Four Ball Tester for Lubricants; TALYSURF Surface Roughness Measuring Apparatus; Journal Bearing Test Rig

X-RAY DIFFRACTION:

A 1700 series Automated Phillips X-ray Diffractometer with Flat Plate, Guinier and Debye Scherrer Cameras and Goniometer.

ANALYTICAL INSTRUMENTATION:

Thermal Analyser (DTA, TGA, DTG upto 1500°C and DSC upto 675°C); Infra Red Spectrophotometer; Particle Size Analyser; Plasma Emmission Spectrophotometer, Single Ion Analyser, Automatic C-S analyser, Electrochemical system Model 378-1.

MINERALS AND CERAMIC LABORATORIES:

Roller Ball Mills, Sieve Shaker; Flotation Cell; Water Elutriator, Grinding and Polishing Machine, magnetic Separator.

BUILDING MATERIALS:

100 T Compression Testing Machine, Flexural Testing Machine, Impact Testing machine, Brick Making Machine.

POLYMERS AND FIBRES:

L.C.R. Meter for Electrical Testing, Impact Tester, Tensile Tester, UV Visible Spectrophotometer, IR Moisture Meter, Oxygen Nitrogen Index Meter, Ultrasonic Tester, Keithley Electrometer.

ELECTROCHEMISTRY:

Environmental Chamber, Potentiostat, Weatherometer, Fisherscope Ultrascope Ultrasonic Cleaner, Salt Spray Unit, Coating thickness measurement units, Salt fog testing cabinet.

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Gupta A, Patel M, XRD studies or some alumino-silicate minerals for composite and ceramic products, Indian Ceramics, 29, 1987, pp 12.

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S. Das S.V. Prasad, Rohatgi PK, Ramachandran TR, Some observations on the matrix microstructure of Al-Si graphite particle composite, Met.Trans, 19A, 1988, pp 1365-1367

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Jha AK, Prasad SV and Upadhyaya, Drg Sliding wear of sintered 6061 Al alloy - graphite composites, Tribology International In Press.

PAPERS IN SEMINARS/SYMPOSIA/WORKSHOP

International Conference on Al alloys, their physical and Mechanical properties, University of Virginia, Charlottesville, June 1986

Rohatgi P.K., Das S, Asthana R, Synthesis structure properties and application of cast Al ceramic particle composites.

Das S, Asthana R, Rohatgi P.K., Solidification of Al alloys in presence of supended graphite particles.

Prasad S.V., Narendra Nath C.S. Rohatgi P.K, Tribological properties of Al alloy matrix particulate comosites.

International Conference on fibre reinforced composites, Sheffield, UK, July 1986.

Khazanchi A.C. Navin Chand, Rohatgi P.K. Use of Sunhemp fibre in cement sheet

IIM Annual Technical Meeting, IIT Bombay, Nov. 1986

Das S, Prasad S.V. Dan T.K. Rohatgi P.K. The role of refinement and modification of silicon phase in hypereutectic Al-Si alloy 3 wt.% graphite particle composite on the sliding wear behaviour.

Jha A.K. Prasad S.V. Updhayaya G.S. Rohatgi P.K. Preparation and properties of 6061 Al alloy graphite particulate composite by P/M route.

Seminar on Development of Mineral Resources of Madhya Pradesh, RRL Bhopal, March 1987

Raju C.B. Kujur B. Ray A.K. and Kumar R, Upgradation of low grade bauxites of M.P.

Amrithphale S.S. Raju C.B, Kumar R, Characterisation and utilisation of pyrophyllite of Tikamgarh, M.P.

Sharma R.K. Raju C.B. Ray A.K. Khazanchi A.C. Development of special ceramic membranes from Natural zeolite of M.P.

Gupta A, Ray A.K. Raju C.B. Kumar R, Utilisation of soapstone, talc and mica minerals of M.P.

Sixth ICCM and ECCM Imperial College, London, July 1987

Navin Chand, Khazanchi A.C. Rohatgi P.K. Structure of Ipomoea Carnea and Development of Polyester, Soil cement matrix composite material with Ipomoea.

Khazanchi A.C. Navin Chand, Rohatgi P.K. Structure of sisal fibre and its use in development of sisal cement corrugated roofing sheets.

National Seminar on Bearings, Madras, September 1987

Prasad S.V. Kumar R, Potential Al alloy graphite composite material for bush bearings applications.

