PROGRESS REPORT 1990

REGIONAL RESEARCH LABORATORY
BHOPAL

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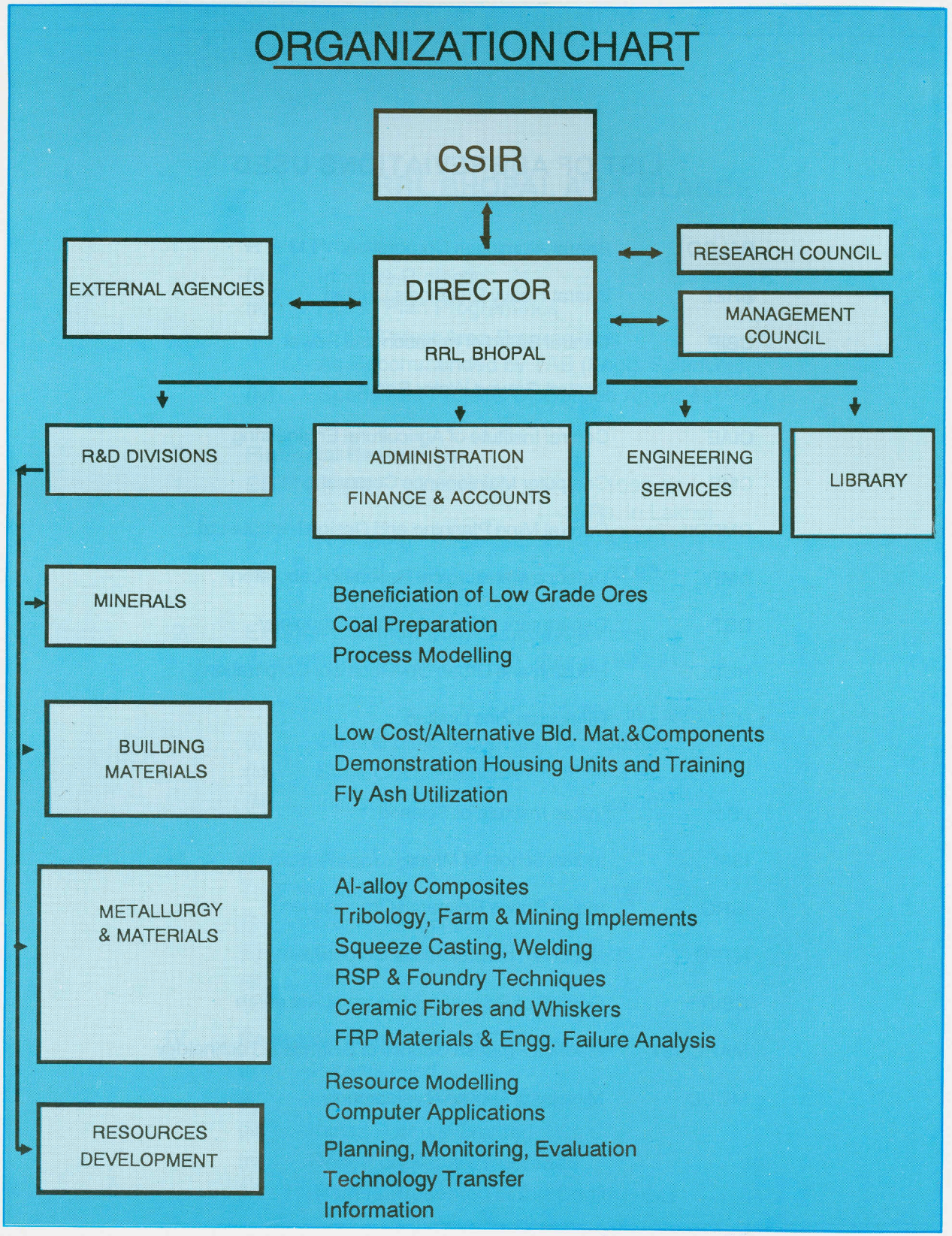
ORGANIZATION CHART



LIST OF ABBREVIATIONS USED

BALCO	Bharat Aluminium Corporation
BHEL	Bharat Heavy Electricals Limited
CBIP	Central Board of Irrigation and Power
CGWB	Central Ground Water Board
CIAE	Central Institute of Agricultural Engineering
CMC	Computer Maintenance Corporation
CMPDIL	Central Mine Planning and Design Institute Ltd.
DMRL	Defence Metallurgical Research Laboratory
DST	Department of Science and Technology
HUDCO	Housing and Urban Development Corporation
HZL	Hindustan Zinc Limited
IBM	Indian Bureau of Mines
IISc	Indian Institute of Science
ISM	Indian School of Mines
ISRO	Indian Space Research Organisation
NTPC	National Thermal Power Corporation
CSIR	Council of Scientific & Industrial Research
MAPCOST	Madhya Pradesh Council of Science & Technology
MOUD	Ministry of Urban Development

RRL BHOPAL AT A GLANCE

I R & D Projects

(i)	Inhouse Projects	6
(ii)	Action Plan Programmes	2
(iii)	CSIR Thrust Area Programmes As Recommended by TAB (Engg. Sciences)	2
(iv)	Sponsored Projects by Outside Agencies	17

II Financial Resources

1. CSIR Grants

		1990-91 (Rs. in Lakhs)
(i)	Recurring	83.00
(ii)	Capital	62.00

2. External Cashflow from Outside Agencies (Committed and Sanctioned) during 1990-91

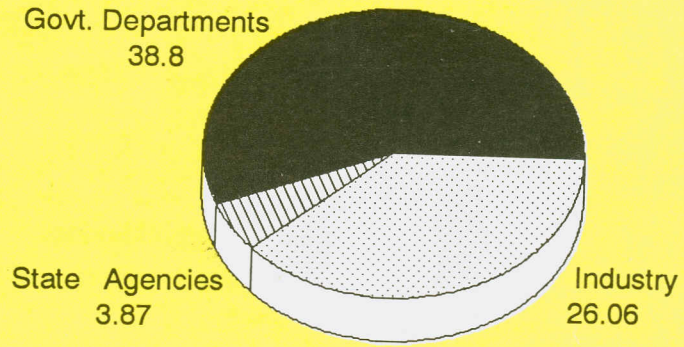
		(Rs. in Lakhs)
(i)	Central Govt. Agencies	38.80
(ii)	State Govt. Agencies	3.87
(iii)	Industry	26.06

III Human Resources

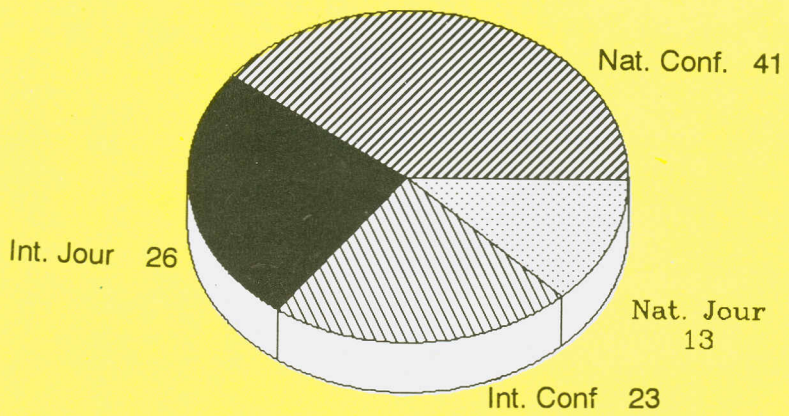
Total No. of Staff		119
(i)	S & T Personnel	79
(ii)	Administrative Staff	35
(iii)	SRFs	5

IV Research Output by S & T Personnel

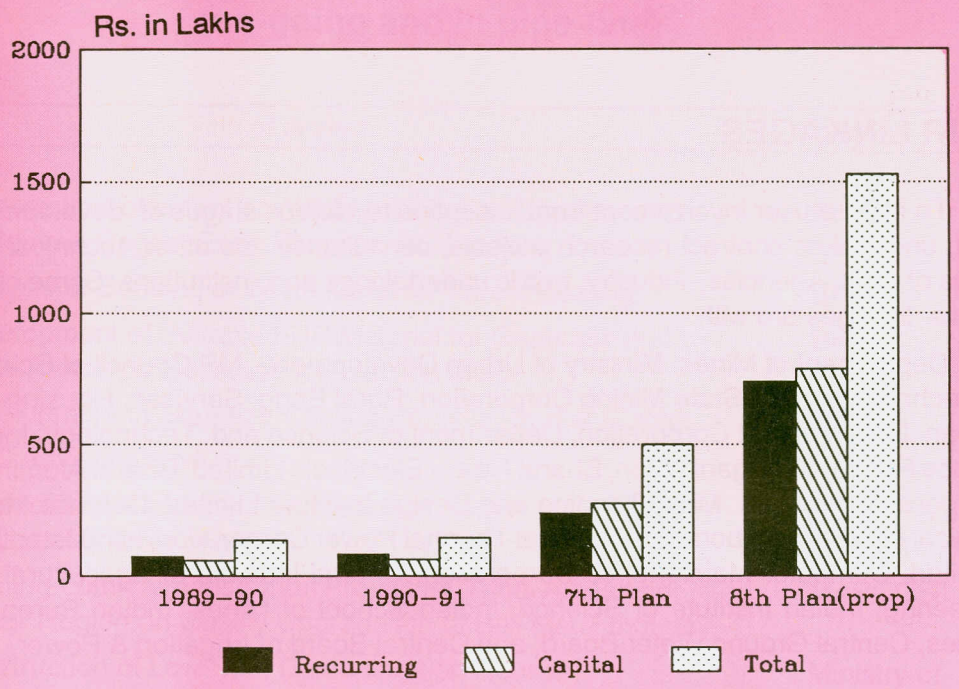
(i)	Patents Filed	7
(ii)	International Patents Granted	2
(iii)	Indian Patents Granted	2
(iv)	Research Papers Published	39
(v)	Papers Presented at the Conferences	64



EXTERNAL CASH FLOW — 1990
(Committed and Sanctioned)



Publications by RRL Scientists during 1989 & 1990



BUDGET & EXPENDITURE

Budget

Actuals Sanctioned*	85-90	89-90	90-91
Recurring	223.716	75.127	83.000
Capital	277.815	0.854	62.000
Total	501.531	135.981	145.000

* Includes incentive allocation of Rs.20.000 lakhs; Additional budget of Rs.1.5 lakh for activities under Action Plan Programme.

OUR LINKAGES

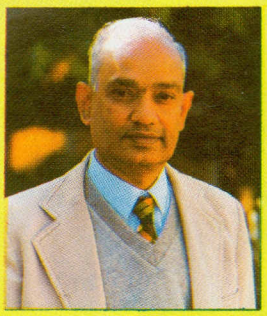
To ensure user involvement from inception to various stages of development, RRL undertakes contract research projects, consultancy and other technical services of Govt. Agencies, industry, public undertakings and institutions. Some of our active linkages are with :

Department of Mines, Ministry of Urban Development, MP Council of Science & Technology, M.P. State Mining Corporation, Rural Engg. Services, Housing and Urban Development Corporation, Department of Science and Technology, Indian Space Research Organization, Bharat Heavy Electricals Limited, Bharat Aluminium Corporation, Central Mine Planning and Design Institute Limited, Defence Metallurgical Research Laboratory, National Thermal Power Corporation, Hindustan Zinc Limited, Computer Maintenance Corporation, Central Institute of Agricultural Engineering, Indian Institute of Science, Indian School of Mines, Indian Bureau of Mines, Central Ground Water Board, and Central Board of Irrigation & Power.

CONTRACT RESEARCH AT A GLANCE
(on-going and in pipe-line)

Title of project	Sponsor
Process Improvement of Welding Annealed Copper used as Squirrel Cages Ends-Rings for AC Machine	BHEL
Analysis of Bonding of White Metal for Thrust Bearing	BHEL
Development of Suitable FRP Material for Gearcase and to Make Prototype Gearcase for Traction Motor	BHEL
Development of Squeeze Casting Process for Half Clamp	BHEL
CMC Advisory Work	CMC
Beneficiation & Industrial Utilisation of Some Fertilizer Minerals of MP	Dept. of Mines, Govt. of India
Training-cum-Demonstration Project for Tribal Artisans of Bastar Region on Quality Upgradation of Bell Metal Industry	MAPCOST
Construction of Low Cost Demonstration Houses	Ministry of Urban Deve-lopment
Pilot Plant Studies of Sisal Fibre Cement Roofing Sheets	Ministry of Urban Deve-lopment
Training-cum-Demonstration on Low Cost Housing Technology	Office of Dev.Comr,M.P.
Laboratory Trials for Manufacture of Clay Ash Bricks with NTPC Pond Ash and Fly Ash	NTPC
Characterization of Fly Ash from Ten Thermal Power Plants	CBIP
Deep-Drawability of Aluminium Alloys (ISS L 19000 & 64430)	BALCO
Development of Light Weight Tribo Materials	DMRL
High Strength Properties of Aluminium Alloy (BSS : LM13)	BALCO
Beneficiation Studies of Tin Ore of Madhya Pradesh	MAPCOST
Metal Matrix Composites for Aerospace Applications	ISRO
Tribological Study on Mining Implements	CMPDIL
Ground Water Modelling	DST

PREAMBLE



DIRECTOR'S REPORT

PROLOGUE

From its humble beginning in the early eighties and introspective periods of review and assessment (sometimes bordering on uncertainties), RRL is now perched up to make distinguished strides as a full-fledged laboratory aimed at carrying out high quality research and acquiring the stature of a premier Institute dedicated to Minerals and Materials.

Keen initiatives from the CSIR to enhance the impetus to this laboratory, constitution of the Research Council, Management Council and High Power Committee for Master Plan, and need-based organisation of research areas and groups have ushered in a phase of vital growth and consolidation.

It is gratifying to report that Dr. A.P. Mitra, DGSIR, visited the Laboratory on 9-10, Nov. 1989. This was his first visit to RRL and coincided with the first meeting of the Research Council. In its first meeting chaired by Dr. P. Rama Rao, Director, DMRL, Hyderabad, new directions and major initiatives were provided and this report summarizes the significant achievements made by the laboratory.

R&D AREAS

Built around the RC-endorsed thrust areas of R&D, viz. Building Materials; Metallurgy and Materials; Minerals and Resources Development and in tune with CSIR philosophy of enhanced emphasis on generation of external cashflow through contract

Metallurgy and Materials

Over the years the Laboratory has developed capabilities in the direction of composites and materials processing and characterization. The Laboratory thrust programmes give a commensurate bias in these areas to generate excellence and develop viable processes and techniques in Metal Matrix Composites (MMCs), Squeeze Casting, Welding, Rapid Solidification Processing (RSP), Tribology, Ceramic Materials, FRP Materials, Corrosion and Engg. Failure Analysis.

Four sponsored assignments from BHEL, Bhopal, envisaging a funding of over Rs.12 lakh are presently being carried out. Work is in progress on a DMRL (Hyderabad) project on aluminium alloy silicon carbide particulate composites. Two short-term schemes on studies related to deep drawability of aluminium alloys (ISS L 19000 & 64430) and high strength properties of aluminium alloy (BSS:LM13) are approved by BALCO.

Several projects are in advanced stages of approval from various agencies. These include proposals on "MMCs for aerospace applications" (ISRO), "Tribological Studies on Wear of Mining Implements" (CMPDIL), and "Advanced High Temperature Aluminium Alloys through RSP".

An effort is being made to take up large integrated projects on engineered materials. This shall involve MMCs, ceramic fibres, whiskers, end product/structure design and special processing techniques which ultimately lead to high performance materials.

Mineral Resources of M.P.

