

वार्षिक प्रतिवेदन

**ANNUAL
REPORT**

1993-94

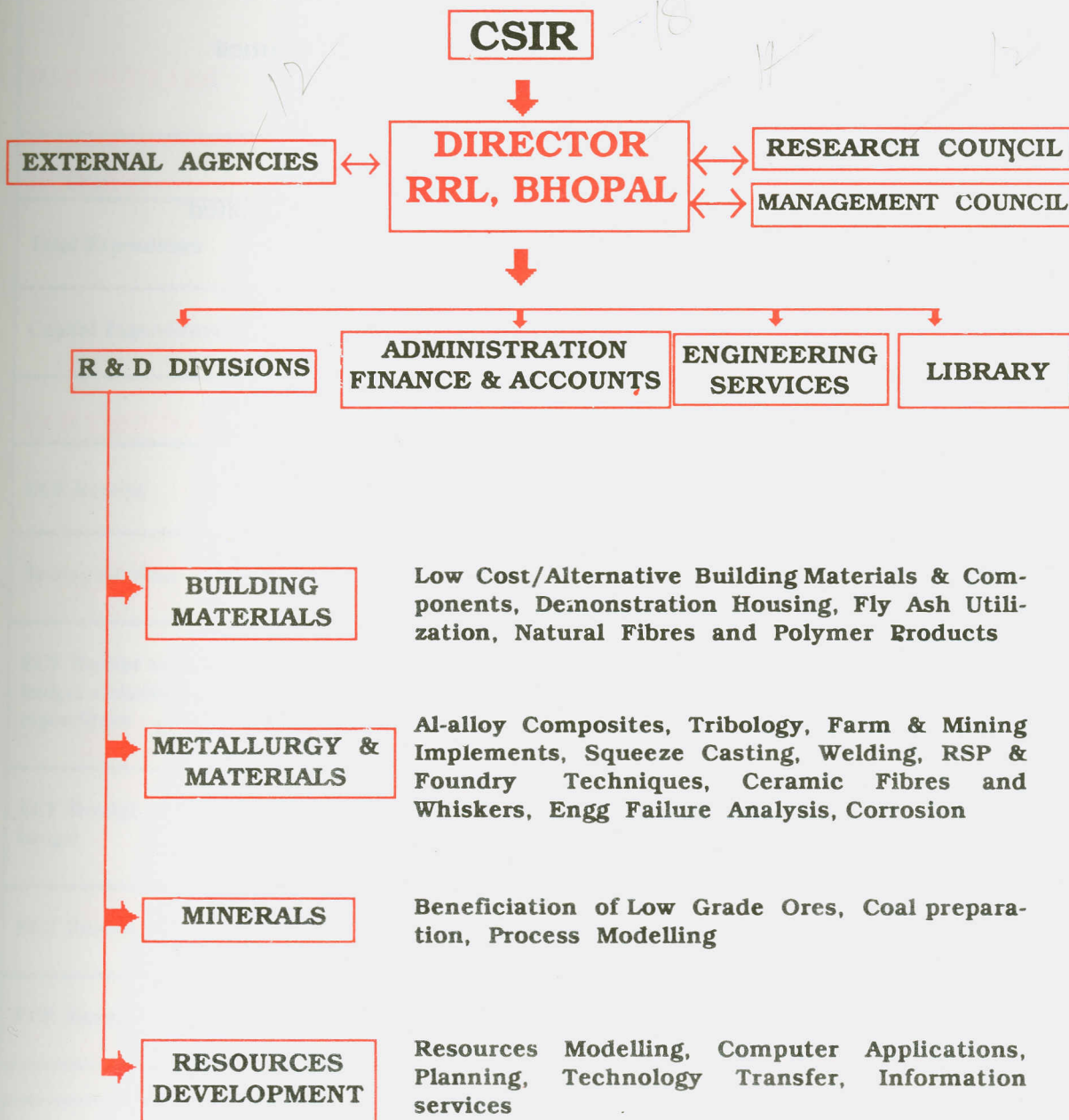


**REGIONAL RESEARCH LABORATORY
BHOPAL**

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ORGANIZATION CHART



LIST OF ABBREVIATIONS USED

BHEL	Bharat Heavy Electricals Limited
BMTPC	Building Materials Technology Promotion Council
CBIP	Central Board of Irrigation and Power
CGWB	Central Ground Water Board
CIAE	Central Institute of Agricultural Engineering
CMPDIL	Central Mine Planning and Design Institute Limited
CPWD	Central Public Works Department
CSIR	Council of Scientific and Industrial Research
DAE	Department of Atomic Energy
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
ICAR	Indian Council of Agricultural Research
IISc	Indian Institute of Science, Bangalore
ISM	Indian School of Mines, Dhanbad
ISRO	Indian Space Research Organisation
NABARD	National Bank for Agricultural and Rural Development
NBO	National Building Organisation
NMDC	National Mineral Development Corporation
NTPC	National Thermal Power Corporation
OCL	Orient Cerawool Limited, Lakhtar
MOUD	Ministry of Urban Development
MPCOST	M.P. Council of Science & Technology
MPSMC	M.P. State Mining Corporation
PHED	Public Health Engineering Department
PWL	Permal Wallace Limited, Bhopal
TADA	Tawa Ayacut Development Authority
TISCO	Tata Iron & Steel Company
VRDE	Vehicle Research & Development Establishment

SOME MAJOR INDICATORS ON INPUTS

(Rs. in Lakhs)

PARTICULARS	YEARS			
	1990-91	1991-92	1992-93	1993-94
BUDGET				
Total Expenditure	157.339	172.657	219.248	265.690
Capital Expenditure	76.101	83.710	102.900	114.690
ECF TREND ANALYSIS				
ECF Receipt	17.015	37.224	45.600	127.025
Testing Services	0.352	0.126	5.470	1.051
ECF Receipt as percentage of budget excluding capital expenditure	21.000	41.800	39.000	61.01
ECF Receipt as percentage of total budget	10.800	21.500	20.700	37.800
ECF Receipt per Scientist (Gr.IV)	0.500	0.930	1.140	2.880
ECF Receipt per person employed	0.150	0.298	0.368	0.758
Gr. IV Scientists (Nos.)	34	41	40	43

ECF-External Cash Flow on account of externally funded projects

A BRIEF ON R&D HIGHLIGHTS

S.No.	Brief description	Present status
1.	FRP Gear Case for Traction Motors (for 2600 hp locomotives of Indian Railways)	Six gear cases were handed over to BHEL on 26.2.94, signifying the successful completion of the MoU amongst BHEL, PWL, and RRL. Gear cases have been sent to RDSO for field trials by RRL.
2.	Coal Washeries Performance Improvement Studies for TISCO	<ul style="list-style-type: none"> • 400 mm Vorsyl Separator (made of MS) installed, parallel to existing HM cyclone. • Increased yield 50.17% (44% with existing HM cyclone) at 17.3% ash recorded for the same feed coal. • Signifies extra 50 Tpd of clean coal without any additional costs. • Prototype unit is being regularly used and around 1500T of raw coal processed in presence of RRL Scientists. • TISCO to procure Vorsyl Separator made of Ni hard for regular operations.
3.	Wood Substitute Programme	<ul style="list-style-type: none"> • RMP door certified for performance (CPWD-TADS-1) • Agreements for technology-transfer signed with two parties for commercial production.
4.	Ceramic Fibre Preforms	<ul style="list-style-type: none"> • Agreement for commercial production at M/s OCL, Lakhtar worked out. • First orders (Rs.35000/-) placed at M/s OCL by IIT, Madras.

5. Aluminium Alloy SiC Particulate Composite, Brake Drum for Janga Jeep
 - Performance evaluation underway at VRDI Ahmednagar.
 - Preliminary trials indicate an efficiency of 30.9% at an initial speed of 50 km/hr (cast iron drum speed 30.9%). Temp. rise after 35 Nos. of brake applications is 95°C compared to 147°C for iron drum under identical conditions.
6. SLIZ Alloys for Bearing Applications
 - Agreement made with M/s Rasmi Die Castings Ltd., Secunderabad (Jan.13, 1994).
 - Bearings of different sizes have been produced and sent to different mines and user industries for field trials.
7. Pilot Plant Trials on Low Grade Rock Phosphate Beneficiation
 - Prefeasibility studies have been carried out and indicate comparable costs of concentrates with imported rock phosphates.
8. Pilot Project on Wasteland Development for NTPC, Rihand Nagar
 - Significant success observed on 2.5 acre site cultivation of wheat, sunflower and vegetables. Discussions held with NTPC officials on extension of the activities into national project aimed at generating scientific information on a large number of sites at different power stations.
9. Ground Water Resources Management
 - A working model developed for Tawa command area and the ground water potential is estimated in different zones of study area.
 - A project for field implementation in Khara village within the above project area is financially supported by Govt. of M.P.
 - Advisory work on location, type and design of water conservation structures to meet peak summer drinking water demands in problem villages of Dhar dist, M.P.

LINKAGES

Central Govt. Depts., Agencies, Institutions

Department of Mines, Indian Bureau of Mines, Department of Science and Technology, Department of Atomic Energy, Ministry of Urban Development, Housing and Urban Development Corporation, Indian Space Research Organisation, Defence Metallurgical Research Laboratory, Indian Council of Agricultural Research, Central Institute of Agricultural Engineering, Central Ground Water Board, National Bank for Agricultural and Rural Development, Indian Institute of Science, Indian School of Mines, Building Materials and Technology Promotion Council, Central Public Works Department, National Building Organisation, UNICEF.