ASM Material Congress, Cincinnati, USA,October 1987

Prasad S.V. Sanadi A.R. Lignocellulosic based natural fibres as reinforcements in polymers

Prasad S.V. A Model to Predict the Abraine near of Brittle Solids

International Conference on composite materials and structures, IIT Madras, January 1988

Gupta A.K. Dan T.K. Saxena B.K. Kumar R, Aluminium alloy-sand particulate composite.

FICCI Annual Conference Seminar on Energy Conservation in industries, New Delhi, February, 1988.

Ekbote P.D. Dan T.K. Khazanchi A.C. Kumar R, Energy conservation through materials selection in Building Industry

National Seminar on Advances in Metal Sciences, IIM, BE College, Howrah 1988

Bose S.K. Saxena B.K. Dasgupta R, Mukherjee S.P. Kumar R, Rapidly solidified Aluminium alloys - a market assessment.

Seminar on Future trends and problems of chemical industry and strategy for chemical engineering education I.E. (India) Bhopal, May 1988

Nair G.G., Mukherjee S.P., Kumar R "Selection of stainless steels for chemical industries."

Amrithphale S.S. Chandra N, Kumar R, "Utilisation of low cost mineral for production of tiles"

National Workshop at CBRI, Roorkee, May 1988

Kumar R, Khanzanchi A.C "Utilisation of flyash - A new aproach"

Pollution control measures for Thermal Power Plant, Nasik, June 1988 Kumar R, Khanzanchi A.C. Utilisation of flyash - A new aproach

IIM Annual Technical/Meeting, Nov. 1988, New Delhi

Narayan S.P., Rao V, Mohanti D.N. "Magnetic properties of spheroisised HSLA Steel."

PARTICIPATION IN SEMINAR/SYMPOSIA/WORKSHOPS

Dr. Yegneswaran attended a seminar on "Technology upgradation in foundry industries" organised by IIF Bhopal Chapter and National Productivity Council, Bhopal June 17, 1986

Dr. R.N. Yadav attended a get-together and training programme for PME scientists CSIR at RRL Hyderabad Sept. 1986

Mr. S.Das and Mr. .K. Jha attended the IIM annual technical meeting at IIT Bombay, Nov. 14-17, 1986

Dr. R Kumar and Shri A.C. Khazanchi attended worshop on Inputs of S&T for the development of Bastar, Jan. 18-21, 1987 organised by MAPCOST, Bhopal

Dr. R Kumar Dr S.V. Prasad, Dr. T.K. Dan and Mr. O.P. Modi attended the Aluminium Congress II, Jan 27-29, 1987 at New Delhi

Shri R.K. Morchalle attended National Workshop on "Plastic & Polymers in Buildings and Building material technologies and pollution statement organised by CBRI Roorkee at New Delhi, Mar 11-12, 1987

Dr. C.B. Raju, Mr. SS Amrithphale, Dr. A.K. Ray, Dr. RK Sharma, Mr. B. Kujur Ms. Anju Gupta, Ms. Prasanna Kumari and Ms. Padma Swamy attended the seminar on "Development of Mineral ?Resources of Madhya Pradesh" organised by RRL Bhopal on March 19-20, 1987

Dr. R.N. Yadav attended workshop on "Technology Futures; Forecasting and policy formulation" organised by NPC and DST Bangalore, April 1-5, 1987

Dr. Navin Chandra and Mr. S. Das attended the wokshop on &&Characterisation of materials for electronics" held at NPL New Delhi, Sept 15-17, 1987

Dr (Ms) Mohini Saxena attended the National Symposium on "Advances in Surface treatments (ASTOM 87) at BARC Bombay, Oct 14-17 1987

Dr. R Kumar and Shri A.C. Khazanchi attended Conference on "Role of Polytechnics for industries" at SV Govt. Polytechnic, Bhopal, Nov. 10, 1987

Shri O.P. Modi attended 41st Annual Technical Meeting of IIM at Trivandrum Nov. 12-14 1987

Shri A.K. Gupta attended Intl. Conference on "Composite materials and structures" at IIT Madras, Jan 6-9, 1988

Dr. K. Basu attended the Seminar of "Energy Conservation in Industries" at FICCI Annual Meeting, Delhi, Feb. 25-26, 1988

Ms Anju Gupta, MS Prasanna Kumar and Ms. Sudha Verma attended the "Third MP Young Scientists Congress" Feb 28 Mar. 1, 1988 at Jiwaji University, Gwalior.