RRL arranged a round table discussions on Jan. 12, 1990 with a view to identifying specific R&D programmes related to minerals of M.P. Shri P.K. Lahiri, Secretary, Department of Mines, Govt. of India, chaired and guided the deliberations in which scientists, technologists and planners representing Govt. Departments, industry, R&D organisations and academic institutes participated.

Potential role of RRL was stressed in technology development for industrial utilisation of low grade phosphates and potash-bearing minerals like glauconitic sandstone available in abundance in M.P. A major portion of rock phosphate deposits in M.P. comprises a grade of P_2O_5 in 5-14% range. This portion remains unused owing to lack of an economically viable process. Similarly, over 940 MT (266 MT proven) of glauconitic sandstone has been indicated in Majhgaon area (Dist. Satna) of M.P.

Beneficiation techniques for non-coking high-ash coals of M.P. was another area identified for RRL to look into.

The Standing Scientific Advisory Group (SSAG) of the Deptt. of Mines, Govt. of India, has approved in principle a three-year project on 'Fertilizer Minerals of M.P.'

First Research Council Meeting

Shri P.K. Lahiri, Secretary, Dept. of Mines ,Chaired Round Table Discussions on Mineral Resources of MP.

and a grant-in-aid of Rs.25 lakh to RRL Bhopal. The M.P. Council of Science & Technology and RRL have worked out proposals for beneficiation of low grade tin ore.

Similarly, the Technology Advisory Board (TAB) has recommended RRL's proposal in CSIR Mission on High Concentration Coal Slurry. RRL has undertaken an advisory assignment for CMC, Calcutta, on software development for modelling mineral processes.

Resources Development

RRL arranged a meeting on Natural Resources Data Base Management System (NRDMS) on 26th March, 1990. Director (NRDMS), Dept. of Science & Technology, New Delhi, Director General of MAPCOST and Director, CGWB, Bhopal, participated. Discussions were held on creating a NRDMS centre in the state of M.P. Also some aspects of ground water resources management were noted. RRL is taking further steps to firm up collaborative projects with these agencies.

Already work on ground water modelling has been initiated for Tawa Basin, Hoshangabad Dist. A project proposal on these aspects is in advanced stages of approval from the DST. To supplement the activities in mathematical modelling and computer applications, modern facilities have been installed including PC/ATs 386, PC-XTs, Laserjet Printer, digitizer, colour plotters and colour printer.

Role in Action Plan Programmes of CSIR

RRL, Bhopal, is the first CSIR institution established in the state of Madhya Pradesh. This region is endowed with a variety of mineral, forest and agro-based resources. The enormous resources potential provides exciting possibilities in terms of developing novel and need based technologies and generating new scientific information.

With the mandate to cater to regional S&T needs, without losing sight of national perspectives, a conscious effort has been made to integrate Action Plan Programmes and Laboratory Thrust Programmes. Training and demonstration programmes undertaken by RRL in 'Low-Cost Housing', and 'Upgradation of Metal Based Industries of Bastar' reflect the efforts to fulfil above aspirations. Activities in resources modelling and ground water are aimed at ultimately creating a natural resources data based system for M.P.

Similarly, efforts are being made, in collaboration with M.P. State Govt. Agencies including M.P. Antyavasayee Sahakari Vikas Nigam Ltd., to take up work related to various prospects of research for the welfare of scheduled castes and scheduled tribes in M.P. Avenues for incorporation of S&T inputs to improve the socio-economic conditions of tribals of M.P. have been considered and some project profiles prepared.

SOME STRENGTHS

It is gratifying to report that RRL, Bhopal, has consistently manifested its scientific contribution through a large number of publications in international and national journals of repute resulting in a very creditable impact factors. A patent each in USA and UK has been granted for the process of manufacture of aluminium alloy graphite particulate composite using uncoated graphite particles for automobile and engineering applications. A culture of seminars is being nurtured to promote an intellectual integrity and exposure to latest trends. The Laboratory had the privilege to host a large number of invited lectures from eminent scientists, technologists and planners. RRL scientists also delivered invited talks at prestigious forums.

In view of the Laboratory embarking on newer areas efforts have been made to acquire commensurate facilities and update the existing equipment in materials characterization, in materials processing, minerals processing in addition to normal back up infra for chemical analysis, mechanical testing, metallography, foundry, workshop, etc. Some of the new equipment added include Atomic Absorption Spectrometer, DCP Spectrometer, Stress Rupture Testing Machine, Elatec High Temperature Furnace, Mozley Mineral Separator, Micropulverizer, Mozley Vanner, Compusieve System, Airjet Sieve, Fischer Coal Analyser, Hydrocyclone Testing, Air Spray Hydrocyclones.

RRL Computer Centre

Awareness on the use of computer facilities has been created amongst scientific and administrative staff of the laboratory. Training for supporting staff was conducted on dBase and Word Processing. Work on computerization of Finance, Accounts, Administration and Library is in progress.

CAMPUS DEVELOPMENT

A good working culture to foster an achieving climate is a prerequisite to meet the aspirations and goal of the Laboratory. The needs in terms of proper Laboratory buildings, staff quarters and amenities have been duly appreciated and a high power committee for Master Plan has been constituted by DGSIR.

The meeting of the High Power Committee was held on 8th Feb. 1990 at RRL, Bhopal. Report on the action by the Committee was also placed in the Research Council Meeting on 17th Feb. 1990 and the concurrence of the RC was obtained.

The laboratory is closely interacting with CSIR Engineering. Unit to work out details in the above regard.

EPILOGUE

With sincere and significant efforts to embark upon well-defined time-targeted research programmes characterized by deliberately built-in tie-up with user agencies, RRL is poised for making its identity in the comity of national S&T institutions. A very keen interaction with sponsoring agencies, Govt. Departments, Industry and Academia has helped the laboratory in the efforts to fulfil the charter. RRL staff blends high level scientific talent, expertise, dedication and vigour to achieve the goals.

The support from Dr. A.P. Mitra, DGSIR and CSIR Headquarters, directions from a very distinguished Research Council chaired by Dr. P. Rama Rao, Director, DMRL, Hyderabad, are gratefully acknowledged.

(Prof. T. C. Rao)
Director, RRL, Bhopal

PROJECT DETAILS

BUILDING MATERIALS

The Ministry of Urban Development has sanctioned two grant-in-aid projects for the demonstration of low cost housing technology and pilot plant studies for making sisal fibre cement corrugated roofing sheets.

Technology based on utilization of a local resource, sisal fibre, as substitute of carcinogenic asbestos fibre, has been developed at RRL, Bhopal. Initial investment for establishment of the plant is less as compared to asbestos cement sheet and the product is 30% cheaper.

Due to simplicity of the RRL technology for casting roofing sheets, it can act as a source of income to rural masses.

An integrated Training Programme on low cost building materials and housing was organised by RRL-Bhopal in June 1990.

Collaborating Institutions

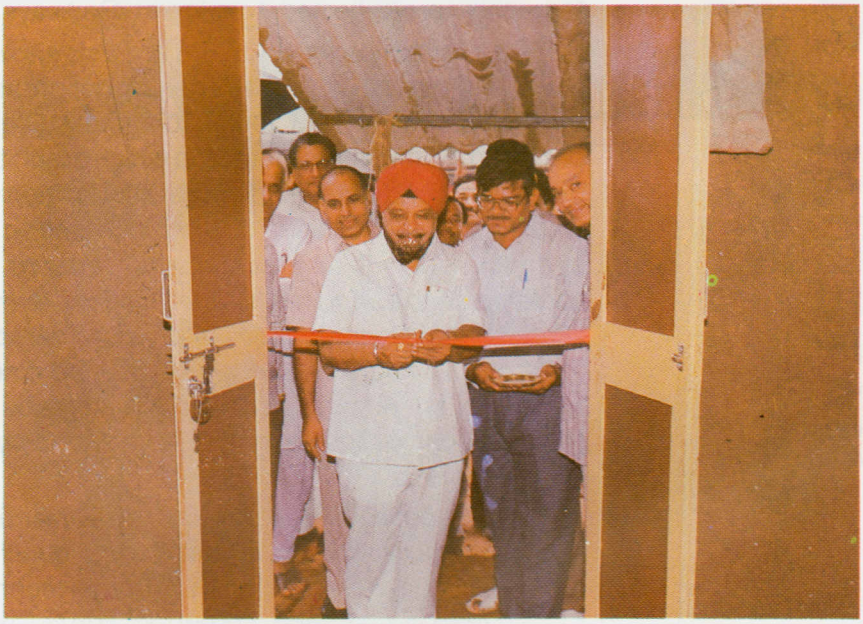
- Regional Research Laboratory, Bhopal
- Central Building Research Institute, Bhopal
- MP Council of Science and Technology, Bhopal
- Manav Seva Kunj Society, Hoshangabad
- Rural Engineering Services, Hoshangabad
- Polytechnology Transfer Centre, Bhopal

As a part of the Training Programme a prototype construction in the form of a small hut consisting of a room 3m x 4m with a covered verandah 1.5m x 2.5m alongwith a low cost waste water disposal unit was made for the purpose of demonstration. The technologies demonstrated were concrete pile for black cotton soil, soil-stabilized mud blocks, fibre roofing sheets and polymer door panels.

Sisal Cement Corruagted Roofing Sheet

Construction of Demonstration Low Cost Housing Unit

Non-erodable Mud Plaster



Inauguration of Low Cost Housing Unit at Village Mudapur, Dist. Hoshangabad

Particle size analysis : Particle size analysis of SiC was carried out and found to be in the size range of 10 - 40 microns.

Morphology of SiC particles : The morphology of SiC particles as received and heat treated up to 1273° K. SiC powder was examined under SEM. Particles are found to be irregular in shape with sharp edges. No change in the morphology of SiC particles was noticed after heat-treatment.

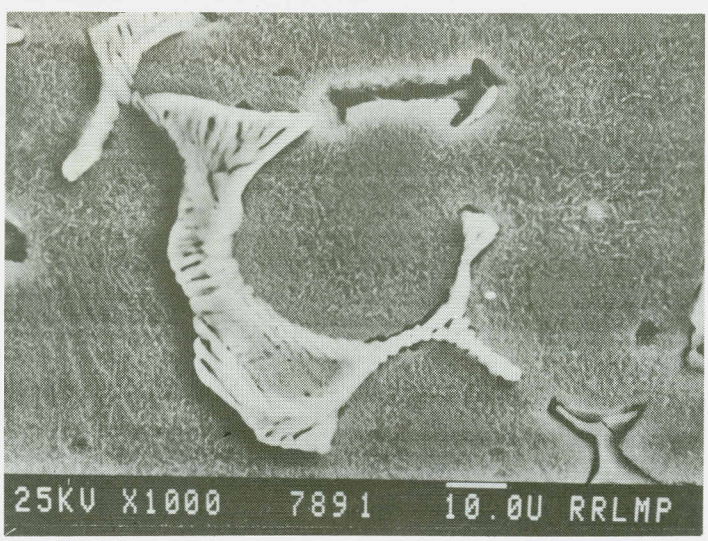
X-ray diffraction studies of SiC particles were carried out. Since the particles will be added to the liquid melt in the pre-heated condition, the particles were heated to 1473° K and the above study was repeated.

Aluminium alloy was prepared in coal fired furnace of capacity 10 kg. The coverall-11 was used as flux and N_2 gas as degasser during alloy melting. The alloy was chemically analysed and the assay was found close to the alloy composition (AA 2124).

Optical micrograph of cast 2124 Al alloy shows dendrites of primary aluminium and precipitates of Cu Mg Al_2 (orthorhombic, s and s' phases).

Tensile specimens of 25 mm gauge length were prepared from cast 2124 Al alloy and tested in INSTRON tensile testing machine at a strain rate of 6.7 x 10-4 s-1. An average of 4 samples were tested for each value. UTS was found to be 166 MPa while that of elongation was 6 %.

*Heat-treatment:*The cast 2124 Al alloy was solutionized at 768° K for different periods of time ranging from 3 hrs to 21 hrs at an interval of 3 hrs to optimize the solutionizing period. The peak hardness was observed at the solutionizing period of 9 hrs. The solutionized samples were subjected to aging treatment at 466° K for different periods ranging from 2 to 20 hrs and hardness measurements were carried out. The peak hardness occurred at an aging period of 10.5 hrs.



Magnified View of the Eutectic Phase of the Al-alloy AA 2124

Tribology Studies in Mining Sector

RRL continued the interaction with concerned agencies on problem related to wear of mining implements. On May 1, 1990 a meeting was organised at RRL with participation of experts from CMPDIL, Ranchi, MAMC Durgapur, HEC Ranchi and BEML Bangalore. Accordingly RRL has formed a joint project proposal with involvement of MAMC, HEC and CMPDIL.

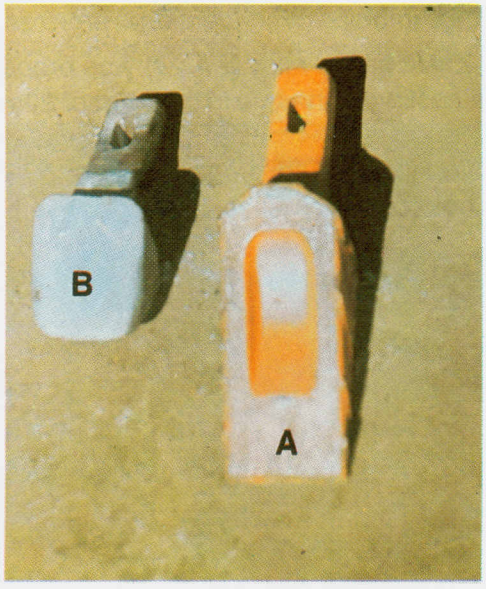
Two components, viz. shovel teeth and pan and chain of chain conveyors, were identified for studies.

CMPDIL will be the nodal agency for coordinating the project activities and BEML will assist in the design of shovel teeth.

After evaluation the progress at the end of the first phase, RRL shall formulate major extension of activities in terms of pilot-plant scale studies involving materials manufacture, testing and evaluation and field trials.

HEC, Ranchi, will be associated in pilot scale production of material and shovel teeth as per RRL, Bhopal, suggestion. For pan and chain conveyors MAMC will accordingly be associated in pilot plant scale production.

Mechanical properties of shovel teeth will be provided by BEML and HEC while MAMC will give for chain and conveyor pans.



A Typical View of Excavator Bucket Tooth: (A) Unused, (B) Reduced to Less than 1/3rd after use in an Electrical Shovel in a Coal Mine

Shovel Teeth in Actual Operation

Tribology of Zinc-Aluminium (ZA) Alloys

The overall aim of the study is to systematically understand the tribological response of the ZA alloys under different conditions and explore the possibilities of utilizing them as bearings in place of conventional bronzes.

Alloy preparation: Zn-Al based alloy (ZA 27) was prepared by liquid metallurgy route using gravity die-casting technique in the form of 20mm dia. and 150mm long cylindrical bars. Simultaneously Cu based conventional bearing alloys were also prepared for comparison of bearing properties with those of ZA alloy. Table 1 summarises typical tribological properties of some alloys prepared at RRL.