Madhya Pradesh State Agencies

Madhya Pradesh Council of Science and Technology, Madhya Pradesh State Mining Corporation, Water Resources Department, Public Health Engineering Department, District Administration in Tribal Regions.

Industrial Sector including PSE's, Private and Local Industry

Bharat Heavy Electricals Limited, Bharat Aluminium Company, Central Mine Planning and Design Institute Limited, National Thermal Power Corporation, National Mineral Development Corporation, Hindustan Zinc Limited, Computer Maintenance Corporation, TISCO, M/s Orient Cerwool Limited, M/s Permali Wallace Limited, Pyrites, Phosphates, Chemicals Limited, M/s Diamond Cements Ltd. Damoh, M/s Rasmi Diecasting Ltd. Hyderabad, M/s Atlas Automotive Components Ltd. Pune.



**Chief Minister's visit
Shri Digvijay Singh addressing a meeting during
his visit to RRL**



**Prof. T.C. Rao, Director RRL Bhopal, showing the RESCA brake drum
to Shri Digvijay Singh**



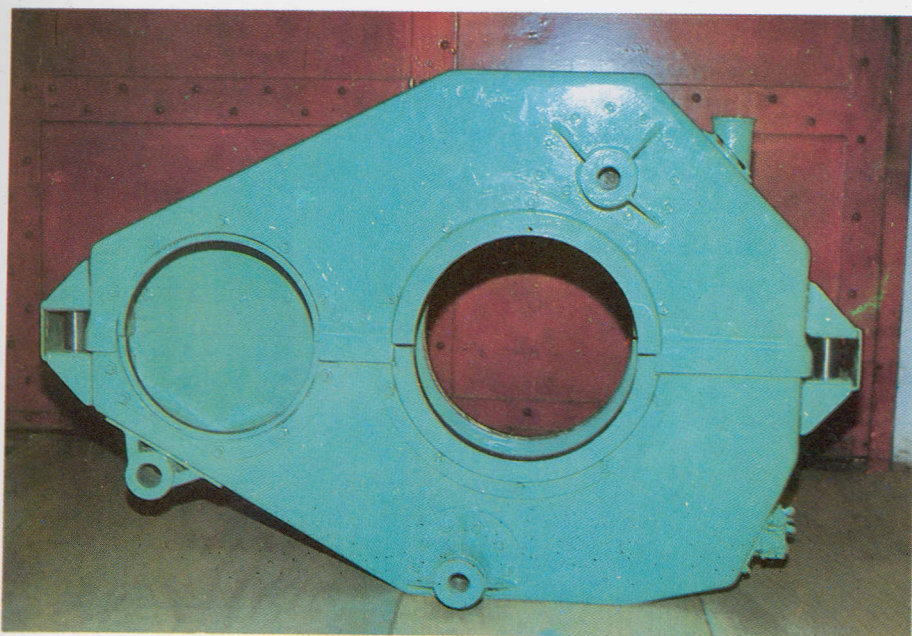
Shri B.K. Rao, Advisor NFTDC and Former Secretary, Dept. of Mines, Govt. of India, was the Chief Guest on the CSIR Foundation Day Celebrations on Sept. 2, 1984. Shri B.K. Saxena, Scientist, RRL received a memento on completion of 30 yrs. in CSIR.



Dr. P. Rama Rao, Chairman Research Council, in the Building Materials Division, CSIR, Dr. T.N. Gupta, Executive Director BMTPC, and Prof. T.C. Rao are also present. The cabins in the background are made of the RMP wood substitute material developed by RRL.



Shri S.K. Handa, Executive Director BHEL Bhopal and Prof. T.C. Rao exchanging documents of supply of FRP gear cases for traction motors of locomotives for Indian Railways.



A view of the FRP gear case. Six such cases were sent by BHEL to RDSO at DLW Varanasi for field trials

FOREWORD



It is a great pleasure to present the Annual Report 1993-94 of the Regional Research Laboratory, Bhopal.

In consonance with the objective of providing meaningful interactive basis to R&D programmes, significant efforts have been made to carry out specific technology development projects in association with user agencies and in particular the industrial sector. The following interesting developments have provided a new fillip to the R&D endeavour of the laboratory:

- * Development of FRP gear case for traction motors for 2500 hp locomotives of Indian Railways;
- * Red mud polymer based wood substitutes;
- * Pilot project on wasteland development at NTPC, Rihandnagar

- * Metal matrix composite materials, ceramic fibre preforms, Al-Si drums, and Z-A alloy based bearing materials;
- * Coal washeries performance improvement studies for TISCO circuit modeling studies for HZL; and
- * Interactions with UNICEF, NABARD, and M.P. State agencies resources management studies with reference to regional need

The External Cash Flow (ECF) receipts on account of sponsored collaborative grant-in-aid projects, and consultancy were Rs.127.025 lakh in typifying a significant increase from Rs.17.015 lakh in 1990-91. A major feature has been the collaborative arrangements made for technology development with identified partners from industry. RRL, Bhopal has embarked on specific product/process development phase.

Our efforts to provide R&D support to societal needs, particularly to develop programmes of the State Govt. of M.P. have attracted major attention. It is gratifying to report that the Honorable Chief Minister of Madhya Pradesh, Digvijay Singh, visited RRL, Bhopal (May 12, 1994) with his ministers and colleagues, the Chief Secretary, and top officials of the State Govt. Projects of relevance to the regional needs including the CSIR ecosystem development plan for Bastar were discussed. Some of the areas identified include projects in low cost housing, water resources management, upgrading traditional metallurgical industry like bell metal, blacksmithy, S&T in leather processing, aromatic and medicinal plants etc. This may call for laboratory efforts and coordination by M.P. State agencies, NGOs etc.

Integration of existing capabilities of scientific staff of the laboratory towards the targets in terms of ECF and S&T output have been possible through the creation of an achieving climate.

The scientific community has been encouraged for participation in interaction with external agencies, presentation of research results

seminars and joining prestigious professional societies. S&T staff has been encouraged to take up higher education. Scientists have been deputed for visits abroad.

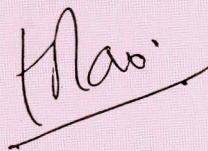
During the year a large number of invited lectures by experts, internal seminars and technical discussions with sponsoring agencies were held.

A five-day short term course and two day national workshop on "Groundwater Resources Modeling and Groundwater Contamination" was organized during April 12-18, 1993.

A seminar on "Recent Trends in Magnetism" was held at the laboratory on Oct. 8-9, 1993, under the auspices of Magnetism Society of India.

In the first meeting of the Research Council, RRL, Bhopal on Nov.9, 1989, the Chairman, referred to "a new opportunity in creative R&D management" Commensurate with this spirit, and the constant guidance and support from the RC, the DGSIR, and the CSIR Hq, RRL, Bhopal has passed the stage of resurrection to one of identity and niche areas. With the experience of over sixty short term and long term projects handled so far, the Laboratory is poised to expand its activities.

RRL, Bhopal records its deep sense of gratitude and appreciation to Dr. P. Rama Rao, Chairman RC and the members of RC, Dr. S.K. Joshi, DGSIR, sponsoring agencies, and M.P. State Govt. for the guidance and support. Inspiring help by Dr. T.N.Gupta, Executive Director, BMTPC, in the establishment of the Building Materials Characterization Centre at RRL, Bhopal is gratefully acknowledged.



(T.C. RAO)
Director

भूमिका

क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल का वर्ष 1993-94 का वार्षिक प्रतिवेदन प्रस्तुत करते हुए मुझे हार्दिक प्रसन्नता का अनुभव हो रहा है। अनुसंधान एवं विकास गतिविधियों को एक सार्थक संपर्क-आधार के रूप में स्थापित करने के उद्देश्य से उपभोक्ता एजेंसियों, विशेषकर औद्योगिक क्षेत्र के सहयोग से महत्वपूर्ण प्रौद्योगिकी विकास परियोजनाएं कार्यान्वित करने के विशेष प्रयास किए गए। निम्नलिखित उल्लेखनीय विकास गतिविधियों ने प्रयोगशाला के अनुसंधान एवं विकास कार्यक्रम को एक नयी दिशा दी :

- भारतीय रेल्वे के लिए 2500 हार्सपावर लोकोमोटिव की ड्रैक्शन मोटर के लिए एफ आर पी गियर केस का विकास
- रेड मड पॉलीमर आधारित लकड़ी की स्थानापन्न सामग्री
- धातु मैट्रिक्स मिश्रित सामग्री, सिरामिक फाइबर प्रिफॉर्म्स, Al-SiC, ब्रेक ड्रम्स एवं जेड-ए मिश्र धातु आधारित बियरिंग सामग्री
- टिस्को के लिए कोल वाशरीज परफारमेन्स विकास अध्ययन तथा हिन्दुस्तान जिंक लिमिटेड के लिए ग्राइंडिंग सर्किटस मॉडलिंग अध्ययन एवं
- क्षेत्रीय आवश्यकताओं के संदर्भ में जल संसाधन प्रबंध के लिए यूनीसेफ, नाबार्ड तथा अन्य राज्य एजेंसियों से सम्पर्क

प्रयोजित, सहयोगी, ग्रांट-इन-एड तथा परामर्श परियोजनाओं द्वारा 1993-94 में कुल बाहरी धन प्रवाह रु 127.025 लाख था, जो कि वर्ष 1990-91 के रु 17.015 लाख की तुलना में काफी अधिक है। प्रौद्योगिकी विकास के लिए उद्योगों के विशिष्ट साझेदारों के साथ सहयोगी कार्य एक उल्लेखनीय बिन्दु है। इस प्रकार क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल विशिष्ट उत्पाद/प्रक्रिया विकास के चरण में है।