Dr. Navin Chandra attended the workshop on "Standard reference materials' organised by NPL New Delhi, March 17-18, 1988.

Dr. R.N. Yadav and Shri P.D. Ekbote attended a "Workshop on Mathematical modelling" at CSIR Centre of Mathematical Modelling at Computer Applications, NAL Bangalore, Mar. 23-25, 1988

Dr. R. Kumar, Shri B.K. Saxena, Dr. S.V.Prasad, Shri G.G. Nair Shri S.P. Mukherjee, Shri A.K. Jha and Shri O.P. Modi attended All India Seminar on "Maintenance Engineering" held at MACT Bhopal July 15-16 1988

Shri B.K. Saxena, All India Seminar-cum-Workshop on Aluminium based Indusries, Sept 22-23, 1988 at Calcutta organised by Institution of Engineers India) West Bengal State Centre.

Shri B.K. Saxena, All India Seminar on "Environmental Problems of Mining and their Management" 8-10, Dec. 1988 organised by Environmental Planning & Co-ordination Organisation, Bhopal

Shri S.A.R Hashmi, Shri A.C. Khazanchi and Dr. Mohini Saxena attended workshop on "Polymer composites as substitutes for conventional building materials" organised by CBRI Roorkee at C.R.R.I. New Delhi on 3rd October 1988.

INVITED LECTURES

S.No	Speaker	Subject
1.	Prof. S. Biswas, Deptt. of Mechanical Engineering IISC, Bangalore	Tribological research
2.	Dr. T.A. Sreedharan, Comalco Research Centre, Australia	R&D Activities in Comalco Research Centre
3.	Prof. A.A. Das, University of Loughborough, U.K.	i Al-graphite system manufacture of components ii Solidification iii Squeeze casting iv Advances in casting technology v Metal matrix composites casting.
4.	Dr. S.K. Chaturvedi, Asstt. Professor State University, USA	Composite materials - an overview
5.	Mr. Shyam Sunder, Research Associate Deptt. of Met. IISC, Bangalore	Computer simulation of closed die forging
6.	Dr. J.P. Redfern, Chairman Stanton Red Craft Ltd., UK	Thermal Analysis
7.	Dr. Ashok K. Mishra Visiting Scientist, Purdue University West Laffayette, USA	Electrochemisorption at electrochemical interfaces
8.	Dr. P.B. Mathur, Dy. Director CECRI, Karaikudi	Electrochemistry R&D activities at CECRI
9.	Prof. Ing. W.Reif, Technische Universitat Berlin	Overview of grain refinement in alloys
10.	Dr. N.C. Nigam, Member, CSIR Governing Body	Address to the scientists of NRL
11.	Dr. B. Majumdar Battele Memorial Institute, Columbus (USA)	i. Life prediction of Thermal Power components ii. Ceramics - matrix composites

LECTURES BY STAFF

S.No	Speaker	Subject
1.	Dr. Rajendra Kumar (Radio Talk)	Forty years of Independance: Science & Technology (Hindi)
2.	Dr. Rajendra Kumar (Radio Talk)	Energy Prospects (Hindi)
3.	Dr. R.N. Yadav (Radio Talk)	Computer Application in Industry Gems of Indian Science in Modern Age.
4.	Mr. B.K. Prasad Training course in manufacturing technology, CIAE Bhopal	Nature of metals and alloys
5.	Mr. A.K. Jha ibid	Powder Metallurgy and its applications in Agricultural Engineering
6.	Dr. Navin Chand SISI Indore	Quality Improvement in Plastic Products Through Testing
7.	Dr. R.N. Yadava Bhopal University	Computer Applications in R&D
	EAC on Aluminium Foundries	
8.	Mr. B.K. Saxena	Environment Protection in Metallurgical Industries
9.	Dr. Kunal Basu	Introduction to Al-alloy Foundries
10.	Dr. R.N. Yadava	Application of PCs in Office Management
11.	Mr. G.G. Nair	Quality Control Through Microscopic Examination
12.	Dr. A.H. Yegneswaran	Quality Control Through NDT
13.	Mr. A.K. Gupta	Melting Furnaces and Heat treatment
14.	Mr. G.G. Nair, CIAE Bhopal	Alloying and Metallography