Table 1 — Tribological Properties of Some Zinc-Aluminium Alloys

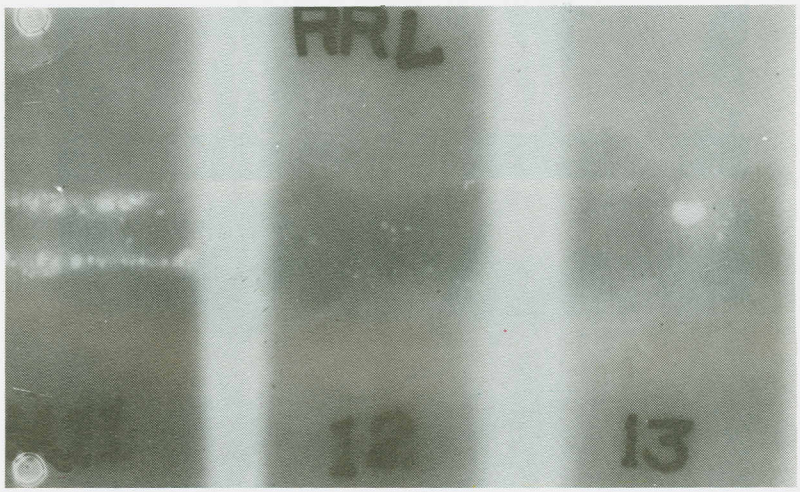
Alloy Desig.	Hardness BHN	Density gm/cc	Wear rate x 10^{-12} m^3/m		Max. temp. rise near the mating surfaces °C	
			Partially dry Lubricated			
			15 MPa	2 MPa	15 MPa	2 MPa
ZA 27	105	4.97	17.5	6.50	115	116
SAE 660	80	8.95	30.0*	18.0	178	80
SAE 64	76	9.00	52.0*	20.0	180	100

* Denotes seizure

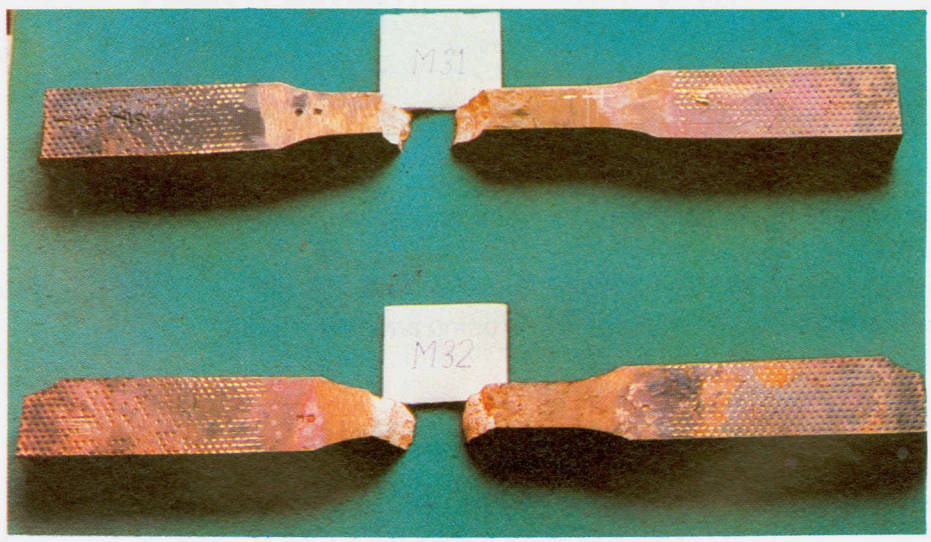
Short Circuit (S.C.) Ring Joint Welding Quality Improvement

For fabrication of S.C. rings for their A.C. machines, BHEL has adopted a method by which ETP copper of suitable cross-section and length is bent in the form of rings and the ends are welded together.

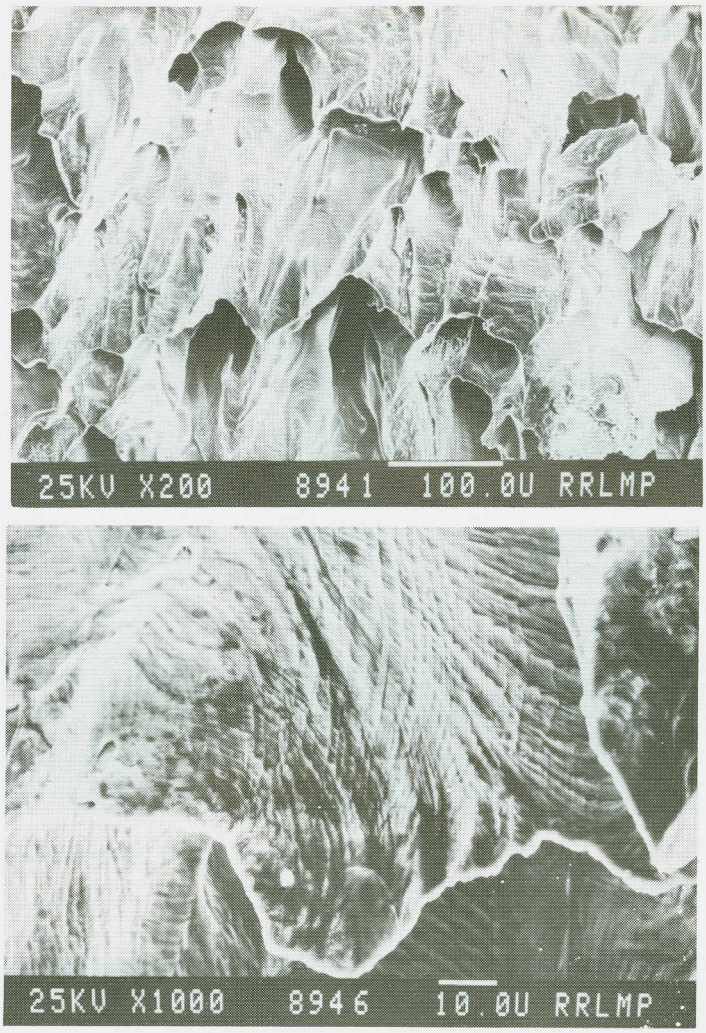
For welding of rings of thickness 20mm and above BHEL is facing heavy weld rejection during the die penetration as well as radiography examinations. This project



Radiograph of Three Weld Joints M-11, M-12 and M-13 Revealing Aligned Porosity, Defect Free Weld and One Large Porosity



Fractured Tensile Test Samples Made from Weld Joints



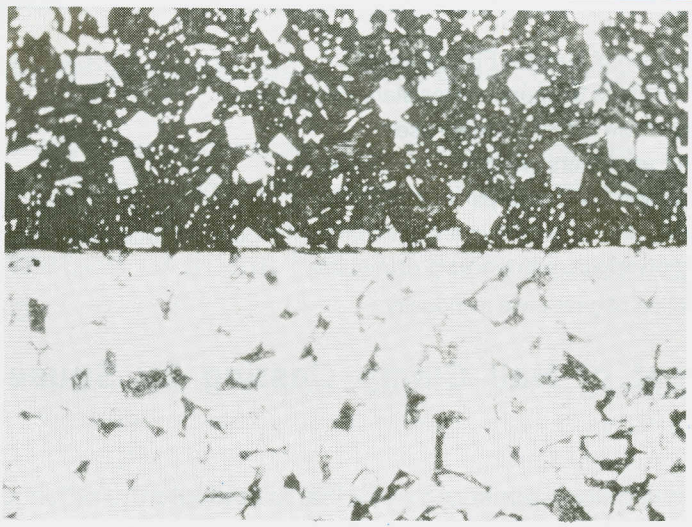
SEM Fractograph of Tensile Fracture Surface Revealing Ductile Nature of the Fracture (X 200 and X 1000)

aims at indicating suitable welding procedure by which this rejection can be minimized at the earliest.

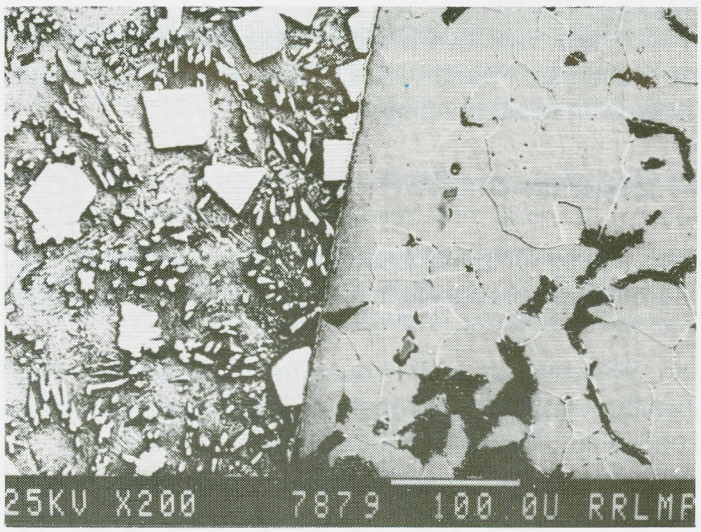
Investigation was confined to the study of the welding process, like joint design, preheating of the samples, precautions being adopted and the skill and capability of the welder.

Bonding Characteristics of White Metal Pad to Mild Steel in Thrust Bearings

The problem of debonding of white metal to mild steel was referred to RRL by BHEL with a view to studying the debonding characteristics and ascertaining the cause of debonding of lining material.



Microstructure of Tin-based Anti-friction Alloy (IS-25) on Mild Steel Backing (X 100)



Scanning Micrograph of the Alloy (IS-25) on Mild Steel Backing (X 200)

The objective of the project is to study the causes of debonding of white metal pad to mild steel in thrust bearing especially with ageing and suggest ways and means to alleviate the problem of debonding.

FRP Gear Case

A project on FRP gear case is approved by BHEL. Initial work on this project is also started. Details regarding the design of gear case and about the present gear case being used by BHEL are being studied.Some salient features of the work are:

- Identification of suitable FRP material
- Alkali/acid/high temperature resistant inner coating
- Testing of raw materials to be used.
- Design Parameters are to be established.
- Optimization of process parameters
- To identify the impact resistant material for the outer surface of the case.
- Making of moulds with the help of industry.
- Fabrication of gear case in industry.

Development of Half Clamp Casting by Squeeze Casting Process

This project is being sponsored by BHEL to evaluate the efficacy of this process for some of the castings for improving the productivity and economics of operation.

Initially simple cylindrical shape castings were made by squeeze casting to optimize process parameters.

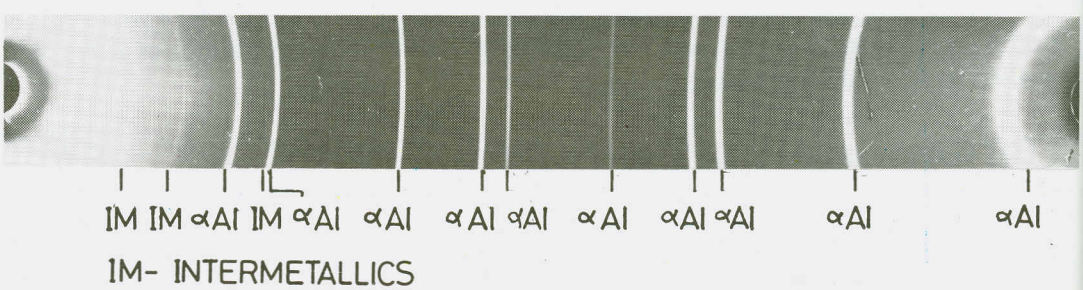
In addition to BHEL, one two-wheeler industry, M/s Gujarat Narmada Auto Limited and one Aluminium Foundry, M/s Ennore Foundries Limited, Madras, have evinced keen interest in this technology.

Exploratory Studies on RSP

As mentioned earlier, RRL has been interacting with the TCRDC, Patiala and ADG CSIR on formulating proposals in the area of Rapid Solidification Processing (RSP).

A report on "Processing and Properties of Advanced High Temperature Aluminium Alloys through RSP" is prepared. This report also highlights some of the work undertaken in this Laboratory.

RRL-Bhopal proposes to develop a new group of aluminium-based alloys with unique and hitherto unattainable properties for applications calling for high temperature strength combined with ductility and high strength to weight ratio. Development of aluminium alloys for following applications is proposed :



XRD of Melt Spun Al-B-Fe-X Alloy

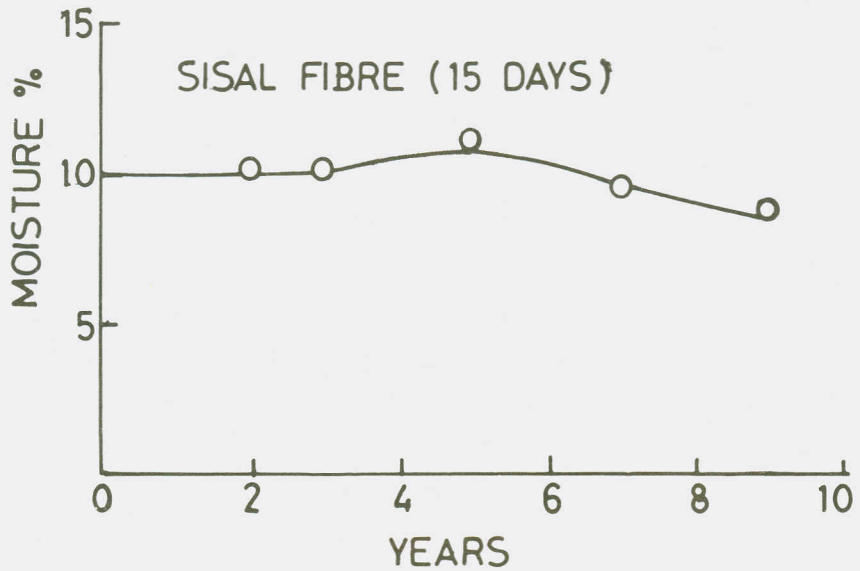
(a) High strength at room temperature and better corrosion resistant alloy development.
(b) Low density, high modulus alloys for space applications.
(c) Improved alloys for high temperature strength applications.

Characterization of some Natural Fibres under different Conditions

It has been reported in the literature that sisal fibre has been under utilized. It is mainly used for the manufacture of ropes for use in marine industry and agriculture. Other cellulosic fibres have been used, due to a number of advantages such as low cost, flexibility during processing, light weight and no health hazard, for various applications.

Sisal fibres have been extracted from the leaves of the plants in April, 1990. Leaves were collected from plants of different ages. For this purpose plants of 2, 3, 5, 7 and 9 years were selected. Extraction of fibres was done with the help of power machine in Bilaspur. Moisture contents were recorded by using an IR moisture meter. Graph is plotted between the moisture content in the fibre and age of the plant.

Lots of samples were prepared for testing the tensile strength of plant fibres of different ages . Thirty samples were prepared from each lot. In all one hundred and fifty samples were prepared. Load, displacement graphs were generated by using INSTRON tensile tester. Stress values of fibres would be calculated from the breaking load. Graph would be plotted between stress and age of the plant.