समाज की आवश्यकताओं, विशेषकर मध्य प्रदेश शासन के विकास कार्यक्रमों हेतु अनुसंधान एवं विकास सहयोग ध्यानाकर्षण का विषय बना है। यह अत्यंत गर्व का विषय है कि मध्य प्रदेश के माननीय मुख्यमंत्री श्री दिग्विजय सिंह ने 12 मई, 1994 को अपने मंत्रीमंडल के सदस्यों, मुख्य सचिव एवं राज्य शासन के उच्च अधिकारियों के साथ प्रयोगशाला का दौरा किया। इस अवसर पर क्षेत्रीय आवश्यकताओं के अनुरूप कार्यक्रमों तथा बस्तर के लिए सी एस आई आर इको-सिस्टम डेवलपमेंट प्लान पर भी चर्चा की गयी। कम लागत की भवन-निर्माण सामग्री, जल-प्रबंध, लोहारी तथा बेल मेटल जैसे परंपरागत धातु आधारित उद्योगों का विकास, चर्म परिष्करण में वैज्ञानिक एवं प्रौद्योगिकीय योगदान, औषधि एवं सांघ पौधे आदि संबंधी एकीकृत परियोजनाओं पर विचार किया गया। इसके लिए सभी प्रयोगशालाओं के मिले-जुले प्रयास तथा म.- प्र.- शासन की एजेंसियों, अशासकीय संस्थानों, यूनीसेफ इत्यादि द्वारा समन्वयन की आवश्यकता होगी।

बाहरी धन प्रवाह एवं वैज्ञानिक एवं प्रौद्योगिकीय परिणामों के संदर्भ में प्रयोगशाला के वैज्ञानिक कर्मचारियों की वर्तमान क्षमता का प्रयोग एक सृजनात्मक वातावरण की स्थापना द्वारा ही संभव हो पाया है।

वैज्ञानिकों को संगोष्ठियों में हिस्सा लेने, बाहरी एजेंसियों से सम्पर्क, आंतरिक संगोष्ठियों के परिणाम प्रस्तुत करने एवं प्रतिष्ठित व्यावसायिक समितियों की सदस्यता हेतु लगातार प्रेरित किया जाता है। वैज्ञानिक एवं तकनीकी कर्मचारियों को उच्च शिक्षा हेतु भी प्रेरित किया गया। विदेश यात्राओं हेतु भेजा गया।

वर्ष के दौरान बड़ी संख्या में आमंत्रित व्याख्यान, आंतरिक संगोष्ठियों एवं प्रायोजक एवं तकनीकी चर्चाएं आयोजित की गयीं।

12-18 अप्रैल, 1993 के दौरान “भूजल संसाधन मॉडलिंग एवं भूजल संदूषण” पर राष्ट्रीय लघु अवधि प्रशिक्षण कार्यक्रम तथा दो दिवसीय राष्ट्रीय कार्यशाला का आयोजन किया गया।

मैग्नेटिक सोसायटी ऑफ इंडिया के तत्वावधान में प्रयोगशाला में 8-9 अक्टूबर, 1993 में “आधुनिक पचलन” विषयक संगोष्ठी का आयोजन किया गया।

क्षेत्रीय अनुसंधान प्रयोगशाला की अनुसंधान परिषद् की पहली बैठक में 9 नवंबर, 1988 परिषद् के अध्यक्ष ने “अनुसंधान एवं विकास के सृजनात्मक प्रबंध के क्षेत्र में नए अवसर खोजे जा सकें” का विचार प्रस्तुत किया था। इस भावना के अनुरूप ही तथा अनुसंधान परिषद् तथा सी एस आई आर के नियमित सहयोग से क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल आज पुनर्जीवन पाकर एक प्रयोगशाला बन कर सकी है। आज तक की साठ से भी ऊपर छोटी और बड़ी परियोजनाओं के अनुभव प्रयोगशाला अपनी गतिविधियाँ बढ़ा रही है।

क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल अनुसंधान परिषद् के अध्यक्ष डॉ. पी. रामाराव परिषद् के अन्य सदस्यों, सी एस आई आर के महानिर्देशक डॉ. एस. के. जोशी, प्रा. एवं मध्य प्रदेश शासन के प्रति उनके मार्गदर्शन एवं सहयोग के लिए हार्दिक आभार। क्षेत्रीय अनुसंधान प्रयोगशाला, भोपाल में बिल्डिंग मटीरियल्स कैरेक्टराइजेशन सेन्टर की सहायता के लिए भी हम उनके आभारी हैं।

टी. सी.

PROJECT DETAILS

BUILDING MATERIALS DIVISION

Research areas of this Division are as follows:

- * Development of low cost/alternate building materials, components e.g. sisal cement roofing sheets, panels bricks etc.
- * Demonstration low cost housing units
- * Flyash, red mud utilization

Research programmes in this Division have evolved from the strong linkages built with Ministry of Urban Development, Building Materials Technology Promotion Council, HUDCO, NBO, NTPC, MPCOST and M.P. State agencies.

Status of the projects in the Division are shown in Table-I.

Table-I : Projects in Building Materials Division

SL. NO.	TECHNOLOGY/ PROJECT	AGENCY	PROJECT COST
1.	Pilot Plant studies of sisal fibre cement roofing sheets	MOUD	Rs. 7.63 Lakh
2.	Low cost cementitious binder from industrial wastes red mud'	MOUD	Rs. 2.1 Lakh
3.	Construction of low cost demonstration houses	MOUD	Rs. 5.38 Lakh
4.	Laboratory trials for the manufacture of clay ash bricks with NTPC pond ash and flyash	NTPC Rihandnagar	Rs. 0.50 Lakh
5.	A study on mechanical properties of sisal fibres produced in M.P.	MPCOST	Rs. 0.524 Lakh
6.	Development of sisal red mud polymer composites for building components as wood substitute	BMTPC	Rs. 8.5 Lakh
7.	Building materials characterisation and testing centre	BMTPC	Rs.28.00 Lakh
8.	Pilot project for wasteland development	NTPC	Rs.12.00 Lakh
9.	Construction of 16 prototype houses using innovative construction techniques and materials	NBO	Rs.15.00 Lakh
10.	Development of ipomoea polymer composites	NBO	Rs. 4.50 Lakh
11.	S&T inputs in the life of tribal women of Patakot, Dist. Chhindwara	CSIR	Rs. 0.70 Lakh

Wood substitutes

Red mud polymer composite material developed by RRL, Bhopal was used for door shutters for elaborate performance tests and field trials. The door shutters have cleared the requisite standards and performance criteria. CPWD has advised RRL to take necessary steps for commercializing the technology. Accordingly RRL has given licenses to two parties around Bhopal in March, 1994 for commercial production of RMP based products.

Pilot project on wasteland development at NTPC, Rihandnagar, U.P.

Significant success on 2.5 acre site for cultivation of wheat, sunflower and vegetables has been observed. The work is now being extended to additional sites, thus covering an area of 15 acres around the Rihandnagar Super Thermal Power Station.

Discussions were held with NTPC officials on extension of the activities into a national project. The proposed project is aimed at generating scientific information on a large number of sites at different power stations.

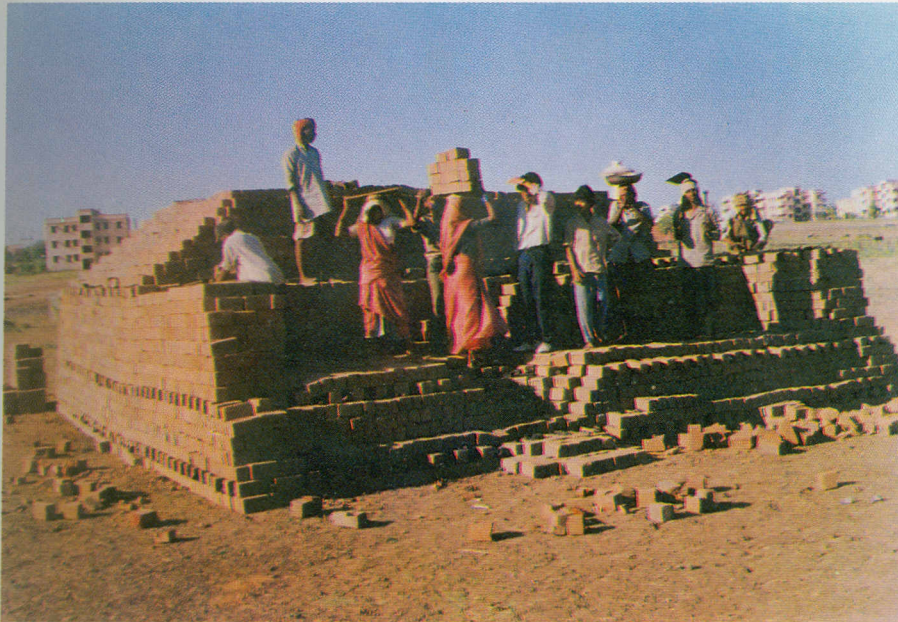
Building Materials Characterization Centre

The centre has now acquired test facilities which include tests for accelerated weathering, foundation, soils, door shutters, cement concrete bricks, sand and aggregates. The centre is being equipped with modern facilities, and is being set up with financial assistance from BMTPC, DST and CSIR

An advanced 200T Universal Testing Machine is being procured.

It is proposed to seek accreditation to the Centre from DST. This will help fulfill the need for a major national facility.