LECTURES BY STAFF

S.No	Speaker	Subject
1.	Dr. Rajendra Kumar (Radio Talk)	Forty years of Independance: Science & Technology (Hindi)
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3.	Dr. R.N. Yadav (Radio Talk)	Computer Application in Industry Gems of Indian Science in Modern Age.
4.	Mr. B.K. Prasad Training course in manufacturing technology, CIAE Bhopal	Nature of metals and alloys
5.	Mr. A.K. Jha ibid	Powder Metallurgy and its applications in Agricultural Engineering
6.	Dr. Navin Chand SISI Indore	Quality Improvement in Plastic Products Through Testing
7.	Dr. R.N. Yadava Bhopal University	Computer Applications in R&D
	EAC on Aluminium Foundries	
8.	Mr. B.K. Saxena	Environment Protection in Metallurgical Industries
9.	Dr. Kunal Basu	Introduction to Al-alloy Foundries
10.	Dr. R.N. Yadava	Application of PCs in Office Management
11.	Mr. G.G. Nair	Quality Control Through Microscopic Examination
12.	Dr. A.H. Yegneswaran	Quality Control Through NDT
13.	Mr. A.K. Gupta	Melting Furnaces and Heat treatment
14.	Mr. G.G. Nair, CIAE Bhopal	Alloying and Metallography

15.	Shri A.C. Khazanchi Orientation training programme	Research & Pilot Plant Planning in Product Development
16.	Mr. A.C. Khazanchi SV Polytechnic, Bhopal	Resources of RRL Bhopal For Industrial Development of M.P.

Industrial Metal Finishing

17.	Dr. Navin Chandra	Pollution Monitoring & Control in Electroplating and Metal Finishing Industries.
18.	Dr(Ms) Mohini Saxena	Copper and Nickel Plating

Metallurgy For Non Metallurgists

19.	Dr. Rajendra Kumar	Introduction to Metallurgy
20.	Mr. B.K. Saxena	Heat Treatment (i)
21.	Mr. A.K. Singh	Solidification
22.	Dr. Kunal Basu	Mechanical Working
23.	Dr. Rajendra Kumar	Heat Treatment (ii)
24.	Mr. S.P. Narayan	Heat Treatment (iii)
25.	Mr. G.G. Nair	Metallography and Failure Analysis
26.	Dr. A.H. Yegneswaran	Mechanical Properties of Metals and Alloys
27.	Mr. R.S. Solanki	Welding
28.	Mr. Kamlesh Pant	Corrosion
29.	Mr. L.C. Mohan	Melting Equipment

TRAINING PROGRAMMES ATTENDED

Sl. No.	Name	Details
1.	Dr. Navin Chand Mr. P.D. Ekbote	6 weeks training in FORTRAN at MACT, May 1986
2.	Mr. S.S. Amritphale	A refresher course on ceramics at Indian Institute of Ceramics CGCRI, Calcutta, 16-17 Sept. 1986
3.	Mr. S.K. Tiwari	A Training on "Online Information Retrieval" 17-19 September, 1986
4.	Dr. R.N. Yadava	A Training Programme on Project Cost Accounting at New Delhi, Oct. 20-25, 1986
5.	Mr. B.K. Prasad Mr. K.K.S Gautam	2 weeks training on 'Pressure Die Casting Machine' at HMT Bangalore, March 1987
6.	Mr. B. Kujur	Course on 'Technology Mission on Drinking Water in Villages' at IRTC Lucknow, 10-29 May 1987
7.	Mr. O.P. Modi	"Quality Management Programme" at Tata Management Training Centre, Pune, 1-6 Aug., 1988.
8.	Shri P.D. Ekbote Mr. S.K. Tiwary Mr. A.Q. Ansari	CDS/ISIS training at NCL Pune, Aug. 22-Sept.3, 1988
9.	Mr. B.K. Saxena	Group discussion-cum-Orientation Programme on "Public Relation in Universities and Research Institutions" at Bombay organised by Association of Indian Universities from 7-12, Aug.1988
10.	Dr. R.K. Rawlley	7 Weeks "CSIR Orientation Training Programme for Scientist-B" held at RRL Hyderabad, and BARC, Trombay
11.	Mr. Ajay Kulshreshth	5 days training in Management of Technology Transfer, Planning and Information System, Bombay organised by National Research Development Corporation, Delhi.
12.	Mr. S.K. Jain	Material Management Course at NGRI Hyderabad for a fortnight

PATENTS FILED

Improvements in or relating to the manufacture of roof coverings Pat. App. NoZ: 228 DEL 86; Filed 860311