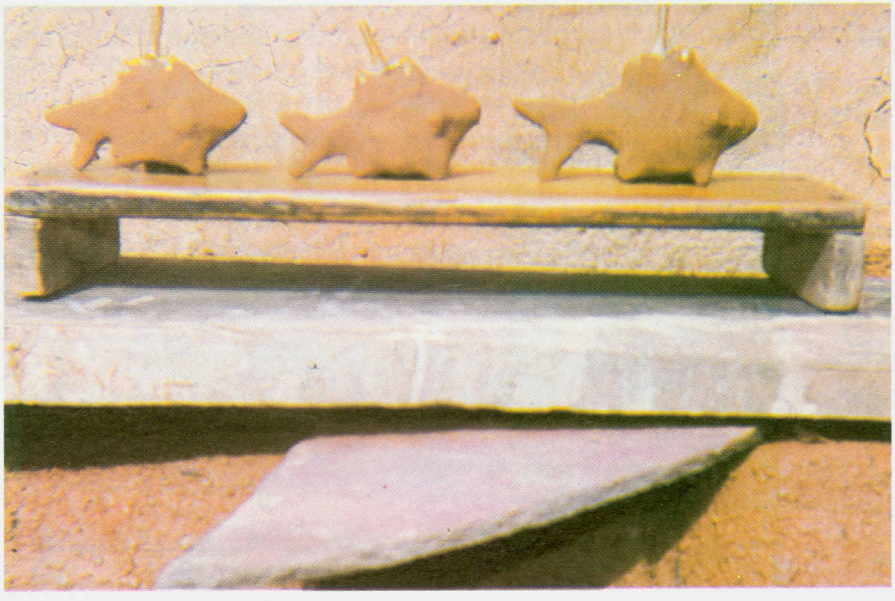
Moisture Content of Sisal Fibre and Age of the Plant

Training Programme for Bell Metal Artisans/ Trainees in Bastar Region

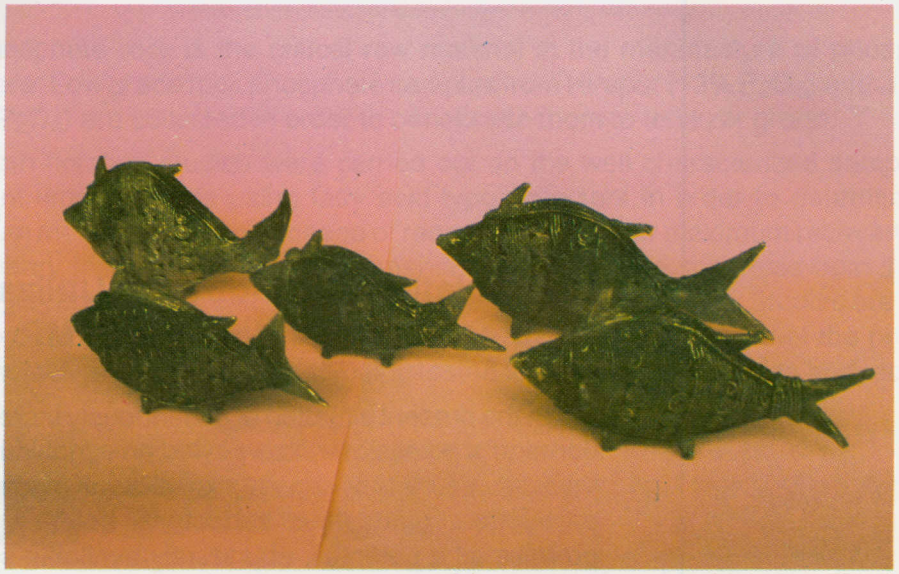
To upgrade the quality of the Bell Metal Industry and uplift the socio-economic conditions of the rural & tribal people of the Bastar Region, the MP Council of Science & Technology, Bhopal, sponsored a project on "Quality upgradation of Metal Based Industries of Bastar Region of M.P." The project envisages the visit of RRL scientists to various places in Bastar for 'On the Spot' study and demonstration at site of the improved technology. The improved technology is simple, less arduous, and commercially viable.

The M.P. Council of Science & Technology has now sponsored five training programmes for training the trainees/artisans in the Tribal Regions of Bastar. All these training programmes are being organised by District Rural Development Agency (DRDA), Bastar. The first training programme was held from 14 to 26 May 1990 at Chilkutti village, about 15kms from Jagadalpur with the active involvement of the scientists of RRL, Bhopal. Sixteen artisans from four different villages participated. The training programme was conducted successfully and the participating artisans showed keen interest to adopt suggested techniques in their craft.

The remaining four programmes will be conducted in Kondagaon, Narayanpur, Bastar and Erakot villages.



Improved Ingate Assembly



Products Made Using Improved Technologies of RRL

Tribal Artisans of.Bastar in Bell Metal casting

MINERALS

Beneficiation and Industrial Utilization of some Fertilizer Minerals of MP

In the present situation of continuously increasing demand of potassic fertilizers in Indian agriculture and thus escalating imports due to lack of indigenous production, glauconitic sandstone holds a good promise as a potential, abundantly available secondary resource of potash. An estimated amount of 940 million tonnes (with proved category of 266 million tonnes) of glauconitic sandstone has been indicated in Majhgawan area of Satna district alone. Deposits in the continuing belt falling in the jurisdiction of U.P. substantially augment the reserve value. For exploiting this presently unutilised reserve particularly for its potash values to be used in the soil, two approaches have been conceived for execution at this Laboratory.

Extraction of potash values from the as-mined sample or from a concentrate prepared by subjecting the as-mined sample to physical beneficiation. Direct application of potash, rich fraction-isolated from the sample or of the as-mined sample after certain treatments, is adopted. To obtain glauconitic sandstone sample, scientists of RRL visited Majhgawan potash field.

Some of the boreholes made during the exploration of the area by GSI were located in the field with the help of a geologist and a surveyor of GSI Panna camp office. Three locations were identified for mining keeping in view the accessibility, depth and grade of the deposit, so as to obtain a representative sample of the area. Approach roads were cleared for bringing the sample from the spots in the field to the motorable road.

Beneficiation of Rock Phosphate

Phosphate rock is the critical raw material in the manufacture of phosphatic fertilizers. Low grade rock phosphate samples from Hirapur (12% P_2O_5) and Jhabua (13% P_2O_5) are collected in order to beneficiate them to fertilizer grade.

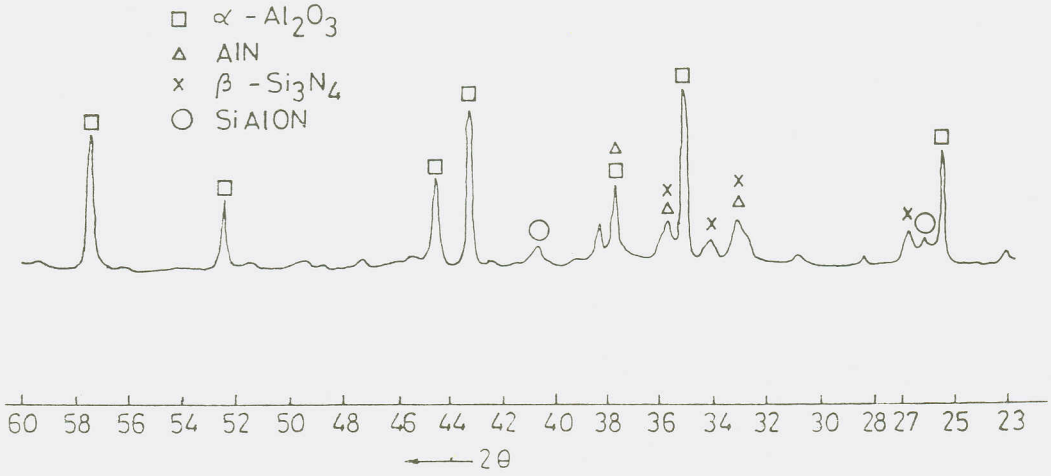
Froth flotation studies were carried out on the well characterized samples at different time of grinds using fatty acid type collectors in order to determine the optimum mesh of grind and dosage of reagents needed for maximum recovery. The preliminary tests have shown the amenability of ferruginous sample from 12% to 30% P_2O_5 content and calcarious sample from 13% to 27% P_2O_5. Studies are under way to optimize the conditions to increase the recovery and grade of the product. More selective reagents are also being tested for improving the grade and recovery values.

Utilization of Aluminosilicate Minerals of MP for Value Added Products

The properties and applications of mullite, nitride and oxynitride ceramics and relevant R&D activities necessary to develop a suitable process of making them in Indian context have been examined. Since the existing processes of making non-oxide ceramics are costly, it is felt necessary to use mineral resources.

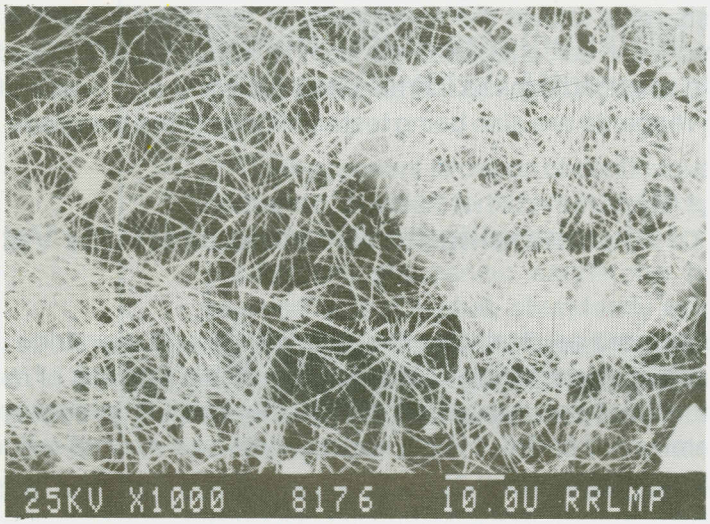
Short ceramic fibres were obtained by simultaneous reduction and nitridation of a ceramic mixture in the system Al_2O_3-SiO_2-RO (FeO +Fe_2O_3 + CaO + MgO) at 1100-1400° C.

As a result of the reduction process, the iron oxides were converted to the metallic form during the formation of AlN and Si_3N_4. Silica present in the system was completely converted to the Alpha-Si_3N_4. From the diffractogram it is also clear that the major phase is Alpha-Al_2O_3.

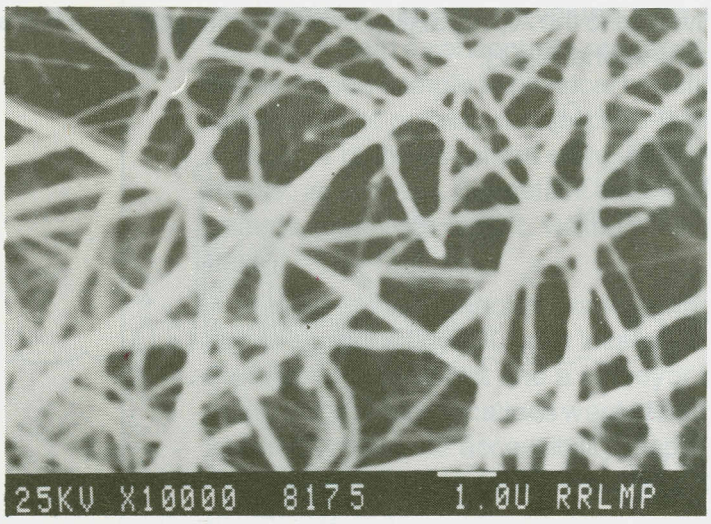


XRD Pattern of the ceramic mixture heat treated at 1300 °C

As the SEM micrographs indicate that short fibers have very smooth and undulated surfaces. The short fibers are like needles which are straight. Some of the fibers are bent along another short fiber which must have a higher strength.It can be conclusively said that there was no distorted structure or branching. The short fibers have maximum diameter of about 0.3 micron and lengths ranging from 10-20 microns. In few cases short fibers of lengths up to 50 microns were also noticed at 1300^{o} C. Further studies are in progress.



SEM Micrograph of Short Ceramic Fibers



SEM Micrograph of Short Ceramic Fibres Showing Smooth Surface

Exploratory Studies in Coal Preparation

Coal remains as one of the important sources of energy irrespective of the environmental problems due its usage. The importance of coal for energy would increase because of the recent oil crisis. The projected requirement of fuel oil for the power sector alone in 1994-95 is 5 million tonnes, accounting for sixteen billion rupees mostly in the form of foreign exchange which is 40% of the total fuel oil requirement of the country. Madhya Pradesh is rich in non-coking coal reserves which, because of high ash content, pose problems during combustion in boilers. Though awareness and importance of dry cleaning of non-coking coals is increasing through out the world and no attempt has been made so far in India to beneficiate non-coking coals using cheap dry beneficiation methods.

Further, the demand for coking coal for the steel industries need not be overstressed. The limited resources of coking coal and its nature which presents the toughest coal washing task, has necessitated to activate vigorous research to overcome the above problems.

Plan of Research Activities

Keeping the above points in view, RRL, Bhopal, has taken active interest to initiate the research work on both coking and non-coking coals. Steps have already been taken to procure some of the modern coal preparation equipments like Mozley Vanner, Table, Cyclone and Multigravity Separator. Attempts are being made to work out research projects through external fundings. The research activities planned can be broadly divided into two areas, viz. Coking coal and Non-coking coal.

COKING COAL

Heavy medium cyclones are the only centrifugal heavy medium separator used in washeries. However, many new techniques have been developed recently in the area of heavy medium separation such as Dynawhirlpool Separator and Vorsyl Separator. This work attempts to compare these techniques at the Laboratory to provide suitable information to coal washeries for improvement of its operation.

Froth flotation is another important technique for fine coal beneficiation. Due to the increase in the fines content of run-of-mine coal which has resulted because of mechanized mining methods, flotation is becoming more important coal preparation process. This work attempts to evaluate the effect of feed characteristics on the efficiency of flotation.

NON-COKING COAL

Non-coking coal beneficiation has not been serioulsy tried so far in India and realizing its need the laboratory has taken steps to work in the following areas of dry beneficiation.

Tribo-electric Separation of Coal

A novel technique to beneficiate coal by dry method has been developed in USA using the tribo-electric properties of coal and shale materials. The laboratory is in touch with Virginia Polytechnique to explore the possibilities of using this method for Indian coals.

Mozley high G separator has been very recently developed in UK which utilizes gravity forces effectively for upgradation of coal. This method will be tried for both coking and non-coking coals in India.

GENERAL INFORMATION

International Symposium on Mineral and Metallurgical Processing, held at Salt Lake City of USA, between Feb. 26 and March 1, 1990 and presented a paper entitled "Industrial Application of Heavy Medium Cyclone Model". The Symposium was attended by about 4500 delegates from Universities, R&D Institutions, Industries and Govt. Agencies from all over the world. It was organised by the Society for Mining, Metallurgy and Exploration Inc. USA.

In addition Prof. Rao served as the Chairman of a Technical Session on Control Strategies and Process Optimization. He visited the Department of Metallurgical Engineering of University of Utah and the Dept. of Mining and Mineral Engineering of Virginia Polytechnic and the State University, Virginia. He also visited the University of California, Berkeley and gave a seminar on "Modelling of Some Fine Coal Processing Techniques". During these visits he exchanged views on modelling of unit operations in mineral and coal preparation operations and also application of dry beneficiation techiques for upgradation of minerals and coals.

Students Meet Scientists

On the occasion of National Science Day this year, RRL organised the NCERT programme "Students Meet Scientists". Sixty students from different schools in Bhopal participated. They were briefed on the operation and functioning of scientific instruments, methods of scientific research and the R&D programmes of the laboratory. A Science Quiz was also organised for the participants. Dr.G.P. Tiwari, Project Director, MAPCOST and Dr. R.K. Singh, Head, Dept. of Physics, Bhopal University, delivered special lectures on the occasion.

Science Kit Distribution

National Council of Science Museums and MAPCOST jointly organised the programme on Feb.13, 1990 at RRL Bhopal. Shri S.K. Patel, Minister of Science and Technology, Govt. of MP presided. Science kits were distributed to trained teachers of schools and science centres in MP by Prof. T.C. Rao.

Training of Trainers

Dr. D.N. Misra, DG, MAPCOST, inaugurated the above programme of the Central Institute of Medicinal and Aromatic Plants, Lucknow, on 27th June 1990 at RRL, Bhopal. The programmes were related to medicinal and aromatic plants available in MP and was jointly organised with MAPCOST and CSIR, PTC, Bhopal.