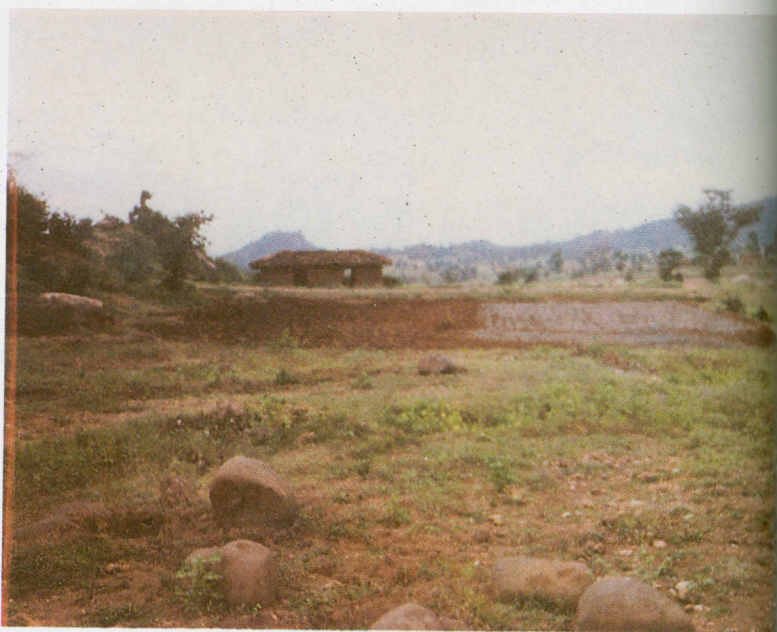
The centre has started attracting a variety of testing assignments from industry and other agencies. CSIR has sanctioned Rs.15.00 lakh towards building for this centre.



For the construction of 16 apartments under the NBO aided project, it is proposed to use innovative materials like clay ash bricks, red mud cementitious binder, R-wood doors and panels, and precast roofing. Picture shows production of clay ash bricks at RRL.



Work on plate load tests for bearing capacity of foundation soil at indoor museum site at Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal was carried out by the Building Material Characterisation Centre of RRL.



The wasteland site (2.5 acres) at Dodhar village near Rihandnagar Super Thermal Power Station



Pictorial view of the crop growth in flyash site

METALLURGY AND MATERIALS DIVISION

R&D activities of this Division include the following:

- * Aluminium based metal matrix composites, squeeze casting and squeeze infiltration,
- * Materials characterization,
- * Wear related problems in mining and agricultural implements,
- * Engineering failure analysis,
- * Welding techniques,
- * Corrosion,
- * Fibre reinforced polymer materials.

During 1993-94, commensurate with the activities, the division has had impressive linkages with prestigious organizations. These include BHEL, DAE, HZL, BALCO, CMPDIL, ISRO, VRDE, DMRL, CBIP, MPEB, ICAR, CIAE and a large number of industries in and around M.P.

Status of the projects in the Division are shown in Table-II.

Table-II : Projects in Metallurgy and Materials Div

SL. NO.	TECHNOLOGY/ PROJECT	AGENCY	PROJECT COST
1.	Development of squeeze casting process for half-clamps	BHEL	Rs. 2.95 Lakh
2.	Process development on a semi commercial level for ceramic preforms	OCL	Rs. 0.50 Lakh
3.	Improvement of performance of copper sucker	Surya Roshni Ltd.	Rs. 0.201 Lakh
4.	Analysis of boiler tube failure	NTPC, BALCO	Rs. 0.085 Lakh
5.	Development of suitable FRP material for gear case and to make prototype gear case for traction of motor	BHEL	Rs. 4.5 Lakh
6.	Improving life of mine implements through tribological studies	CMPDIL	Rs.36.79 Lakh
7.	Effect of rate of deformation on magnetic anisotropy of Nd-Fe-B alloy	INDO-US	Rs.19.83 Lakh
8.	Development of Aluminium metal matrix composites for aerospace applications	ISRO	Rs.10.48 Lakh
9.	Metallurgy and process development for quality upgradation for better performance of critical parts of agri. machinery	ICAR	Rs. 9.19 Lakh

10.	Studies on corrosion of modified cast irons	MPCOST	Rs. 0.60 Lakh	ongoing
11.	Development of suitable grinding media for cement	MPCOST	Rs. 0.60 Lakh	ongoing
12.	Structure and properties of advanced high temperature aluminium base alloy through rapid solidification processing	DST	Rs. 0.88 Lakh	ongoing
13.	Process development for manufacture of bonded magnets of rapidly solidified Nd-Fe-B alloys	MPCOST	<u>Rs. 0.20 Lakh</u>	ongoing
14.	Characterization of fly ash from ten thermal power stations	CBIP	Rs. 11.40 Lakh	ongoing
15.	Fundamental studies on the stress corrosion of metals	DAE	Rs. 4.032 Lakh	ongoing
16.	Surface modification techniques for improving the wear resistance of mine and farm implements	(TIFAC) DST	Rs. 2.05 Lakh	ongoing
17.	Life extension of coal feed bunkers at STPS, Sarni	MPEB	Rs. 4.96 Lakh	ongoing
18.	Failure investigation of coal feed bunker at STPS, Sarni	MPEB	Rs. 3.60 Lakh	ongoing
19.	Survey of medical X-ray equipment	CSIR	Rs. 2.00 Lakh	ongoing

FRP gear case for traction motors

An indigenous fibre reinforced plastic (FRP) gear case has been jointly developed by RRL, Bhopal, Permali Wallace Limited (PWL), Bhopal and BHEL, Bhopal. This gear case is proposed for traction motor (TM 4906 AZ) of Broad Gauge Diesel Locomotives for use in Indian Railways.

The FRP gear cases were handed over to BHEL on 26.2.94, signifying the successful completion of the MoU amongst BHEL, PWL, and RRL. These have been sent to RDSO and have been mounted on traction motors at DLW, Varanasi for field trials.

Fabricated from low carbon steel St-42S by welding and bending of 6-8 mm thickness, the conventional gear cases require lifting for mounting and demounting for greasing and for other maintenance. The FRP gear case weighs 78 kg compared to the steel case which weighs 150 kg. FRP cases are used in a locomotive.

Low carbon steel is also susceptible to corrosion and failures in the field leading to the leakage of lubricant. The heavy weight of the steel case sometimes causes its detachment from the traction motor due to vibration and/or impact which is very common for locomotives. The light weight and corrosion free FRP gear case is expected to offer several advantages over the conventional steel gear case.

Ceramic fibre preforms, Squeeze cast components

RRL, Bhopal has developed a process for manufacture of fibre-reinforced discontinuous alumino-silicate short fibres of varying volume fractions, shapes and sizes. The preforms have been produced in a semi-commercial scale in association with M/s Orient Cerwool Limited (OCL), Lakhtaev, a licensee of M/s Premier Refractories and Chemicals, Inc., USA.

Samples of these fibre preforms of various thickness and sizes have been tested at IIT Madras, IISc. Bangalore; and HAL Bangalore, for evaluation. HAL Bangalore has found the infiltrated preforms to be quite satisfactory. There is no damage to the preform and fibres uniformly distributed in the fibre matrix.

RRL, Bhopal has entered into an agreement with M/s Atlas Ceramics Components Limited (AAC), Pune, a leading manufacturer of ceramic components, for upscaling the process to manufacture squeeze cast ceramic composites for applications in engineering industries.

BHEL, Bhopal has also evinced interest to set up squeeze casting of aluminium alloy components used in electrical machinery.

RESCA brake drum

RESCA brake drums made by RRL were fitted in a Nissan Jonga Jeep and subjected to performance evaluation at Vehicle R&D Establishment, Ahmednagar. Initial results have been very encouraging. The brake efficiency, at speeds 30, 40, 50 km/hr., and fade behaviour trial of cast iron and RESCA were carried out. At an initial speed of 50 km/hr the cast iron drum showed an efficiency of 30.9 % whereas the RESCA drum showed 39.0. It was also observed that enhanced improvement was possible at higher vehicle speeds.

It was also recorded that the maximum temperature rise in RESCA (after 35 number of brake application) was 95°C compared to 147°C in cast iron.

The brake drum made of a composite material (RESCA), combines the low density of aluminium with the stiffness and wear resistance of reinforced ceramic. The composite brake drum weighs only about half the conventional cast iron drum and conducts heat three times more efficiently.

An agreement has been made with M/s Rasmi Die Casting, Hyderabad for producing engineering components based on particulate MMCs.

Mining implements

There is ample scope for improvement in the working life of shovel teeth through suitable heat treatment or compositional modification. It is expected that the life span of shovel teeth can be enhanced by the order of 20-40% by suitable treatment.

Shovel teeth were collected from South Eastern Coalfields Ltd., Bilaspur and Rajrappa mines of Bihar and subjected to appropriate heat treatment. The field trials are in progress.

Laboratory tests on implements collected from various mines and alternate steel compositions were carried out. Presently manganese steels and alloy steels are used for the manufacture of shovel teeth.

Based on laboratory studies production of prototype shovel teeth is being carried out by M/s Trishul Cast Alloys Pvt. Ltd., Bhopal for subsequent field

trials at mining sites.

Upgradation of agriculture implements

Tillage, harvesting and weeding agricultural tools are generally fabricated from mild and medium carbon spring steel scrap. The material quality is therefore, life of the implements is poor.

Primary tillage implements such as duck foot cultivator, shovel reversible mould board plough were processed and fabricated at RRL. The performance was compared with standard company make available in market. Field trials were carried out at CIAE Bhopal. The implements were mounted in tractor and run in clayey soil (30 to 35% clay) of 1.2 to 1.5 bulk density for

In case of duck foot cultivator, reduced scoring and about 40% less wear loss due to abrasion was noted. Field trials on shovel reversible mould board plough are being carried out at Tamil Nadu Agricultural University, Coimbatore.