Improvements in or relating to the manufacture of wall panels using soil/and stems of Ipomoea carnea (Besharam)

Pat. App. No. 353 DEL 86; Filed 860421

Improvements in or relating to the manufacture of cementatious binder Pat. App. No. 372 DEL 86, Filed 860708

A process for the manufacture of aluminium graphite particulate composite using uncoated graphite particles for automobile and engineering applications.
Pat.App. No:780 DEL; 86;Filed 860902

Process for the manufacture of Aluminium alloy-silica sand composite for brake liner and engineering applications.
Pat.App. No:781 DEL; 86;Filed 860902

A process for the manufacture of red mud filled PVC composite materials
Pat.App. No:805 DEL; 86;Filed 860910

A Process for the preparation of ceramic membrane for water filtration
Pat.App. No:1029 DEL; 86;Filed 861126

A process for the production of silicon carbide fibres from rice husk
Pat.App. No:590 DEL; 86;Filed 871222

An improved process for the manufacture of ceramic tiles
Pat.App. No:1108 DEL; 86;Filed 871222

An improved process for insulating bricks from talc
Pat.App. No:1107 DEL; 86;Filed 871222

TECHNICAL & ANALYTICAL SERVICES RENDERED

S.No	Party's Name	Subject
1.	Mukand Iron & Steel Co. Bombay	Improvement of Al alloy Formed Products
2.	Govt. Engineering College, Raipur	Thermal Characteristics of Marble Samples
3.	Samrat Ashok Technical Institute, Vidisha	Assessment of Properties of Adhesives
4.	Insulators & Electricals Co. Mandideep	Testing of Insulators
5.	Omega Engg. Corporation, Bhopal	Tensile & Elongation Testing
6.	D.K. Insulation Industries, Bhopal	(i) Tensile and Impact Tests. (ii) Tensile, Compression & Water Absorption Test. (iii) Chemical Analysis of Ceramic Sample
7.	M.P. Rajya Sah. Vikas Bank, Bhopal	Testing of Water Samples
8.	Micaply, Bhopal	Tensile Testing of Epoxy Glass
9.	Gujrat Enterprises, Baroda	Hardness Test on Steel Samples
10.	Associate Engineers, Bhopal	Tensile Testing of Sample No. HRS 1138
11.	Gujarat Entreprises, Baroda	Hardness Test on Steel Pads.
12.	Vikram University, Ujjain	Infra Red Spectroscopic Analysis of Inorganic Compounds.
13.	Rockdrilbits Pvt. Ltd., Govindpura	Chemical Analysis of Metal Samples.
14.	Omega Engg. Corporation, Bhopal	Mechanical Testing of Samples.
15.	B.H.E.L., Bhopal	Cross Checking of Scale For Governor Spring.
16.	Forgewell Industries, Bhopal	Impact Test on Forged and Heat-Treated EN24 Steel Specimen.
17.	South Eastern Coalfields Ltd. Shadol	Balance Testing

18.	Permali Wallace Ltd., Bhopal	Testing of Phenolformaldehyde Resin Type V-373 For Self Life.
19.	Bank of Baroda, Bhopal	Chemical Analysis of Metallic Samples.
20.	Premier Brass & Metal Works Pvt. Ltd., Bhopal	Chemical Analysis of Brass Samples.
21.	Ahmedabad Electricity Co. Ltd.	Chemical Analysis of Two Steel Samples.
22.	M.P. Sharma, Ex-MLA, Shivpuri	Quantitative Analysis of Lime Stone
23.	Water Works Dept. Municipal Corpn., Bhopal	Analysis of Alumina Ferric Sample.
24.	Surya Tools & Equipments Pvt. Ltd., Hyderabad	Coating of Electrical Insulation Meterial on SS-304 Tubes.

LIBRARY

I. BOOKS

Year	Total No. of books
1984-85	1887
1985-86	2343
1986-87	2850
1987-Dec. '88	3997

II. Subscription of Periodicals

Year	No. of Periodicals
1985	74
1986	85
1987	88
1988	112

III. Reprints

No. of Reprints procured upto December 1988	1849

BUDGET

(Rs. in lakhs)

		Actual Expenditure		Sanctioned
		1986-87	1987-88	1988-89
1.	Recurring	30.644	43.200	47.000
2.	Capital	57.462	56.733	48.00
	Total :	88.106	99.933	95.00