National Seminar on Standards in Construction Engineering

A two-day National Seminar on "Standards in Construction Engineering" was held at Bhopal on 3rd Aug.1990. Mr. S.K. Sharma, Chairman and Managing Director, Housing and Urban Development Corporation, New Delhi, inaugurated the seminar. Lt.Gen. A.S. Bhuller, President SEI, DG (Quality Assurance), Ministry of Defence, Delhi, was the Chief Guest. The seminar was organised jointly by Regional Research Laboratory Bhopal, and Institute of Standards Engineers, Bhopal, with the co-sponsorship of Madhya Pradesh Science & Technology Council, Bhopal, Central Public Works Department, New Delhi and Central Building Research Institute, Roorkee.

Mr. S.K. Handa. General Manager in-charge, BHEL Bhopal, Dr. D.N. Misra, Director General, MAPCOST, Shri V.S. Mathur, Director, BSI, Bhopal and Prof. T.C. Rao, Director, RRL, Bhopal, were also present on the occasion. Shri A.C. Khazanchi, Head, Building Materials Division conducted the seminar. Over 150 delegates from Govt. of M.P., National Laboratories, Research Organisations, CPWD, MP PWD, CPA-Bhopal, BDA-Bhopal, M.P. Housing Board, Regional Engineering Service, Bhopal, and HUDCO attended the Seminar.

National Seminar on 'Standards in Construction Engineering'

CSIR Foundation Day Celebrated

Regional Research Laboratory (RRL), Bhopal, celebrated the CSIR foundation day at a simple function organised in the RRL premises on 26.9.1990. Prof. G.S. Marwaha, Former Director of Indian School of Mines, Dhanbad and Consultant (Environment) was the chief guest on the occasion. The programme was presided over by Dr. D.N. Misra, Director General, MAPCOST.

Prof. Marwaha gave a detailed account of specific issues and the role of Environement Planning and Management. He mentioned several thrust areas of R&D activities in the field of environment and ecology including surface land, water and air and stressed the need for an interdisciplinary research in this area. Earlier Prof. T.C. Rao welcomed the chief guest and gave a brief account of CSIR. He mentioned that RRL, Bhopal, is taking up major projects in low cost housing, fertilizer, minerals and natural resources data base management of MP.

Dr. D.N. Misra, in his presidential address, lauded the efforts of CSIR. He mentioned that RRL, Bhopal, has a major role to play in the development of scientific base in MP.

On this occasion, mementoes were presented to Dr. D.N. Misra and Mr. G.G. Nair. Winners of the various competitions held for children of RRL,Bhopal, were given prizes by Mrs. Marwaha. An Open Day was observed for the general public, students, engineers and entrepreneurs.

Various equipment were also displayed. Later video films on CSIR were screened. All these programmes evolved a very encouraging response.

Prof. G.S. Marwaha delivering Keynote Address

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Prof. G.S. Marwaha delivering Keynote Address

Society Chapters at RRL

MRSI

Bhopal Chapter of Materials Research Society of India (MRSI) was inagurated by the eminent material scientist Prof. T.S. Murthy, former Vice-Chancellor of Sagar University. Prof. T.C. Rao, Director, RRL, Bhopal and Chairman of MRSI, Bhopal chapter, highlighted the objectives and proposed activities of this chapter. Prof. R.K. Singh, Head, Dept. of Physics, Bhopal University, is Convenor and Dr. Navin Chand, Scientist, RRL, Bhopal,is the Treasurer for the Chapter. A resolution was passed on this occasion to congratulate Prof. C.N.R. Rao, President, MRSI, on his being honoured with fellowship by the US Academy of Sciences.

SAEST

Prof. T.C. Rao inaugurated the Bhopal Chapter of the Society for Advancement of Electrochemical Science and Technology (SEAST) on March 21, 1990. Shri A.C. Khazanchi (Chairman), Dr. G.P. Tiwari of MAPCOST (Vice-Chairman), Dr. Navin Chandra (Secretary) and Shri S.P. Pathak (Jt.Secretary) are the office-bearers of the Bhopal Chapter.

IIM

Bhopal Chapter of the Indian Institute of Metals (IIM) was inaugurated by Shri K.S. Sharma, Secretary, Industries Govt. of MP, on Nov.30,1990. Prof. T.C. Rao, Director, RRL , is the Chairman of the Chapter. Other Office Bearers are Dr. G.P. Tiwari of MAPCOST (Vice-Chairman), Shri S.K. Bose (Secretary), Dr. A.H. Yegneswaran (Treasurer) and Dr. S. Das (Joint Secretary).

Hindi Day Celebration

Hindi Day was celebrated on 14 Sept. 1990 in the Laboratory. Various competitions were held on this occasion, i.e. essay competition, quiz, extempore speech, noting and drafting in Hindi and dictation for non-Hindi speaking employees. The main function was presided over by Shri P.S. Rathore, Acting Director, Environment Planning and Coordination Organisation (EPCO), Bhopal. The programme received good response from the employees.

RC AND MC MEETINGS

The 3rd meeting of the RC was held on October 20th, 1990 under chairmanship of Dr. P. Rama Rao. The progress of the laboratory projects and sponsored assignments was presented in the meeting. New facilities setup in the laboratory were appreciated by the RC.

The 4th meeting of the MC took place on December 29th, 1990.

APPENDICES

APPENDIX - 1

RESEARCH COUNCIL

Prof. P.Rama Rao, Director, Defence Metallurgical Research Laboratory, Kanchan Bagh, P.O. DMRL Hyderabad - 500 258	Chairman
Shri K.P. Banerjee, Jt. General Manager, Larsen & Toubro Ltd, Sakivihar, Powai Bombay - 400 076	Member
Dr. T.R. Ramachandran, Director, Jawaharlal Nehru Centre for Aluminium Research, Design and Development Mohta Apartments, Katol Road, Chawani, Nagpur - 440 013	Member
Shri J.K. Bhasin, Chairman, Central Electricity Authority, Seva Bhawan, R.K. Puram, New Delhi - 110 022	Member
Shri R.K. Saraf, Director (Personnel), Bharat Heavy Electricals Limited, BHEL House, Siri Fort, New Delhi - 110 049	Member

Prof.D.N. Mishra, Director General, Madhya Pradesh Council of Science & Technology, Maharana Pratap Nagar, Bhopal - 462 011	Member
Dr. T.N. Gupta, Consultant, Ministry of Urban Development, G-Wing, Room No. 116, Nirman Bhawan, New Delhi - 110 001	Member
Shri C.P.S. Nair, Chief Technical Adviser, Dept. of Mines, Min. of Steel & Mines, Shastri Bhawan, New Delhi - 110 001	Member
Dr. O.N. Mohanty, Scientist, National Metallurgical Laboratory, Jamshedpur - 831 007	DGSIR Nominee
Dr. Surya Prakash, Scientist, Planning Division,CSIR, Anusandhan Bhawan, Rafi Marg, New Delhi - 110 001	CSIR HQ Representative
Prof.T.C. Rao, Director, Regional Research Laboratory, Bhopal - 462 026	Member
Dr. R.N. Yadava, Scientist, Regional Research Laboratory, Bhopal - 462 026	Secretary

APPENDIX - 2

MANAGEMENT COUNCIL

Prof. T.C. Rao, Director, Regional Research Laboratory, Bhopal - 462 026	Chairman
Dr. K.S.Narasimhan, Scientist, Regional Research Laboratory, Bhubaneswar - 751 013	Member
Dr. O.N. Mohanty, Scientist, National Metallurgical Laboratory, Jamshedpur - 831 007	Member
Shri A.C. Khazanchi, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member
Dr.A.H. Yegneswaran, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member
Shri K.K.S. Gautam, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member
Shri R.K. Morchhale, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member

APPENDIX - 2

MANAGEMENT COUNCIL

Prof. T.C. Rao, Director, Regional Research Laboratory, Bhopal - 462 026	Chairman
Dr. K.S.Narasimhan, Scientist, Regional Research Laboratory, Bhubaneswar - 751 013	Member
Dr. O.N. Mohanty, Scientist, National Metallurgical Laboratory, Jamshedpur - 831 007	Member
Shri A.C. Khazanchi, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member
Dr.A.H. Yegneswaran, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member
Shri K.K.S. Gautam, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member
Shri R.K. Morchhale, Scientist, Regional Research Laboratory, Bhopal - 462 026	Member

The Finance & Accounts Officer Regional Research Laboratory, Bhopal - 462 026	Member
DGSIR or his Nominee, CSIR Headquarters New Delhi - 110 001	Permanent Invitee
The Administrative Officer, Regional Research Laboratory, Bhopal - 462 026	Member Secretary

APPENDIX - 3

DISTINGUISHED VISITORS

1. Dr. A.P. Mitra, Director General, CSIR, New Delhi.
2. Dr.R.K. Iyengar, ADG, CSIR, New Delhi.
3. Dr. N.H. Quen, Director, Special Materials Co.Ltd.,Hanoi,Vietnam.
4. Dr. G.P. Phondke, Director, PID, New Delhi.
5. Dr. M .Ramamoorthy, Director General, CPRI, Bangalore.
6. Dr. P.K .Iyengar, Chairman, Atomic Energy Commission, Bombay.
7. Shri P.K. Lahiri, Secretary, Dept. of Mines, Govt. of India, New Delhi.
8. Dr. P. Chidambaram, Director, Physics Group, BARC, Bombay.
9. Dr. M.P. Dhir, Director (Engg. Coord), CSIR, New Delhi.
10. Shri R.N. Bhargava, Adviser (Planning), CSIR, New Delhi.
11. Shri Hemraj, Dy. Financial Adviser, CSIR, New Delhi.
12. Shri T.N. Jaggi, Former Chairman, Pyrites, Phosphates and Chemicals Ltd., New Delhi.
13. Shri P.S. Rao, Chairman-cum-Managing Director, BALCO, New Delhi.
14. Shri S.K. Choudhary, Controller General, IBM, Nagpu.r
15. Shri O.P. Dubey, Managing Director, MP State Mining Corporation, Bhopal.
16. Dr. R.S. Kapil, Director, RRL, Jammu
17. Shri S.K. Sharma, Chairman-cum-Managing Director, HUDCO, New Delhi.
18. Dr. R.K. Midha, Director (NRDMS), DST, New Delhi.
19. Shri D.K. Jain, Project Coordinator, CMPDIL, Ranchi.
20. Shri A. Chakravorty, Chief Metallurgist, MAMC, Durgapur.
21. Shri A.K. Das, Chief Design Engineer, MAMC, Durgapur.
22. Shri Ajith Kumar, R&D BEML, Bangalore.
23. Shri D.N. Prasad, HEC, Ranchi.
24. Shri S.K. Kulkarni, M/s Morris Electronics Ltd., Pune.
25. Shri Suresh Chandra, NMDC, Hyderabad.
26. Shri N.R. Nair, CEL, New Delhi.
27. Shri S.A.S. Sundaram, Jt. Secretary, Ministry of Urban Development, New Delhi.
28. Prof. G.S. Marwaha, Former Director, ISM, Dhanbad.

29. Dr. Bhaduri, Director, IICB, Calcutta.
30. Shri N.R. Subbaram, Joint Adviser (Patents), CSIR, New Delhi.
31. Lt. Gen. A.S. Bhullar, Quality Assurance, Min. of Defence.
32. Shri S.K. Handa, General Manager (Incharge), BHEL Bhopal.
33. Shri C.V. Sundaram, Former Director, IGCAR, Kalpakkam.
34. Prof. P.C. Kapur, Dept. of. Metallurgy, IIT, Kanpur.
35. Dr. Pradip, TRDDC, Pune.
36. Shri D.S. Tiwari, Chairman, MP Pradushan Nivaran Mandal, Bhopal.
37. Shri V.S. Vijayaraghavan, Director, CGWB(NCR), Bhopal.
38. Dr. S.K. Pradhan, PSO, DST, New Delhi.
39. Shri Harsh Mander, Managing Director, MP Antyavasayee Sahkari Nigam Ltd., Bhopal.
40. Shri K.S. Sharma, Secretary, Industry and Commerce, MP Govt.

APPENDIX - 4

RESEARCH PAPERS AUTHORED BY RRL SCIENTISTS

1. **S V Prasad** "Composite for Friction and Wear Applications", Concise Encyclopedia of Composite Materials, *106* (1989)11
2. **J James** "Techniques for the Study of Cement Hydration",A Chapter in the Book,"Cement & Concrete:Science and Technology",(Ed.S N Ghosh)ABI Books Ltd, New Delhi, 1990 (in Print)
3. **A K Jha, S V Prasad and G S Upadhayaya** "Sintered 6061 Al-Alloy Solid Lubricant Particle Composites:Sliding Wear & Mechanisms of Lubrication",Wear,*133* (1989)163
4. **A K Jha,S V Prasad and G S Upadhayaya** "Sintering Behaviour & Properties of 6061 Al-Alloy Titanium Carbide Particle Composite",Science of Sintering,*21*(1989)81
5. **A K Jha,S V Prasad and G S Upadhyaya** "Preparation & Properties of 6061 Al-Alloy based P/M Particle Composites,Solid State Phenomena,*8&9*(1989)283
6. **T C Rao,B Govindarajan and M Vanangamudi** " An Empirical Model for Batch Coal Flotation", Coal Preparation,*6*(1990)126
7. **T C Rao,B Govindrajan and M Vanangamudi** "A Kinetic Model for Batch Coal Flotation, Minerals Engineering,*2(3)*(1989)403
8. **Navin Chand and Sudha Verma** "Efficient Application of Chlorinated Paraffin Wax - SB 203 Emulsion as Hemp Fibre", Fire & Safety, *15*(1989)325
9. **Navin Chand and Sudha Verma** "Mechanical Characterization of EDA treated SunHemp Fibre",Science & Culture, *55(4)*(1989)138
10. **Navin Chand** " Coating Increases UTS of Sunhemp Fibre", Indian Textile Journal (1989)106
11. **Navin Chand** "Morphology & Dielectric Properties of Limestone Filled PE", Popular Plastics and Packaging, *34*(1989)61
12. **Navin Chand** "Polymer Composites Development with Natural Fibre", Indian Textile Journal,(1989)118
13. **S Das,S V Prasad and T R Ramachandran** "Microstructure of Rapidly Solidified Al-Si Graphite Composites, Script. Metallurgy, *23*(1989)3