Surface Engineering Activity - Satellite Centre

RRL Bhopal was chosen for one of the five surface engineering activity centres being set up by DST. Programmes of the Centre relate to surface engineering of agricultural implements:

Literature survey and market survey in surface modification technology for improving the wear resistance of mine and farm implements was

With a view to know the present status and look into the future potential of surface engineering technology as applied to the mining and agricultural sector, a questionnaire was prepared for the manufacturers and users of agricultural implements. The questionnaire aims at finding out the problem areas in the fields, the presently used methods for improvement together with an assessment of the role surface engineering may play in improving the life of the implements in a cost effective manner.

Bearing Materials

Extensive R&D activities have been initiated at RRL to explore the potential of development of a variety of SLIZ alloys as a replacement of bronze bushes for heavy machineries used by the mining sector.

An agreement has been signed with M/s Rasmi Die Castings (RDC) Ltd., Secunderabad for making 'SLIZ' bush bearings. Bushes weighing around 20-50 Kg each have been prepared at Secunderabad and sent to South Eastern Coalfields Ltd., Bilaspur, and Longwall Mines, Moonidih, Dhanbad, for performance evaluation.

There exists considerable scope for cost and weight reduction by substitution of bronze bushes in heavy machineries in mining industry. For example, an excavator for cutting coal/ore, uses as many as 32 bushes (bronzes) weighing in the range of 10-60 Kg each.

Stress corrosion of metals

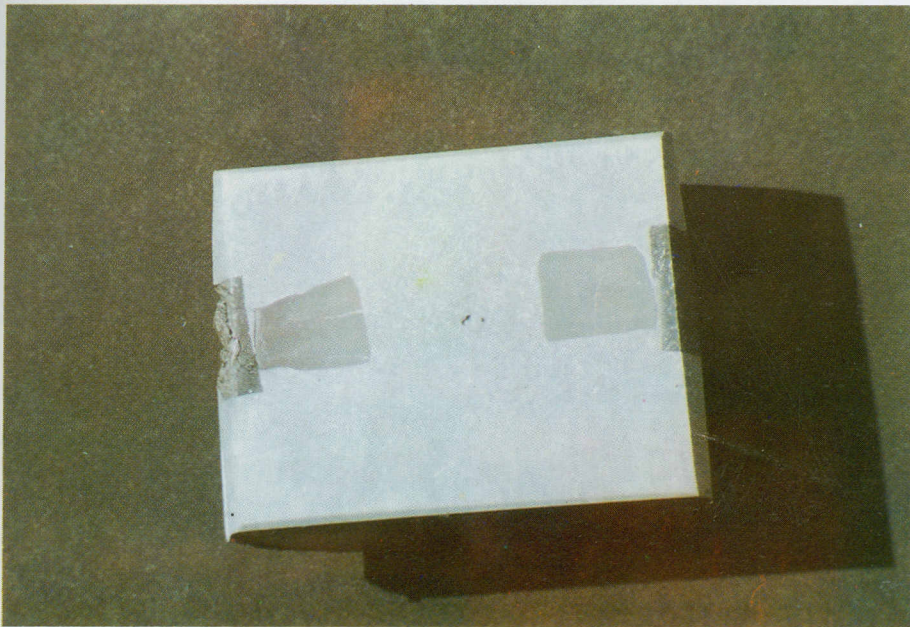
The objective of the project supported by Dept. of Atomic Energy is to study the basic mechanism of the stress corrosion of metals such as Aluminium, Zirconium and Titanium based alloys and steel in different environments and to elucidate the relationship between applied load and corrosion characteristics of the respective systems.

Descaling of heat exchanger tubes

RRL developed a corrosion resistant formulation in which no mineral acids are used. This formulation has been successfully demonstrated for the descaling of heavily scaled heat exchanger tubes. The work was carried out for Central Power Research Institute (Bhopal).



Squeeze cast half clamps supplied to BHEL, Bhopal



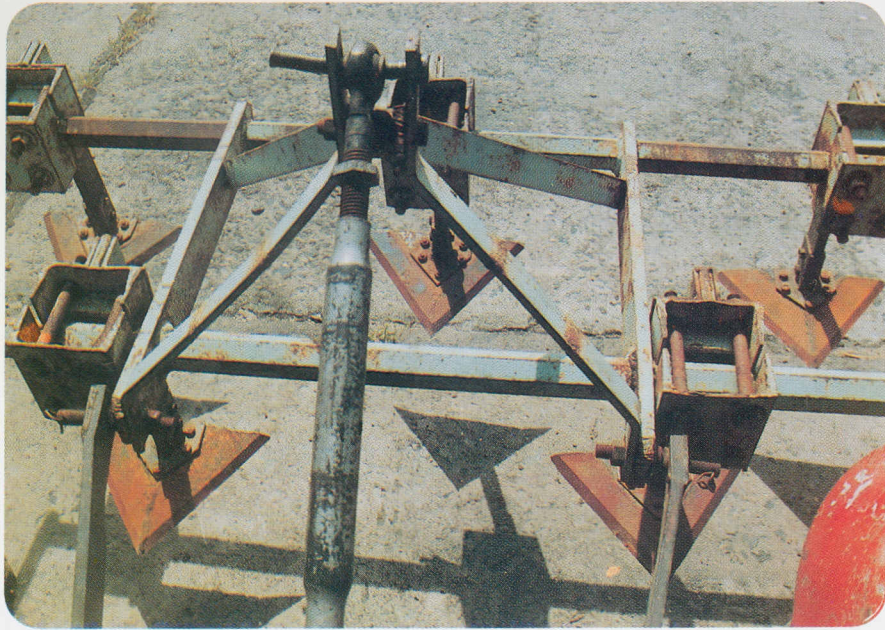
Cylindrical ring preform infiltrated with Al-alloy



SLIZ alloy bushes have been sent to South Eastern Coalfield and other coal mine sites



An agreement was signed with M/s Rasmi Die Casting Ltd., for component development based on Al-alloy composite



A view of duck foot cultivator, one row incorporates the improved cultivator



Drag force measurement of duck foot cultivator at CIAE, Bhopal

MINERALS DIVISION

Main R&D activities of this Division are built around the following:

- * Beneficiation of low grade ores,
- * Utilization of some fertilizer minerals of M.P.,
- * Studies on utilization of alumino-silicate minerals for developing mullite and other value added ceramic materials,
- * Beneficiation techniques and modeling studies related to coal and mineral preparation processes.

Major linkages of this Division are with Dept. of Mines, IBM, GSI, MPCOST, M.P. State Mining Corporation, TISCO, HZL, and CMPDIL.

Table-III shows the status of the projects.

Table-III : Projects in Minerals Division

SL. NO.	TECHNOLOGY/ PROJECT	AGENCY	PROJECT COST
1.	Studies on proper utilization of Narmada sand of M.P.	MPCOST	Rs. 0.896 Lakh
2.	To carry out beneficiation studies with Sijua group coal fines using water only cyclones	TISCO	Rs. 0.50 Lakh
3.	Feasibility studies on reduction of alumina content in Noamundi iron ore slimes using Multi Gravity Separator	TISCO	Rs. 0.50 Lakh
4.	Studies on steel plant wastes and as an alternate heavy medium in HM separation of coal	TISCO	Rs. 0.50 Lakh
5.	Modeling studies on a lead-zinc ore grinding circuit	HZL	Rs. 0.70 Lakh
6.	Test work on multi gravity separator for the treatment of lead rougher concentrate	HZL	Rs. 0.95 Lakh
7.	Beneficiation and industrial utilization of some fertilizer minerals of M.P.	Dept. of Mines	Rs.25.00 Lakh
8.	Modeling & performance studies on Vorsyl Separator	TISCO	Rs.10.00 Lakh
9.	Exploratory investigation on utilization of flyash for industrial ceramics	DST	Rs. 9.4341 Lakh
10.	Modeling and scale up studies in water only cyclone treating coal	CMPDIL	Rs. 3.00 Lakh
11.	Studies on limestones	Diamond Cement	Rs. 0.60 Lakh

Feasibility studies on reduction of alumina in Noamundi Iron Ore Slimes using Multi Gravity Separator

Detailed tests conducted on multi gravity separator with Noamundi iron ore slime samples indicate that the slimes can be effectively treated to reduce alumina content to 2.03% in concentrate from 6.95% in the feed at 49.97% yield value. Iron content increases from 54.51% to 65.57% and silica reduces from 4.10 to 1.38%.

Modeling studies on lead-zinc ore grinding circuit

The problem was referred to RRL with a view to increase the capacity of lead-zinc ore grinding circuit at Zawar Mill of Hindustan Zinc Ltd. With proper control of water addition to the sump, the ball mill could be operated at minimum of 40-41 tph solids rate, (current rate being 36 tph), without adversely affecting the fines and solids content in overflow.

The work has a wide potential for application in other mineral processing industries.

Reduction of graphite in lead concentrate using Multi-Gravity Separator

Hindustan Zinc Ltd., referred to RRL, a problem of reduction of graphite content in the concentrate to the acceptable limit using multi-gravity separator. The graphite content in the final lead concentrate should be less than 3%. Above this, graphite reduces the lead sinter strength.