14. **S Das and S V Prasad** "Microstructure and Wear of Cast Aluminium Silicon Materials Alloy Graphite Composites,"Wear of Materials, *9*(1989)399
15. **S Das,S V Prasad and T R Ramachandran** "Microstructure and Wear of Cast Al-Si Alloy Graphite,"WEAR, *133*(1989)173
16. **S P Narayan,V S Muneswar and A H Yegneswaran** "Spheroidisation Studies on High Strength Low Alloy Steel",Tool and Alloy Steel, *23*(1989)
17. **S Das,S V Prasad, P Asthana and P K Rohatagi** "Some Modified Structure of Matrix in Cast Al-Alloy Graphite Particle Composites",Z.Metallokde, *80*(1990)144
18. **K Basu,R S Solanki,V S Muneswar,A H Yegneswaran and A K Singh** "Squeeze Casting of Al & Its Alloy",Indian Found. Journal, *35(10)*(1989)25
19. **P D Ekbote,A C Khazanchi,T K Dan and R Kumar** "Energy Conservation Through Materials Selection in Building Industry", Research and Industry, *34*(1989)74
20. **P K Rohatagi,R N Yadava,P Asthana and S Ray** "Energetics of Particle Tranfer from Gas to Liquid during Solidification Processing of Composites", Metallurgical Transaction, *21A*(1990)2073
21. **S K Bose,R G Ganguly,A N Sinha,P K De and N K Das** "High Strength Al-Mn Alloys Through RSP Route",Trans.Indian Inst.of Metals, *42*(1989)563
22. **R Dasgupta,S K Bose,and R Kumar** "Tribological Behaviour of RSP Al-Si Base Alloys",Trans.ICMS Publishers Trans. Tech. Publications, *38* & *39*(1989)277
23. **S K Bose,R G Ganguly,A N Sinha and P K De and N K Das** "Property Improvements in RSP Al-Mn alloys",Trans.ICMS Publishers, Trans.Tech. Publications, *38* & *39*(1989)287
24. **T C Rao, R Venugopal,A P Karan and M Vanangamudi** "Effect of Fineness of Feed on Green Palletization Behaviour of Particulates",Transactions Ind. Inst. of Metals, *42*(1989)
25. **S Das,S V Prasad and T R Ramachandran** "The Influence of Matrix Microstructure on the Wear of Al-Si Alloy Graphite Composites",Proceedings on Fundamental Relation, TMS Fall Meeting Indianapolis, USA, 1989
26. **A K Jha,S V Prasad and G S Upadhyaya** "Preparation and Properties of 6061 Aluminium Alloys", Powder Metallurgy, *32*(1989)309
27. **S P Narayan,V Rao,S Das and O N Mohanty** "Micro-structural and Magnetic Studies on Thermo Mechanically Treated HSLA Steel",Journal of Magnetism & Mag.Material, *88* (1990)71
28. **R Venugopal,M Mandal and T C Rao** "A Treatise on Froth Flotation as an Interactive Phenomenon",IE (I) Journal, *71* (1990)
29. **(Ms)S Chatterji,M Vanangamudi,JP Barnwal and T C Rao** "Behaviour of Individual Species in Batch Coal Flotation Operation", IE (I) Journal,(1990)

30. **N Suresh and M Vanangamudi and T C Rao** "Technical Note Water Distribution in Water",Mineral Engg.(Accepted)
31. **Navin Chandra,Sangeeta Dhar and B K Saxena** "Corrosion of Super-purity Aluminium in deaerated Mineral Acids", Bull. Electrochem, *6(5)* (1990)487
32. **O P Modi, M N Mungole and K P Singh** "Potentiodynamic Studies of Modified 9Cr-1Mo Ferritic Steel in Sulphuric Acid and Seawater" Corrosion Science, *30*(1990)941
33. **A K Jha,S V Prasad,G S Upadhaya** "Mechanical Behaviour of Sintered 6061 Aluminium Alloy and its Composites Containing Soft and Hard Particles", Z. fur Metallkunde, *81*(1990)457
34. **A K Jha,S V Prasad and G S Upadhaya** "Activated Sintered 6061 Aluminium Alloy Particulate Composites Containing Coated Graphite, in Controlled Interphases in Composite Materials",Ed:Hatsuo Ishida, Elsevier Science Pub-co-Inc.1990.
35. **A K Jha.S V Prasad and G S Upadhaya** "Dry Sliding Wear of Sintered 6061 Al-Alloy Graphite Particle Composites",Powder Metallurgical International, *22*(1989)321
36. **A K Jha,S V Prasad and G S Upadhyaya** "Surface Roughness of Sintered 6061 Al-Alloy Based Particle Composites", Powder Met. Int. *21*(1989)15
37. **Navin Chandra, Sangeeta Dhar and B K Saxena** "Corrosion of Aluminium in Aqueous Solutions of Different pH",J.Electrochem. Soc.India, *39*(1989)160
38. **B K Prasad,S V Prasad and A A Das** "Abrasion Resistance of Squeeze Cast Al-Alloy-Matrix Composites", Proc. of the National Conference on Industrial Tribology (NCIT-89), Trivandrum, India, 1989
39. **B K Prasad and T K Dan** "Microstructure and Property-Related Changes in a Pressure Die Cast Graphitic Al-Si Alloy Induced by Heat Treatment",J Mater.Sci.Lett., *9*(1990)951
40. **B K Prasad,S Das and S V Prasad** "The Significance of Matrix Microstructure on the Solid Lubrication Characteristics of Graphite in Aluminium Alloys",Proc. TMS fall meeting on Innovative Composite Processing, Detroit, U.S.A., 1990.
41. **B K Prasad,S V Prasad and A A Das** "Material Removal Mechanisms and Micro-Structural Changes During Abrasion of Squeeze Cast Aluminium Alloy-Matrix Composite Material", Proc. International Conference and Exhibition on Advances in Composite Materials, ASM International,Bombay, 1990
42. **B K Prasad and T K Dan** "Effects of Solutionizing a Graphitic Hypereutectic Al-Si Alloy at various Temperatures and Time",Ibid.

43. **B K Prasad,T K Dan,and P K Rohatgi** "Pressure Die Cast Al-Si-Graphite Composites",Ibid.
44. **B K Prasad,T K Dan and P K Rohatgi** "Synthesis of an Al-Si Alloy-Graphite Particulate Composite by Pressure Die Casting Technique and its Characterization", Proc.of the 7th CIMTEC- World Ceramics Congress and Satellite Symposia,Italy, 1990
45. **B K Prasad** "Microstructural Modifications and Changes in Properties of an Aluminium-Silicon-Graphite Composite by Heat Treatment",Ibid.
46. **B K Prasad** "Microstructural Modifications and Improvement in Properties of a Hypoentectic Al-Si Alloy Dispersed with Graphite Particles", J.Mater. Sci. Lett., (Accepted)
47. **S V Prasad and B K Prasad** "Abrasive Wear Mechanisms in Ceramic Particle Dispersed Al Alloys",International Conference on Tribology of Materials, ASM International,Oak Ridge,USA, 1990
48. **B K Prasad and T K Dan** "Heat Treatment of a Hypoentectic Al-Si Alloy: Effect of Overheating", International Conference on Aluminium (INCAL-91), Bangalore (Accepted)
49. **B K Prasad,T K Dan and P K Rohatagi** "Characterization of a Pressure Die Cast Al Alloy-Graphite Particle Composite", Ibid.
50. **S Das S V Prasad and T R Ramachandran** "Tribology of Al-Si Alloy-Graphite Composites :Tribo induced Graphite Films And the Role of Silicon Morphology",Met. Sci.Engg. (Accepted)
51. **S Das S V Prasad and T R Ramachandran** "The Influence of Matrix Microstructure on the Wear of Al-Si Alloy-Graphite Composites", A TMS Publication (Conf. Proc.),Indianapolis,1989
52. **S S Amritphale and M Patel** "Ceramic Wall Tiles from Pyrophyllite Mineral",J. Silicate Ind,*5-655*(1990)169
53. **Navin Chandra, Sangeeta Dhar and B K Saxena** "Corrosion of Aluminium in Aqueous Solution of Different pH", J.Electrochem Soc India *39(3)*(1990)160-164
54. **R K Rawelly and C B Raju** "Mineralogical Investigations on Glauconite Sandstone of MP" Communicated
55. **J James,C B Raju and R Kumar** "Reactivity of Fly Ash by DTA" In the Proceeding of the Seminar on Thermal Analysis in R & D held at REC Jammu, Oct. 2989.
56. **R K Rawelley and C V Raju** "Classification of Potash Bearing Fertilizer Mineral by DTA", in the Proceeding of the Seminar on Thermal Analysis in R&D Held at REC Jammu, Oct. 1989
57. **C B Raju** "Microstructure and Crystallisation Kinetics of Glass Ceramic from Pegmalities Containing Lepidolite",In the Proc. of XV International Congress on Glass at Leningrad, 1989

13. **Kiran Singh, A Chauhan and A Khazanchi** "Cadmium Toxicity & Bacillus Subtiliis from Flyash", 78th ISC,Indore, (Accepted)
14. **A C Khazanchi, Mohini Saxena, R K Morchhale and R K Chauhan** "Development of New Building Materials: Red Mud Cement & Sisal Fibre Reinforced Roofing Sheets in Cement/Polymer Matrix", 3rd International Seminar, NCCBM, New Delhi, 1990.
15. **S R Karade, A C Khazanchi, R K Chauhan, A K Singh, R K Morchalle and M K Patel** "Development of New Bldg. Material for Construction Industry", Institution of Engineers, Calcutta, 1990
16. **Sethi and A C Khazanchi** "Wasteland Development using Flyash", Wasteland News-1990, Society for Promotion of Wastelands Development, New Delhi, 1990
17. **A C Khazanchi and Mohini Saxena** "Interfacial Phenomenon of New Natural (organic) Fibres in Polymer Matrix for Construction Engineering", 3rd International Conference on Composites Interfaces, Ohio, USA, 1990
18. **A C Khazanchi, Mohini Saxena and T C Rao** "Material Science of Natural(organic) Fibres in Polymer/Cement/Mud Matrix for Application in Construction Engg.", Comp. Mat. with Textile Reinforcement for use in Bldg.Cons.& Related Application, LYON, France,1990.
19. **G G Nair, S P Mukherjee and A C Khazanchi** "Failure Analysis as a Primary Trouble Shooting Tool to Assess Hazard Factor in Large Structure and Industry, Int.Metallo. Soc. 23rd Annual Convention, Leigh, 1990
20. **S Das, S V Prasad and T R Ramachandran** "Microstructure of Cost Al-Si Alloys in Presence of Dispersed Graphite Particles", Workshop on Testing & Characterization of Materials, Bombay, 1990
21. **S S Amritphale, Navin Chandra and A K Singh** "Effect of Some Phosphatic Binders on Thermal Transformations of Pyrophyllite", National Seminar on Standards in Construction Engg.,Bhopal, 1990
22. **Navin Chandra, B Kujur and M K Ban** "Monitoring & Control of Pollutant Fluoride Ions", Sixth National Convention of Environmental Engineers and Seminar on Environment and Ecology: Indian Scenario, Ranchi, 1990.
23. **J James and C B Raju** "Reactivity of Fly Ash", Proceeding of National Seminar on Standards in Construction Engg., Bhopal, 1990
24. **C B Raju,J James and T C Rao** "Microstructure of Short Ceramic Fibre" Workshop on Ceramic Powders-End Products Organised by the Indian Ceramic Society Hyderabad Chapter, Hyderabad, 1990
25. **B K Prasad and T K Dan** "Effects of Solutionizing a Graphitic Hypereutectic Al-Si Alloy at various Temperatures and Time", International Conference and Exhibition on Advances in Composite Materials (ICACM-90), ASM International, Bombay, 1990.

58. **C B Raju and M Patel** "Microscopic Studies on Some minor Minerals of M.P",The Indian Mining and Engineering Journal, *XXVIII*(1989)21

59. **R S Solanki, V S Muneswar, A H Yegneswaran and A K Singh** "Squeeze Casting of Aluminium and its Alloys", Indian Found. Journal, *35(10)*(1989)25-34

60. **S K Bose and R Dasgupta** " Rapidly Solidified Al-Mn Alloys under Dry Sliding Conditions", Communicatd to Journal of Material Sciences, (1990)

61. **O P Modi, A K Singh, A H Yegneswaran and P K Rohtagi** "Temperature and Strain Rate Effects on tensile Behaviour of Al-IMg-2.5 Graphite Particulate Composite", Proc. Int. Conf.& Exh. on Advances in Composite Materials, ASM, Bombay, 1990.

62. **A K Jha, S V Prasad and G S Upadhyaya** "Sintered 6061 Al-Alloy Particle Composites Processing and Mech. Behaviour", Conf. Proc. on Advance Metal Ceramic Matrix Composites 119th TMS Annual Meeting & Exhibition, 1990.

APPENDIX - 5

PAPERS PRESENTED BY SCIENTISTS OF RRL, BHOPAL

1. **A C Khazanchi and R K Chauhan** "Cementatious Binder from Al-Industries Waste",Indian Engg.Congress, Madras, 1990.
2. **A C Khazanchi and R K Chauhan** "Cementatious Binders from Al-Waste", Roorkee University, 1990.
3. **A C Khazanchi** "Material Science of Cement & Concrete",Indian Science Congress, Madurai, 1989
4. **A C Khazanchi and A K Srivastava** "Science of Ipomoea Carnea (Beshrum) Plant as Reinforcing Material for Application in Housing",Presented in Science Congress, Cochin, 1990.
5. **A K Gupta, S N Tiwari, B K Saxena and S N Malhotra** "Studies on Morphology of 43rd Annual Tech. Shrinkage Defects in Al-Si Alloy Castings", 43rd Annual Tech. Meeting (IIM),Calcutta, 1989
6. **R S Solanki, AK Singh CB Raju and K Basu** "Development of Aluminium Red Mud Particulate Composite by Squeeze Infiltration", 43rd Annual Tech. Meeting (IIM), Calcutta, 1989
7. **S Das, S V Prasad and TR Ramachandran** "Sliding Wear Behaviour of Cast Al-Si Alloy Graphite Composites", 43rd Annual Tech. Meeting (IIM), Calcutta,1989
8. **A H Yegneswaran** "Deformation Behaviour of Cadmium and its Alloys", 43rd Annual Tech. Meeting (IIM), Calcutta, 1989
9. **S Das, R Dasgupta, S K Bose and R Kumar** "Microstructural Evolution of some Rapidly Solidified Aluminium Alloys", 43rd Annual Tech. Meeting, (IIM),Calcutta,1989
10. **S K Bose and R Dasgupta** "Wear of Rapidly Solidified Aluminium Alloys", 43rd AnnualTech.Meeting (IIM), Calcutta, 1989
11. **A C Khazanchi and T C Rao** "Recent Advances in Development of Natural Fibre Stems Composites in polymer Cement/Mud Matrices Composites for Construction Engg.", 1st Annual Gen. Meeting, MRS, NCL Pune,1990
12. **A C Khazanchi** "Recent Development in the use of Local and Agro-based Material for Housing", in the Seminar,CIAE,Bhopal,1990.

26. **B K Prasad, T K Dan and P K Rohtagi** "Pressure Die-Cast Al-Si Graphite Composites", Ibid.

27. **B K Prasad, S V Prasad and A A Das** "Material Removal Mechanisms and Microstructural Changes during Abrasion of Squeeze Cast Aluminium Alloy- Matrix Composites", Ibid.

28. **M Saxena, B K Prasad and T K Dan** "Corrosion Behaviour of 2014 Alloys & Graphite Particle Composites in various Environments" Ibid.

29. **S V Prasad and B K Prasad** "Abrasive Wear Mechanisms in Ceramic Particle Dispersed Aluminium Alloys", International Conference on Tribology of Composite Materials, ASM International,Oak Ridge, USA, 1990.

30. **B Govindarajan, J P Barnwal, M Vanangamudi and T C Rao** "Performance Studies on Industrial Coal Flotation Circuits", National Seminar on Performance Optimisation of Preparation Plants, Dhanbad, 1990.

31. **A C Khazanchi,R K Morchhale and Mohini Saxena** "Surface Modification of Plant Fibres for Development of Fibres in Cement/ Polymer/Clay Composites," International Conf. on Interfacial Phenomena in Composite Materials, Univ. of Sheffield, U.K., 1989.

32. **A C Khazanchi** "Structural Behaviour of Sisal-cum-Coir Fibre and their Application in Cement Corrugated Sheets", 7th ICCM Int. Conf. on Composites Materials, China, 1989.

33. **A C Khazanchi and R K Chauhan** "The Microstructure and Chemistry of Red Mud Cement and Concrete", Int. Conf. on Microstructure Chemistry, 1990

34. **B K Prasad** "Microstructural Modifications and Changes in Properties of an Al-Si-Graphite Composites by Heat Treatment", 7th CIMTEC World Ceramics Congress and Satellite Symposia, Italy, 1990.

35. **R K Rawelly and C B Raju** "Classification of Potash Bearing Fertilizer Minerals by DTA", 7th National Symposium on Thermal Analysis, REC, Jammu, 1989.