Low grade lead rougher concentrate containing 19.6% lead and 9.8% graphite was sent from Rajpura-Dariba mines. Test work was carried out to exploit the wide difference in specific gravity of lead and graphite for the separation using multi-gravity separator. The operating variables of multi-gravity separator were optimized and a lead concentrate of 57.4% lead with 1.2% graphitic carbon could be obtained maintaining as high a recovery as 69.8%.

Based on the work done at RRL Bhopal, HZL is going to install a plant scale Multi Gravity Separator which will treat full stream of slurry from the flotation bank.

Steel plant waste as an alternate heavy medium in HM sep coal

The objective of this work was to carry out tests with steel plant waste (by R&D Division of TISCO) and magnetite in a heavy medium cyclone under identical conditions and compare the results in terms of yield and quality of clean coal.

From laboratory tests, it was shown that the steel plant waste may be used as heavy medium solids in beneficiation of coal. However, detailed characterization studies of steel plant waste is essential to establish its suitability as heavy medium solids.

Studies for beneficiation of Sijua group coal fines using water-only cyclones

The project was taken up for TISCO to study the beneficiation characteristics of Sijua Group coal fines (-500 micron) using water-only cyclone.

From the results obtained, it is evident that the Sijua group coal fines have very good washability characteristics. It can be beneficiated using a water-only cyclone where the yield of clean coal upto 89% can be obtained at a grade of less than 14% ash content. The theoretically obtainable yield of clean coal ash is 93%.

The project has created awareness in the user industry on the usage of water-only cyclone to treat coal fines. In this context, TISCO is likely to set up a water-only cyclone at Jamadoba in collaboration with RRL.

Industrial coal washery performance improvement studies

Vorsyl Separator (400mm) was installed at TISCO West Bokaro, replacing the existing HM Cyclone. Increased yield 50.17% (44% with existing HM Cyclone) at 17.3% ash was recorded for the same feed coal. This development resulted in an extra 50 tpd of clean coal without any additional costs. Prototype is now regularly used and around 1500t of raw coal processed in present operations. Scientists. TISCO has decided to procure Vorsyl Separator made of steel for regular operations.

Installation of industrial scale Vorsyl Separator at other coal washeries in the country would generate necessary confidence to facilitate adoption of this technique.

Rock phosphate beneficiation

60 T siliceous rock phosphate from Hirapur has been sent to IBM, Ajmer for pilot plant trials. Laboratory tests were conducted with a grind size 90% -200 mesh. A concentrate assaying 32% P_2O_5 with 75% recovery was produced.

Simultaneously, pre-feasibility studies have been carried out on the basis of flow sheet developed by the laboratory. The cost of production of phosphate concentrate for different grind sizes has been estimated. The results of this study indicate that the costs of concentrates produced by the beneficiation flow sheet developed by RRL, are comparable with costs of imported rock phosphates. It is proposed to complete the development of software on feasibility and optimization and also step up interaction with fertilizer manufacturers.

Fly ash as raw material for industrial ceramics

A wide range of interaction was possible on the exploratory studies on fly ash as raw material for industrial ceramics. This included contacts with M/s WIDIA (India) Ltd., M/s Orient Abrasives Ltd., M/s Sandvik Asia and DMRL, Hyderabad.

Nitrided products containing SiAlON (powders and whiskers) were given to M/s WIDIA (India) Ltd., Bangalore and M/s Sandvik, Pune for evaluating them for cutting tool insert applications.

RESOURCES DEVELOPMENT DIVISION

Resources Development Division of RRL, Bhopal has active R&D programmes in water resources management. Set up recently (1990) the Division has mandate to carry out computer aided studies in integrated water resources management and forest resources management. Main capabilities of the laboratory exist in mathematical modeling and systems analysis. Table-IV shows the status of projects in this area.

Table-IV : Projects in Resources Development Di

SL. NO.	TECHNOLOGY/ PROJECT	AGENCY	PROJECT COST
1.	Groundwater evaluation through modeling in the area of Tawa river basin	DST	Rs. 8.97 Lakh
2.	Development of true groundwater surface with the help of mathematical modeling	DST	Rs. 1.342 Lakh
3.	Micro-level study on waterlogging problem at Kharar village Seoni-Malwa block, Hoshangabad dist., M.P.	TADA	Rs. 5.45 Lakh

Groundwater Resources Management Studies

The project was sponsored by DST for studies on the water-logging in Tawa canal command area, Hoshangabad dist. After carrying out surveys, computer aided mathematical modeling techniques are used to understand the water-logging mechanisms. The study would help in formulating conjunctive irrigation management practices required to be implemented.

Based on the work carried out under this project, the Laboratory is attracting more work from the user agencies.

New Interactive Projects

A wide range of involvement of state agencies like Water Resources Department, Public Health Engineering Department, Tawa Ayacut, Central Board of Secondary Education and local authorities in project formulation has been possible through intensive interactions. Collaborative work is being envisaged along with the departments of M.P. Government, CGWB and UNICEF for carrying out

groundwater resources evaluation in a selected sub-basin of drought prone western Madhya Pradesh.

A project on Groundwater balance studies in dark areas sponsored by NABARD aims at development of methodologies to be followed in assessing the groundwater potential and its level of exploitation in hard rock areas of Sanwer Block, Indore district which may be adopted in other areas of western M.P.

RRL is closely interacting with Public Health Engineering Dept., Water Resources Dept., Agricultural Dept., and Central Ground Water Board to design and develop management schemes for water resources in severe water crisis areas of Chambal basin of the western Madhya Pradesh. After intensive discussions, a project on Water Resources Management studies in the Chambal has been formulated and submitted to Govt. of M.P. The study would identify the technological options available for developing water resources through groundwater and surface water storages, rainfall harvesting, additional recharge to the hard rock aquifers etc. This is expected to lead to identification of the sources of safe drinking water resources for each village.

A survey was conducted in Dhar and Jhabua districts and a brief technical report was prepared for UNICEF and PHED on the artificial recharge activities being carried out in these districts. The findings were presented by UNICEF at a Global Meet at Bangalore.

The laboratory is putting its best efforts to bridge the gap between the modern developments on water resources management especially groundwater, and the techniques adopted by the implementing agencies.

Short Term Course and National Workshop on "Groundwater Resources Modeling and Groundwater Contamination"

RRL, Bhopal organized a five-day Short Term Course and two day National Workshop on "Groundwater Resources Modeling and Groundwater Contamination" during April 12-18, 1993.

Prof. John P. Greenhouse, Department of Earth Sciences, University of Waterloo, Canada specially participated in the events and guided the

proceedings. The Short Term Course was sponsored by Department of Science and Technology, New Delhi and UNICEF. The Workshop was sponsored by CSIR, UNICEF, Public Health Engineering Department, NABARD, Department of Science & Technology, and M.P. Council of Science & Technology.

The Short Term Course was aimed at imparting an intensive training on various concepts on formulation of the problem and methodologies for obtaining suitable solutions to various groundwater problems. The course focused on the use of modeling methodologies and their advantages as management tools. The course was attended by thirty participants from various departments of M.P. State like Dept. of Irrigation, Public Health Engineering Department, Agriculture Department; R & D and academic institutions from different parts of the country.

The Workshop was attended by experts from various parts of the country from various Govt. Departments. Academic and research Institutions. The topics included were Groundwater Systems Analysis, Command Area Development, Biological and Industrial Contamination, Geophysical Methods for Contamination Monitoring.



A National Workshop on Groundwater Resources Management was held at RRL



Resources Development Division was called upon to take up survey and studies in water scarce regions in Dhar district M.P. The picture shows a typical structure under construction for water conservation. (Photo Courtesy : Unicef, Bhopal)

APPENDICES

APPENDIX - 1

RESEARCH COUNCIL

Prof. P. Rama Rao

Chairman

Secretary,
Govt. of India,
Department of Science & Technology,
Technology Bhawan,
New Mehrauli Raod,
New Delhi-110 016.

Shri A.C. Wadhawan

Member

Chairman-cum-Managing Director,
Hindustan Zinc Limited,
Udaipur.

Shri C.P.S. Nair

Member

Vrindavan,
C.P. Gopala Panicker Lane,
Sasthamangalm,
Trivandrum-695 010.

Prof. H.S. Ray

Member

Director,
Regional Research Laboratory,
Bhubaneswar-751 013.

Shri M.I. Beg

Member

Chairman
Central Electricity Authority
Department of Power,
Seva Bhawan, R.K. Puram,
New Delhi-110 066.

Shri S.K. Handa

Member

Executive Director,
Bharat Heavy Electricals Ltd.
Bhopal-462 022.

Dr. T.N. Gupta

Executive Director
Building Materials & Technology
Promotion Council (BMTPC),
G-116, Nirman Bhawan,
New Delhi-110 001.

Member**Dr. T.R. Ramachandran**

Director,
Jawaharlal Nehru Centre for Aluminium
Research, Design and Development,
Opp: Wadi police station
Amaravati Road, Wadi
Nagpur-440 023.

Member**Dr. O.N. Mohanty**

Scientist,
National Metallurgical Laboratory,
Jamshedpur-831 007.

DGSIR Nomin**Prof. T.C. Rao**

Director,
Regional Research Laboratory,
Bhopal-462 026.

Member**Dr. R.N. Yadava,**

Scientist,
Regional Research Laboratory,
Bhopal-462 026.

Secretary

**During 1993-94 Eighth and Ninth meetings of the RC were held on
1993 and October 15-16 & 30, 1993 respectively.**

APPENDIX - 2**MANAGEMENT COUNCIL**

Prof. T.C. Rao Director, Regional Research Laboratory, Bhopal-462 026.	Chairman
Dr. A.D. Bhide Scientist, National Environmental Engg. Research Inst. Nehru Marg, Nagpur-440 020	Member
Dr. A.K. Dubey Scientist, CMRI Regional Centre Central Building Research Institute, Roorkee-247 667.	Member
Dr. Kunal Basu Scientist, Regional Research Laboratory, Bhopal-462 026.	Member
Shri B.K. Saxena Scientist, Regional Research Laboratory, Bhopal-462 026.	Member
Dr. C.B. Raju Scientist, Regional Research Laboratory, Bhopal-462 026	Member
Mrs. Alka Meshram Scientist, Regional Research Laboratory, Bhopal-462 026.	Member

Finance & Accounts Officer
Regional Research Laboratory,
Bhopal-462 026.

Member

DGSIR or his Nominee
CSIR Headquarters
New Delhi-110 001.

**Permanent
Invitee**

Controller of Administration
Regional Research Laboratory,
Bhopal-462 026.

**Member
Secretary**

During 1993-94 Thirteenth, Fourteenth and Fifteenth meetings of MC were held on May 12, 1993, October 11, 1993 and January 7, 1994 respectively.

APPENDIX - 3**DISTINGUISHED VISITORS**

- Digvijay Singh**, Hon'ble Chief Minister, M.P.
- Kantilal Bhuria**, Hon'ble Minister, Tribal Welfare, M.P.
- Ibrahim Qureshi**, Hon'ble Minister, Science & Technology, M.P.
- A. Parthasarathi**, Additional Secretary, DSIR, New Delhi.
- N.C. Aggarwal**, Financial Adviser, CSIR, New Delhi.
- Prof. B.B. Dhar**, Director, CMRS, Dhanbad.
- Prof. T.R. Anantharaman**, Emeritus Scientist, NPL, New Delhi.
- N.S. Sethi**, Chief Secretary, Govt. of M.P.
- K.S. Sharma**, Secretary, Housing & Env., Govt. of M.P.
- I.S. Rao**, Secretary, Tribal Welfare, Govt. of M.P.
- Badal K. Das**, Secretary, PHED, Govt. of M.P.
- Dr. J.G. Negi**, Director General, MPCOST, Bhopal.
- Prof. T.S. Murthy**, Former Director General, MPCOST, Bhopal.
- Shyam Sunder**, Director, Irrigation Research, Govt. of M.P.
- Prof. S. Ramashesan**, Dept. of Civil Engineering, IIT, Kanpur.
- Dr. V.S.R. Murthy**, IIT, Kanpur.
- Prof. G.S. Murthy**, IIT, Kanpur.
- Prof. G.S. Sarma**, BHU, Varanasi (U.P.).

B.K. Rao, Advisor NFTDC, Hyderabad and Former Secretary, Dept. of Mines, Govt. of India.

P.C. Gupta, Ex. CMD, NMDC, Hyderabad.

D.C. Jain, CMD, M.P. Agro Industries Corporation, Bhopal.

P.S. Tomar, MD, Mining Corporation, Bhopal.

T.N. Jaggi, Ex-Chairman-cum M.D., Pyrites, Phosphates & Chemicals Ltd.

S.P. Singh, GM (E&M), CMPDIL, Ranchi

K.S.S.N. Rao, Managing Director, Rasmi Diecasting Ltd., Secunderabad.

Shailendra Rao, Managing Director, Atlas Automotive Company Ltd., Pune.

L. Prasad, Senior Executive, Tata Robins Fraser, Tatanagar.

A.T. Kusre, ICICI, Bombay.

Amitabh Kumar, ICICI, Bombay.

Dilip Fauzdar, Consultant, UNICEF, New Delhi.

Prof. J.P. Greenhouse, University of Waterloo, Canada.

Pallesvenning Jensen, Danish power consultant, Denmark.

Jorgen Kofod, Danish power consultant, Denmark.

Dr. J.V.S. Sutcliffe, Senior Consultant, World Bank, U.K.

Dr. Glen Walker, CSIRO, Water Research Centre, Australia.

Dr. Pranab Pandya, Director, Brahmvarchas Shodh Sansthan, Shantikunj, Haridwar.

Fr. Eugane D'Souza, Archbishop, Bhopal.

APPENDIX - 4

**AGREEMENTS FOR COLLABORATIVE WORK,
TECHNOLOGY DEVELOPMENT,
TECHNOLOGY TRANSFER**

S.No.	Name of Party	Date of agreement	Nature
	M/s Rasmi Die Castings Ltd., Secunderabad.	13.10.93	Collaborative arrangements for Component Development on Al-alloy based particulate composites.
	M/s Atlas Automotive Components Ltd., Pune.	9.11.93	Collaborative arrangements for development of a process for manufacture of Al-alloy casting by squeeze casting incorporating ceramic fibre preforms and salt cores for making AMMC castings.
	M/s Rasmi Die Castings Ltd., Secunderabad.	13.1.94	Component development based on SLIZ alloys.
	M/s Meena Industries, Govindpura, Bhopal.	23.3.94	License for manufacture of R-Wood doors, panels, etc.
	M/s Encons Ltd., Bhopal.	28.3.94	-do-

APPENDIX - 5

RESEARCH PAPERS AUTHORED BY
RRL SCIENTISTS

1. **R. Venugopal, D. Viswanatha, P. Sanyal, and T.C. Rao**, "Flotation characteristics of chalcopyrite ore", IE(I) Journal-MN (1993).
2. **A.K. Majumder, T. Sharma and T.C. Rao**, "Extraction of potassium from glauconitic sandstone by the roast leach method", International Journal of Mineral Processing, 38 (1993), 111-123.
3. **B.R. Rao, L.S. Rao, A.K. Majumder and T.C. Rao**, "Fluoride aided potassium extraction from glauconitic sandstone for liquid fertilizer", Minerals Engineering, 6 (4), 1993.
4. **M. Saxena, A.K. Jha and G.S. Upadhyaya**, "Corrosion behaviour of sintered 6061 aluminium alloy-graphite particle composites", Journal of Materials Science, 28 (1993), 4053-4058.
5. **M. Saxena, O.P. Modi, B.K. Prasad and A.K. Jha.**, "Erosion and corrosion characteristics of an aluminium alloy-alumina fibre composite", Wear, 169 (1993), 119-124.
6. **B.K. Prasad**, "Structure-property relations in a hypereutectic aluminium-silicon alloy dispersed with graphite particles", J.Mater.Sci., 28 (1993), 100-104.
7. **S. Das and B.K. Prasad**, "Tribological behaviour of Aluminium alloy composites : A comparative study with a copper base alloy", Wear, 162-164 (1993), 64-74.
8. **B.K. Prasad, T.K. Dan and P.K. Rohatgi**, "Characterization and microstructural modifications of pressure die cast eutectic aluminium-silicon alloy-graphite composite", Mater: Trans. Japan Inst.Met., 34 (1993), 474-480.

S. Das, B.K. Prasad, A.K. Jha, O.P. Modi and A.H. Yegneswaran, "Three-body abrasive wear behaviour of 0.98% C Steel", *Wear*, 162-164 (1993), 802-810.

O.P. Modi, B.K. Prasad, A.K. Jha, S. Das and A.H. Yegneswaran, "Abrasive wear behaviour of an AISI 5132 steel under low stresses", *Mater.Trans.Japan Inst.Metals*, 355 (1994), 67-73.

L.S. Rao, B.R. Rao, B. Govindarajan and T.C. Rao, "A model for leaching of glauconitic sand-stone using reduced time plot concept", *Minerals and Metallurgical Processing*, August, 1993, 119-123.

B.K. Prasad, O.P. Modi and A.K. Jha, "The influence of Al_2O_3 fibres on the sliding wear behaviour of an aluminium alloy LM5", *Tribo-Int.* (in press).

B.Govindarajan and T.C.Rao, "Modelling and performance studies on Vorsyl separator", *Metals, Materials and Processes* (In press).

Arati Roy, R.N. Yadava and Raj Kishore Katiyar, "A problem of thermal stresses in bonded dissimilar micropolar elastic half spaced containing a penny shaped crack at the interface", *J.of M.A.C.T.*, 26 (1993), 7-24.

G. Subramanian, Navin Chandra and G. Prabhakar Rao, "Response of chloride ion selective electrode in partially aqueous media", *Trans. Saest*, 28 (4), 1993.

1-6

APPENDIX - 6**PAPERS PRESENTED BY RRL SCIENTISTS**

1. **Asokan P, M. Saxena, J. Prabakar, S. Shrimanth, S.K. Bose and A.C. Khazanchi**, "Flyash utilisation in wasteland development", National Seminar on Utilisation of flyash, organised by M.P. Pollution Control Board, Bhopal, April 15, 1993.
2. **Asokan P, S.R. Karade and A.C. Khazanchi**, "Bricks manufacturing from flyash", National Seminar on Ash utilisation, organised by NTPC, Korba, May 7, 1993.
3. **Asokan P, M. Saxena, Prabakar. J, S. Shrimanth and R.S. Ahirwar**, "Ash utilisation for conditioning wasteland soil and its interaction", National Seminar on Ash utilisation, organised by NTPC, Korba, May 7, 1993.
4. **R.N. Yadava, M.V.R.L. Murthy, and B. Tirupati**, "Ground water management modelling through linear programming", Seminar on "Water resources development performance overview", May 29, 1993, Institute of Engineers, Bhopal.
5. **B.Govindarajan, L.S.Rao and T.C.Rao**, "Vorsyl separator- An efficient centrifugal separator for Indian coals", Coal Quality Improvement, May, 1993, CMPDIL, Ranchi.
6. **O.P. Modi**, "Dry sliding wear and corrosion behaviour of squeeze cast aluminium alloy-silicon carbide composites", Dept. of Materials Engg. & Materials Design, University of Nottigham, U.K., July 8, 1993.
7. **A.H. Yegneswaran**, "Solid state phase transformations", ISTE Summer School on "Heat treatment principles, process and problems", July 5-18, 1993.
8. **A.K. Jha**, "Theory of tempering", ISTE Summer School on "Heat treatment principles, process and problems", July 5-18, 1993.