36. **K Basu, R S Solanki V S Muneswar A H Yegneswaran and A K Singh** "Squeeze Casting of Commercial Purity Aluminium and Lm-6 Alloy", Tech-89, International Seminar on Emerging Technology for New Metals, Material and Super Alloy, Hyderabad, 1989.

37. **R S Solanki V S Muneswar A H Yegneswaran and K Basu** "Structure-Property Relationship in Squeeze Cast Aluminium Alloys", Promat-89 Conference on Processing of Material- Critical Issues, IISc, Bangalore,1989.

38. **R S Solanki, A K Singh And Kunal Basu** "A High Energy Density Fusion Welding of Nodular Cast Irons", 25th National Welding Seminar, Bombay, 1990.

26. **B K Prasad, T K Dan and P K Rohtagi** "Pressure Die-Cast Al-Si Graphite Composites", Ibid.
27. **B K Prasad, S V Prasad and A A Das** "Material Removal Mechanisms and Microstructural Changes during Abrasion of Squeeze Cast Aluminium Alloy- Matrix Composites", Ibid.
28. **M Saxena, B K Prasad and T K Dan** "Corrosion Behaviour of 2014 Alloys & Graphite Particle Composites in various Environments" Ibid.
29. **S V Prasad and B K Prasad** "Abrasive Wear Mechanisms in Ceramic Particle Dispersed Aluminium Alloys", International Conference on Tribology of Composite Materials, ASM International,Oak Ridge, USA, 1990.
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31. **A C Khazanchi,R K Morchhale and Mohini Saxena** "Surface Modification of Plant Fibres for Development of Fibres in Cement/ Polymer/Clay Composites," International Conf. on Interfacial Phenomena in Composite Materials, Univ. of Sheffield, U.K., 1989.
32. **A C Khazanchi** "Structural Behaviour of Sisal-cum-Coir Fibre and their Application in Cement Corrugated Sheets", 7th ICCM Int. Conf. on Composites Materials, China, 1989.
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35. **R K Rawelly and C B Raju** "Classification of Potash Bearing Fertilizer Minerals by DTA", 7th National Symposium on Thermal Analysis, REC, Jammu, 1989.
36. **K Basu, R S Solanki V S Muneswar A H Yegneswaran and A K Singh** "Squeeze Casting of Commercial Purity Aluminium and Lm-6 Alloy", Tech-89, International Seminar on Emerging Technology for New Metals, Material and Super Alloy, Hyderabad, 1989.
37. **R S Solanki V S Muneswar A H Yegneswaran and K Basu** "Structure-Property Relationship in Squeeze Cast Aluminium Alloys", Promat-89 Conference on Processing of Material- Critical Issues, IISc, Bangalore,1989.
38. **R S Solanki, A K Singh And Kunal Basu** "A High Energy Density Fusion Welding of Nodular Cast Irons", 25th National Welding Seminar, Bombay, 1990.

39. **S Das, S K Bose,R Dasgupta,S V Prasad and R Kumar** "Tribological Behaviour and Structure of Advanced High Temperature Aluminium Alloys", Indo-US Workshop in Metal Sciences, Goa, 1989.
40. **S K Bose, R Dasgupta, S Das and A H Yegneshwaran** "Rapidly Solidified Alloys—A Commercial Assessment", International Conference on Aluminium (INCAL-91), Bangalore (Accepted).
41. **S K Bose,R Dasgupta** "Wear of Rapidly Solidified Al-Mn Alloy under Dry Sliding Conditions", Ibid
42. **M V R L Murthy and K V G K Gokhale** "Groundwater Modelling in Canal Command Areas-A Case study", All India Seminar on Groundwater Investigation, Management and Geophysical Techinques, Lucknow, 1990.
43. **T C Rao, S Sanjeev Rao and G M Rao** "Beneficiation of Indian Low Grade Phosphate Deposites-Problems and Prospects", 28th NMD and 44th ATM and the International Symposium on Materials for Advanced Technology Systems, Indian Institute of Metals, Tiruchirapalli, 1990.
44. **B K Prasad, O P Modi, S Das, A K Jha and A H Yagneswaran** "Low Stress Abrasion of 5132 Steel", 28th NMD and 44th ATM and the International Symposium on Materials for Advanced Technology Systems, Indian Institute of Metals, Tiruchirapalli, 1990
45. **S P Narayan, R J Singh, O N Mohanty and S V Prasad** "Effect of Heat Treatment on Magnetic Properties of HSLA Steel", 28th NMD and 44th ATM and the International Symposium on Materials for Advanced Technology Systems", Indian Institute of Metals, Tiruchirapalli, 1990
46. **A K Gupta, B K Saxena, S N Tiwari and S L Malhotra** "Studies on Morphology of Shrinkage Defects in Aluminium Copper Alloy Castings", 28th NMD and 44th ATM and the International Symposium on Materials for Advanced Technology Systems, Indian Institute of Metals, Tiruchirapalli, 1990

APPENDIX - 6

LECTURES BY OUTSIDE EXPERTS AT RRL, BHOPAL

1. Dr. Som R Soni, Chief Executive Officer, Ad Tech Systems Research Inc. Dayton, OH, USA on **"Automated Systems for Composite Materials Analysis"**.
2. Dr. SS Narayan, Madras on **"Optimisation through Mathematical Modelling and Simulation in Minerals Processing"**.
3. Dr. RL Sonalikar, Reader,LIT Nagpur **"Application of Magnetic Fields in Mineral Preparation"**
4. Shri TN Jaggi, Former Chairman-cum-Managing Director, Pyrites,Phosphates and Chemicals Ltd.", **Evaluation of Indian Phosphate Rock as Resource for Phosphate Fertilizers"**
5. Prof. TS Murty, Former Vice-Chancellor, Sagar University **Interferometry Techniques in Materials Science"**
6. Dr. RS Kapil, Director, RRL Jammu, **"Medicinal and Aromatic Plants of MP"**
7. Prof. DS Bhargava, University of Roorkee **"Environmental Awareness "**
8. Prof. ES Dwarkadasa, IISc, Bangalore, **"High Strength Spinodal Alloys, Development of Al-Li alloys"**
9. Shri PR Rao, Scientist, DOA, Ministry of Defence, Bangalore, **"How to Introduce a Product through R&D"**.
10. Mr. Braham Prakash, ITMMEC, IIT Delhi delivered a lecture on **"Systematic Approach to Friction and Wear Studies of Materials"**
11. Mr. Braham Prakash, ITMMEC, IIT Delhi delivered a lecture on **"Bearing Material and their Performance"**
12. Shri RN Bhargava, Adviser (Planning), CSIR, New Delhi delivered a talk on **"R&D Management, CSIR Overview and Eighth Plan Approach"** on Sept.10,1990
13. Mr. C.V. Sundaram, Former Director, IGCAR, Kalpakkam **"Materials in Nuclear Power Generation"** on Oct. 12, 1990
14. Mr. Harsh Mandar, Managing Director,M.P. Antyavasayee Development Corporation,Seminar on **"Various Prospects of Research for The Welfare of Scheduled Castes and Scheduled Tribes"** on Oct.31,1990

APPENDIX - 7

INVITED LECTURES BY RRL SCIENTISTS

1. Prof. TC Rao, delivered lectures on following topics at **"Refresher Course on Ore Beneficiation** at IBM Nagpur :
   "Application of Computers in the Field of Ore Beneficiation"
   "Selection and Control of Classifier with Special Emphasis on Cyclones"
2. Prof.TC Rao delivered lectures on "**Classification Techniques**' during the short term refreshercourse on "**Mineral Classification and Concentration**", IIME, Puri
3. Dr. AK Gupta, "**Casting Defects - A Case Study in Aluminium Alloy Castings**", IIF, Bhopal Chapter, Bhopal
4. Shri AC Khazanchi, "**Materials Characterisation, National Seminar on Autoclaved Calcium Products**", CBRI, Roorkee
5. Dr. AH Yegneswaran, "**Materials Science R&D Activities at RRL Bhopal**" at International Workshop on Physics of Materials, Barkatuollah University, Bhopal
6. Shri AC Khazanchi, "**CSIR Thrust Area Programmes and Technologies National Dialogue for Promotion of Innovative Housing**", Ministry of Urban Development, New Delhi
7. Dr. RN Yadava, "**Energetics of Particle Transfer into Liquid Melts**", National workshop on Modelling of Metallurgical processes, NML, Jamshedpur
8. Dr (Ms) Mohini Saxena,"**Natural fibres**" Nutan College, Bhopal
9. Prof. TC Rao, "**Modelling of Fine Coal Preparation Processes**" Dept. of Materials Science & Mineral Engg., University of California, Berkeley, USA
10. Dr RN Yadava, Radio Talk on "**Computers in Scientific Research**"
11. Dr. Navin Chandra", **Applications of Ion Sensitive Electrodes to Pollution Monitoring**" IT,BHU, Varanasi
12. Shri AC Khazanchi, "**Use of Local Plant Based Materials and Agricultural Wastes in Housing**", CIAE, Bhopal
13. Dr. Kunal Basu, "**Squeeze Casting Technology to Automobile Engineering Industry**", EF Ltd., Aluminium Foundry
14. Dr. A.K. Gupta, "**Bell Metal Casting Technology by Tribals of MP in Bastar Region**", IIF, Bhopal Chapter, Bhopal
15. Dr. Navin Chandra, "**Fundamentals of Corrosion & Methods of Prevention**",Trng. Prog. on Cor., BHEL, Bhopal

APPENDIX - 8

INTERNAL SEMINARS

1. Shri S K Bose: **Ferrites,** Jan.25,1990
2. Shri A C Khazanchi: **Recent Development in Building Material for Low Cost Housing**,Feb.22,1990
3. Dr. R.N. Yadava: **Modelling in Particulate Composites,** March 2,1990
4. Dr. Navin Chandra: **Ion Sensitive Electrodes**, March 9,1990
5. Dr. Kunal Basu: **Squeeze Casting of Al Alloys,** March 23,1990
6. Dr. C B Raju : **Ceramic Materials from Minerals of MP**, April 20,1990
7. Shri P D Ekbote :**Creativity Analysis in R&D Management,** April 30,1990
8. Dr.A H Yegneswaran : **Metal Matrix Composites,** May 4,1990
9. Shri S P Narayan : **Magnetic Materials Processing and their Application,** May 11,1990
10. Dr.Navin Chand : **Natural Fibre and Ipomea — the Potential Plant Materials of Madhya Pradesh,** May 18,1990
11. Dr. A K Jha : **Dry sliding Wear of Al-Composites,** June 1,1990
12. Dr.S Das : **Microstructure and Wear of Al-Si Alloy Graphite Composite,** June 8,1990
13. Shri O P Modi: **Aluminium Alloys SiC Particulate Composites,** June 22, 1990
14. Dr.(Ms) Mohini Saxena : **Corrosion Characteristics of 2014 Al-Alloy and 2014 3wt% Graphite Particulate Composite in Different Environments**, June 28,1990
15. Mr. B K Prasad : **Zinc Aluminium Based Alloys - A Review of the Status**, July 5,1990
16. Mr.S S Amrithphale : **Ceramic & Refractory Materials from Pyrophyllite** on July 19, 1990
17. Dr.R K Rawlley : **Potash in the Agriculture on** July 26,1990
18. Dr. MVRL Murthy : **Ground water Resources Evaluation through Modelling**, July 31, 1990.
19. Dr. A K Gupta, **Shrinkage Defects in Al-Casting,** Oct.26,1990

20. Mr.B.Govindarajan, **Modelling of Coal Flotation Operations** in the Fourth Review Meeting of Indo-US STI Programme, held at RRL, Bhopal on Oct. 12-13, 1990

21. Mr. V S Muneshwar: **Effect of Aluminium on Hand and Brittle Cast from Microstructure,** Nov. 1,1990
22. Mr. L C Mohan: **Quality Circle**, Nov. 8, 1990
23. Mr. S A R Hashmi: **Rheology of Polymers**, Nov. 22, 1990

APPENDIX - 9

PATENTS NEWS

A process for the Manufacture of Aluminium graphite particulate Composite using uncoated Graphite particles for Automobile and Engineering Applications; P K Rohtagi, T K Dan, S C Arya, S V Prasad, S Das, A K Gupta, B K Prasad and A K Jha, US Patent No. 4946647 w.e.f. Aug. 7, 1990 for a period of 17 years and UK patent No. 2194799 w.e.f. March 14, 1990 for a period of 20 years.

Patents Filed

1. 497/DEL/89 : A Process for making Unglazed Ceramic Tiles from Pyrophyllite : S S Amritphale, Navin Chandra, A K Singh and R Kumar
2. 949/DEL/89 : A Process for the Preparation of Cementitious Binder from Aluminium Industries Waste-red Mud: R K Chauhan and A C Khazanchi
3. 1240/DEL/89 : A Process for the Production of Bricks : A C Khazanchi, S R Karade and C B Raju
4. 1241/DEL/89 : A Process for the Preparation of Roof and Wall Covering from Natural Fibre Reinforced Red Mud, Fly Ash in Polymer Matrix, A C Khazanchi , M K patel and M Saxena
5. 1242/DEL/89 : An Improved Process for the Treatment of Plant Material for Making them useful as Reinforcement in Matrices Clay/Cement/Polymer : M Saxena,R K Morchalle and A C Khazanchi
6. 1251/DEL/89 : A Process for the Improvement and Modification of Wastement and Desert Soils from Thermal Power Plants Waste Fly Ash for Conversion in to Productive Land Mas : A C Khazanchi,A Chauhan,S Sethi and T C Rao
7. 836/DEL/89 : A Process for the Production of Short Ceramic Fibre of A12O3 and Nitrides of Aluminium and Silicon ,C B Raju, Jose James and T C Rao

APPENDIX - 10

MEMBERSHIPS AND RECOGNITION OF SCIENTISTS OF RRL, BHOPAL

Prof. T.C.Rao

- Member **Standing Scientific Research Committee for S&T Projects in Coal Sector**, Ministry of Energy, Dept. of Coal, Govt. of India.
- Member **Steering Group on Establishment of Nickel Production Facilities**, CSIR.
- Member **Working Committee on Research (a sub-committee of the Governing Council)**, Central Power Research Institute, Bangalore.
- Member **Advisory Board for Indian Bureau of Mines**, Ministry of Steel and Mines, Dept.of Mines. Govt. of India.
- Member **Standing Science Advisory Group**,Ministry of Steel and Mines, Govt. of India.
- Member **Committee for Selection of National Consultant for UNDP assisted Project IND/86 040- Establishment of Modern Mineral Processing Lab. at Nagpur**, Ministry of Steel & Mines, Dept. of Mines, Govt, of India.
- Regional Editor **Minerals Engineering**, International Journal published by Pergamon Press, U.S.A.
- Member Editorial Board **Coal Preparation**, Multinational Journal published by Gordon and Breach Science Publications, New York
- Member **Advisory Committee**, Hindustan Zinc Limited, Udaipur
- Member **Industrial Metallurgy Division Council**, IIM, Calcutta

Shri A.C. Khazanchi

- Member **Organising Committee of the 4th Conference of Asian and Pacific Congress on Strength Evaluation (APC-91)**, Beijing, China

Dr.Kunal Basu

- Fellow **Institution of Engineers (India)**.
- Received an award for **best presentation of technical paper** during the 43rd Annual Technical Meeting of the IIM held at Calcutta between 14th and 17th Nov.,1989

Dr. S Das

Awarded **certificate** by IIM in the Metallographic Contest during the 43rd Annual Technical Meeting of the IIM held at Calcutta between 14th and 17th Nov., 1989

Dr. Navin Chandra, Shri B Kujur and Shri M K Ban

Awarded **certificate of merit** for the paper "Monitoring and Control of Pollutants Fluoride Ions" presented at the sixth National Convention of Environmental Engineers and seminar on Environment and Ecology-Indian Scenario by the Institution of Engineers India, Ranchi Local Centre

Dr. Mohini Saxena

- Member **Editorial Advisory Board**, Scientist of Physical Sciences, Bhopal

Dr. Navin Chandra

- Member **SEED Programme Sponsored by Department of Non-Conventional Energy Sources**, Macromolecular Research Centre, Jabalpur

Shri B K Saxena and Dr. A K Gupta

- Awarded for the **best presentation** on his paper "Studies on Morphology of Shrinkage Defects in Aluminium Copper Alloy Castings" in the Poster session of 28th NMD and 44th ATM and the International Symposium on Materials for Advanced Technology Systems Held at Tiruchirapalli on Nov.14-17,1990 organised by Indian Institute of Metals.

APPENDIX - 11

WORKSHOPS/ CONFERENCES/ MEETINGS ATTENDED

1. Dr.Navin Chandra, "Fourth International Symposia on Frontiers of Electro-Chemistry", SAEST & CECRI, Madras, Nov, 1989
2. Shri O.P Modi, workshop on "Wear and Erosion of Materials in Thermal Power Stations", CPRI, Bangalore, Dec, 1989
3. Dr. RK Rawlley and Shri M Prasad, short term refresher course on "Mineral Classification and Concentration", Indian Institute of Mineral Engineers, Puri, Dec, 1989
4. Shri AC Khazanchi, national seminar on "Autoclaved Calcium Products", CBRI, Roorkee ,New Delhi, Jan.,1990
5. Shri AC Khazanchi, Shri OP Modi, Shri BK Prasad and Dr (Ms) Mohini Saxena, international conference on "Advances in Composite Materials", ASM International India Chapter, Bombay, Jan, 1990
6. Dr. RN Yadava and Shri AK Singh, workshop on "Mathematical Modelling of Metallurgical Processes", NML, Jamshedpur, Jan, 1990
7. Dr. AH Yegneswaran, "38th Annual Convention", Institute of Indian Foundrymen", Baroda, Jan, 1990
8. Prof. TC Rao, Dr. AH Yegneswaran and Dr. Navin Chand international workshop on "Physics of Materials", Barkatullah University, Bhopal, Jan, 1990
9. Shri PD Ekbote, 2nd Annual Business Meeting on "Marketing CSIR Knowledge Bases", NCL, Pune, Jan, 1990
10. Shri AC Khazanchi, Shri SP Narayan, Shri VS Muneshwar and Miss Rupa Dasgupta, "Annual General Meeting of MRSI", NCL, Pune, Feb, 1990
11. Prof. TC Rao and Dr. CB Raju, "SSAG Meeting of Department of Mines", New Delhi, Feb, 1990
12. Shri AC Khazanchi, Shri BK Saxena and Dr (Ms) Mohini Saxena, "Meeting of Nodal Committee for Training at CSIR", New Delhi, Feb, 1990
13. Dr. Navin Chand, "XI International Congress on Use of Plastics in Agriculture", New Delhi, Feb, 1990
14. Dr. Navin Chand and Shri SAR Hashmi, international conference on "Plast India", New Delhi, Mar, 1990

15. Shri AC Khazanchi, 1st meeting of nodal committee "Action Plan on Low Cost Building Materials and Housing", New Delhi, Mar, 1990
16. Dr. MVRL Murthy, international workshop on "Ground Water", NGRI, Hyderabad, Mar, 1990
17. Dr. S Das, workshop on "Testing and Characterisation of Materials", Bombay, Mar, 1990
18. Dr. CB Raju, CSIR scientists and entrepreneurs meet on "Utilization of Fly Ash", Balco, Korba, Mar, 1990
19. Shri SP Mukherjee and Dr. AK Jha, "Working Committee Meeting", Centra Board of Irrigation and Power, New Delhi, Apr, 1990
20. Dr. AH Yegneswaran, workshop on "Residual Life Assessment of Therma Power Plant Components and their Rehabilitation", BHEL, US aid and NP New Delhi, Apr, 1990.
21. Dr. AH Yegneswaran and Dr. AK Jha, lectures on "Falex Machine and Tribo Research", Tribo Tech, New Delhi, Apr, 1990.
22. Dr. AK Jha and Shri Mukherjee, meeting at CBIP New Delhi, Apr, 1990
23. Shri AC Khazanchi and Dr. CB Raju, "2nd Advisory Committee Meeting", CBIP, New Delhi, May, 1990
24. Shri SK Bose, "Meeting on MMCs", IISc, Bangalore, May, 1990
25. Dr. Navin Chandra, "Sixth National Convention of Environmental Engineer and Seminar on Environment and Ecology", IIE, Ranchi, Sept, 1990
26. Dr.RN Yadava, meeting on "Business Meeting on Marketing of CSIR Software", SERC,Madras, Oct,1990
27. Dr.Navin Chandra, Seminar on "Atomic Absorption Inductively Coupled Plasma and Optical Emission Spectroscopy", GBC and NULAB, New Delhi, Nov, 1990
28. Prof. TC Rao, Dr. Kunal Basu, Dr.AH Yegneswarwan, Shri SP Narayan, Dr. AK Gupta and Shri K Venkateswarlu, 28th NMDand 44thATM and the InternationalSymposium on Materials for Advanced Technology Systems, Indian Institute of Metals, Tiruchirapalli, Nov.1990,
29. Dr. K Basu and Shri K Venkateswarlu, Metallographic Contest 28th NMD and 44th ATM and the International Symposium on Materials for Advance Technology Systems, Indian Institute of Metals, Tiruchirapalli,Nov,1990.

APPENDIX - 12

HIGHER EDUCATION AND TRAINING COURSES ATTENDED BY SCIENTISTS OF RRL, BHOPAL

Mr. S Das has been awarded Ph.D. by IIT, Kanpur for his thesis "Microstructure and Wear of Al-Si Alloy Graphite Composites". His work was supervised by Dr. S.V. Prasad, Scientist-E, RRL and Prof. T.R. Ramachandran at IIT, Kanpur.

Mr. AK Gupta received his Ph.D from BHU, Varanasi, on his thesis "Studies of Shrinkage Defects in Aluminium Alloy Castings".

TRAINING COURSES

4th CSIR-BITS Orientation Training Course for Scientist-B was attended by Ms Rupa Dasgupta, Shri S A R Hashmi and Shri V S Muneshwar

APPENDIX - 13

STAFF NEWS

1. Dr. S V Prasad,Scientist-E, resigned (Jan.18,1990)
2. Shri.G K Bhatnagar,Section Officer transferred to CSIR Complex, Palampur, as Administrative Officer (March 5,1990)
3. Shri. G G Nair,Scientist, retired on superannuation (March 31,1990)
4. Shri. B R Channan,COA,transferred to PID, New Delhi (April 16,1990)
5. Shri S K Tiwari,Senior Librarian, resigned (23rd Aug. 90)
6. Ms. V Sayee Lakshmi,Senior Stenographer, resigned (10th Oct. 90)

APPENDIX - 14

MEMBERS OF STAFF OF RRL, BHOPAL

Prof. T.C. Rao	Director

BUILDING MATERIALS

Mr. A.C. Khazanchi	Scientist F
Dr. (Ms) M. Saxena	Scientist B
Mr. R.K. Morchale	Scientist B
Mrs.Alka Meshram	Scientist B
Mr. J. Prabakar	Scientist B
Mr. S.R Karade	SLA/Gr.II(2)
Mr. Rajinder Singh	SRF
Ms. Jaspal Kaur	SRF
Ms. Aparna Chauhan	SRF
Mr. V.K. Gupta	JRF
Mr. Ajay Kulshresth	JSA/Gr.III(1)
Ms. Mini Mol	Senior Stenographer
Mr. S.K. Botham	Helper/Gr.I(1)

METALLURGY & MATERIALS

Dr. Kunal Basu	Scientist-F
Mr. S.K. Bose	Scientist-E II
Mr. B.K. Saxena	Scientist-E II
Dr. Navin Chandra	Scientist-E I
Mr. S.P. Mukharjee	Scientist-C
Dr. A.H.Yegneshwaran	Scientist-C
Dr. Navin Chand	Scientist-C
Mr. S.P. Narayan	Scientist-C
Mr. R.S. Solanki	Scientist-C
Dr. A.K. Jha	Scientist-C
Mr. O.P. Modi	Scientist-C
Dr. S. Das	Scientist-C
Mr. L.C. Mohan	Scientist-C
Mr. B.K. Prasad	Scientist-B
Mr. V.S. Muneshwar	Scientist-B
Mr. A.K. Singh	Scientist-B
Ms. Rupa Dasgupta	Scientist-B
Mr. S.A.R. Hashmi	Scientist-B

Dr. A.K. Gupta	Scientist-B
Mr. M.K. Ban	JSA/Gr.III(1)
Mr. T.S.V.Ch. Rao	JTA/Gr.III(1)
Mr. K.Venkat	JTA/Gr.III(1)
Mr. P.K. Rangari	SLA/Gr.II(2)
Mr. P.N. Patil	Lab Assistant/Gr.II(1)
Mr. D.K. Singh	Technician/Gr.II(1)
Mr. Indraj Yadava	Junior Security Guard
Mr. G.B. Gurang	Junior Security Guard

MINERALS

Dr. C.B. Raju	Scientist-C
Mr. K.K.S. Gautam	Scientist-C
Mr. B.Govindarajan	Scientist-C
Mr. J.P. Barnwal	Scientist-C
Mr. S.S.Amritpale	Scientist-B
Dr. R.K. Rawlley	Scientist-B
Mr. Murari Prasad	Scientist-B
Dr. Jose James	Scientist-B
Mr. Sanjeeva Rao	Scientist-B
Mr. S.P. Pathak	Scientist-B
Mr. A.K. Majumdar	Scientist-B
Mr. P. Banerjee	SSA/Gr.III(2)
Mr. B. Kujur	SSA/Gr.III(2)
Mr. B. Ranganath Rao	SRF
Mr. K. Srinivas	JSA/Gr.III(1)
Mr. J. Konar	JTA/Gr.III(1)
Mr. P.C. Meshram	SLA/Gr.II(2)
Mr. B.L. Pradhan	Helper/Gr.I(1)

RESOURCES DEVELOPMENT

Dr. R.N. Yadava	Scientist-E
Mr. P.D. Ekbote	Scientist-C
Dr. M.V.R.L. Murthy	Scientist-C
Dr. (Mrs.) Arati Roy	Scientist-B
Mrs.Deepa Choudhary	Program Assistant
Mr. Rishi Kumar	Librarian
Mr. Abhay Yadava	Roneo Operator/Gr.II(1)
Mr. Samdarsi Pali	Cataloguer/Gr.II(1)

DIRECTOR'S SECTION

Mr. T.P. Prasanan	Senior Personal Assistant (Adhoc)
Ms. Manisha Dubey	Hindi Translator
Mr. Vishwanathan.N.	Senior Stenographer
Mrs.Sathi Vijayan	Senior Stenographer (Adhoc)
Mr. R.N. Pradhan	Junior Security Guard

ENGINEERING SERVICES

Civil

Mr. R. Dubey	AEE(Civil)/Gr.V(A)(4)
Mr. N. Saha	Senior Draughtsman/Gr.III(2)
Mr. R.K. Chauhan	JTA/Gr.III(1)
Mr. M. Gurjar	Plumber/Gr.II(1)
Mr. V. Anthony	Junior Security Gurd

Electrical

Mr. M.K. Jain	JE(Elect)/Gr.V(A)(1)
Mr. Manik Chandra	STA/Gr.III(2)
Mr. Akhter Ullah	Electrician/Gr.II(1)
Mr. Vijay Golait	Messenger

WORKSHOP & TRANSPORT

Mr. L.C. Mohan	Scientist-C
Mr. J.P. Pandey	Foreman/Gr.III(1)
Mr. Ujjwal Mukut	SLA/Gr.II(2)
Mr. Ramesh Kosthi	SLA/Gr.II(2)
Mr. Nehru Ram	Technician/Gr.II(1)
Mr. Arvindra K. Asthe	Technician/Gr.II(1)
Mr. R.K. Gurjar	Lab Assistant/Gr.II(1)
Mr. Bharat Patil	Mechanic/Gr.II(1)
Mr. Md. Rafiq	Driver/Gr.II(1)
Mr. Ramcharan Malvi	Driver/Gr.II(1)
Mr. G.S. Yadav	Driver/Gr.II(1)
Mr. L.N. Sahu	Helper/Gr.I(1)

ADMINISTRATION, STORES & PURCHASE

Mr. C.S. Shanmughom	Administrative Officer
Mrs.Shyamala Soman	Senior Stenographer
Ms. Asha Trivedi	UDC(Adhoc)
Mr. K.P.Tripathi	Junior Security Guard

Estt. Section

Mr. B.N. Dikshit	Section Officer
Mr. R.N. Ram	Assistant
Mr. P.K. Srivastava	Assistant
Mr. Jaypal Kujur	LDC
Mr. Satish Kumar	Helper/Gr.I(1)

General Section

Mr. S.V. Sarma	Section Officer
Mr. H.N. Rao	Lab. Supervisor/Gr.III(1)
Mr. B.C. Pal	Assistant
Mr. N.K. Pethari	LDC
Mr. Anil Gond	Messenger
Mr. Arun Saxena	Guest House Keeper
Mr. G.D. Sootha	Cook-Cum-Bearer
Mr. Devilal Junior	Security Guard
Mr. Dayaram	Safaiwala

Stores & Purchase

Mr. Sikander Sultan	Dy. Stores & Purchase Offic
Mr. Girish Chand	UDC
Mr. D.M. Chilbule	Stores Purchase Assistant
Mr. R.N. Sharma	Stores Attendent
Mr. Harihar Singh	Junior Security Guard

FINANCE & ACCOUNTS

Mr. B.D. Jha	Finance & Accounts Officer
Mr. P.K. Satyanesen	Assistant F&A (Adhoc)
Mr. C.V.B. Subramanian	LDC
Mr. N.S. Jadav	LDC(Adhoc)

APPENDIX - 15

RRL YEAR NOTES, 1989 and 1990

- Early '89: CSIR Society decides to retain RRL Bhopal in CSIR
- July '89: Dr. Rajendra Kumar, Director, retires on attaining superannuation
- Sept '89: Research Council and Management Council constituted
- Oct. '89: Prof. T.C. Rao joins as Director
- Nov. '89: Dr. A.P. Mitra, DGSIR visits RRL; First Meeting of RC held; High Power Committee for Master Plan constituted
- Early '90: Four major areas are identified for the laboratory and organised as :

  Minerals

  Building Materials

  Metallurgy & Materials

  Resources Development
- Round table discussions on "Mineral Resources of MP" held. Shri P.K. Lahiri, Secretary, Dept. of Mines, GOI, chaired and guided the deliberations.
- Intensive interaction with Dept. of Mines, Ministry of Urban Development, HUDCO, DMRL, BHEL, BALCO, ISRO, DST, M.P. State Agencies, M.P. Council of Science & Technology, CBIP, NTPC, etc.
- Series of meetings held with participation of external agencies related to Tribological studies in mining sector; Ferrites from Blue Dust; Natural Resources Data Management System (NRDMS)
- April-May '90: Projects from Dept. of Mines, BHEL, Ministry of Urban Development, MAPCOST approved
- VIII Plan proposals submitted to CSIR
- RC meets twice (Feb. and Oct. 90); Area-wise review of R&D projects started
- MC meets four times (Feb., July, October and December '90