S. Das, "Precipitation hardening and heat treatment of non-ferrous alloys", ISTE Summer School on Heat treatment principles, process and problems, July 5-18, 1993.

A.H. Yegneswaran, "Diffusion hardening", ISTE Summer School on Heat treatment principles, process and problems, July 5-18, 1993.

Mohini Saxena, "Utilisation of industrial waste for the construction of Building materials", ISTE Summer School on "Heat treatment principles, process and problems", July 5-18, 1993.

Asokan P, M. Saxena, S. Shrimanth, S.R. Karade, S.K. Bose and A.C. Khazanchi, "Utilisation of flyash", National dialogue on Utilisation of flyash and phosphogypsum, organised by BMTPC, HUDCO and APIDO, July 23-24, 1993 at Hyderabad.

O.P. Modi, B.K. Prasad, A.K. Jha, S. Das, and A.H. Yegneswaran, "Influence of microstructure of abrasion resistance of 5132 steel", National Seminar on "Power Plant Materials" Sept. 11-12, 1993, Maulana Azad College of Technology, Bhopal.

R.S. Ahirwar, A.C. Khazanchi, S.K. Bose and R.K. Chauhan, "Cementitious binder using industrial waste : Red mud", *ibid.*

P. Asokan, M. Saxena, and S.K. Bose, "Flyash utilisation for Wasteland development", *ibid.*

S. Das, S.P. Mukherjee, and A.H. Yegneswaran, "Metallurgical characterisation of grinding balls", *ibid.*

R.S. Solanki, V.S. Muneshwar and B.K. Saxena, "Importance of remnant life prediction and life extension of coal feed bunkers", *ibid.*

S.K. Bose, "Advanced metallurgical techniques in failure analysis", *ibid.*

Asokan P, M. Saxena, A.C. Khazanchi and S.K. Bose, "Bulk utilisation of flyash for wasteland development", National Seminar on Material for Thermal power plants, organised by Indian Institute of Engineers (M.P. State), Sept. 11-12, 1993 at MACT, Bhopal.

20. **S.P. Narayan, D. Mondal and K. Basu**, "A simple process of decarbonization of CRNGO silicon steel for small scale industries", National Seminar on Recent Trends in Magnetics-Materials and Applications and 12th Technical Meet on Magnetics Society of India, Oct. 8-9, 1993.
21. **D.P. Patil and T.C. Rao**, "Shear flocculation - A process to recover valuable minerals from slimes", 4th Asian Mining, An International Conference on Mining, Ecology & Mineral Processing, Calcutta, Oct. 22, 1993.
22. **B.R. Rao, D.P. Patil, J.P. Barnwal and T.C. Rao**, "Citronella oil: A new reagent for coal flotation", 31st National Metallurgists Day, 47th Annual Technical Meeting, Nov. 17-19, 1993, Hyderabad.
23. **M. Prasad, A.K. Majumdar, G.M. Rao and T.C. Rao**, "Beneficiation studies of a lean grade cherty-calcareous rock phosphate ore of Jhabua (M.P.)", 31st National Metallurgists Day, 47th Annual Technical Meeting, Nov. 17-19, 1993, Hyderabad.
24. **S.P. Narayan, D. Mondal, R.S. Solanki and K. Basu**, "Studies on the decarbonization of CRNGO silicon steel", 47th ATM of IIM at Hyderabad, Nov. 17-20, 1993.
25. **T.C. Rao**, "Modelling studies on some coal washery units", at IIM Annual Meeting, Hyderabad, Nov., 1993.
26. **M. Saxena, R.K. Morchhale, P. Asokan and S.R. Karade**, "Bulk utilisation of flyash : An innovative approach", National Seminar on Environmental aspects of Thermal power stations, organised by NTPC R&D Centre, Noida (U.P.), Dec. 9-10, 1993.
27. **S. Das, A.K. Jha, B.K. Prasad, O.P. Modi and A.H. Yegneswaran**, "Micromechanism of material removal during abrasive wear of Al alloy-SiC composites", 47th ATM of IIM, Hyderabad.
28. **L.C. Mohan**, "Recent innovative foundry practices", IIF Transactions 1993.
29. **L.C. Mohan**, "Casting defects", IIF short term foundry refresher course, proceedings.

4. **L.C. Mohan**, "Traditional bell metal craft in M.P.", IIF seminar on foundry business proceedings.

5. **Navin Chandra, S.S. Amritphale and B. Kujur**, "Ceramic separator for zinc/bromine battery", Int. Conf. Energy Environment and Electrochem., Karaikudi, 1993.

6. **S.S. Amritphale, Navin Chandra and B. Kujur**, "Effect of some phosphatic binders on sintering behaviour of pyrophyllite", 95th Annual Meeting and Exposition of Am.Ceram.Soc., Cincinnati, Ohio, 1993.

7. **Mohini Saxena**, "Alternate materials of constructions", organised by TTTI, Bhopal.

8. **Navin Chand**, "Fibres", organised by Science, Maths teacher training centre, Ravi Shankar Nagar M.P. Higher Sec. Ed. Board, Bhopal.

9. **Navin Chand**, "Next generation materials", Academic staff college R.D. University, Jabalpur.

10. **Navin Chand**, "Surface modifications", Academic staff college R.D. University, Jabalpur.

11. **S.S. Amritphale, Navin Chandra and A.K. Singh** " Optimisation of process parameters for pyrophyllite based floortiles", National Seminar on Alternate Housing Materials, RRL, Bhopal 12-13, March 1993.

12. **A.C. Khazanchi, R.K. Chauhan, B. Kujur and Navin Chandra** " Pozzolanitic cement from agricultural wastes - Rice husk", *ibid.*

13. **Navin Chandra, S.S. Amritphale, J. Konar and V.S. Munishwar** "Corrosion protection of cast-iron Impellar of the water pumps by Electroless Nickel coating" Four Natl. Convention of Electrochem. Madras, July 1993.

APPENDIX - 7**LECTURES****Invited Lectures by outside experts**

A.K. Chaki, Saurabh Metals, Mandideep, Bhopal, "Recent technologies and application of steels".

A.K. Chaki, Saurabh Metals, Mandideep, Bhopal, "High performance steel for mine/thermal power/cement".

Sudhir Singhal, Scientist, IIP, Dehradun, "Use of natural gas in transportation".

Prof. G.S. Sarma, BHU, Varanasi (U.P.), "Recent development of metals in HSLA steel".

Jorgen Kofod, Danish Power Consultant, Denmark, "Flyash environment".

L. Prasad, Senior Executive, Tata Robins Fraser, Tatanagar, "Beneficiation of non-cooking coal".

Dr. Pranab Pandya, Director, Brahmvarchas Shodh Sansthan, Shantikunj, Haridwar, "Science and Spiritualism"

Dr. J.V.S. Sutcliffe, Senior Consultant, World Bank, U.K., "Water balance of Betwa basin".

Dr. V.S.R. Murthy, IIT, Kanpur, "Matrix microstructure and interface microstructure on SiC fibre-ceramic matrix composite".

Dr. Salvi, PID, New Delhi, "Why we should popularise science".

Prof. T.R. Anantharaman, Emeritus Scientist, NPL, New Delhi, "Metals, my friends, metallic structure my obsession: Looking back cover four decade of involvement in metallurgical research".

Prof. T.R. Anantharaman, Emeritus Scientist, NPL, New Delhi, "Science spirituality and yoga".

Prof. G.S. Murthy, IIT, Kanpur, "Super plasticity".

Dr. R. Bhima Rao, Scientist, RRL, Bhubaneswar, "Grinding aids for industrial minerals".

Amitabh Kumar, ICICI, Bombay, "Innovative Schemes of ICICI to Foster Institution Industry Linkage".

Mr. R.N. Parlikar, Sr. Deputy Director, IICT, Hyderabad, "Process Technology Transfer".

Internal Seminars

S.S. Amritphale, "A process for making activated MnO_2 from manganese ore pyrolusite by chemical method"

P. Asokan, "Thermal power plant's pollutants and resources"

J.P. Barnwal, "Beneficiation of coal using centrifugal HMS".

Udaya Bhaskar, "Developments in flotation techniques".

Kunal Basu, "Squeeze casting".

S.K. Bose, "Metallurgical characterization".

N. Chand, "Research on polyethylene".

N. Chandra, "Corrosion of cast iron".

S. Das, "PC-APD software package for X-ray diffraction studies".

Rupa Dasgupta, "Rapid solidification of Al-base alloys".

P.D. Ekbote, "Commercialisation of CSIR knowledgebase - new prospects".

K.K.S. Gautam, "Maintenance of equipments".

B. Govindarajan, "Optimisation through modelling".

A.H. Yegneswaran, "Visit to Germany on surface engineering programme".

A.K. Jha, "Abrasion wear of 5132 steel".

S.A.R. Hashmi, 'Bi-axially oriented polypropene films".

L.C. Mohan, "Steels".

D. Mondal, "Squeeze infiltration technique for production of AMMC".

A.K. Majumdar, "Beneficiation of low grade phosphate of Jhabua of M.P.". .

M.V.R.L. Murthy, "Water-logging problems in Tawa canal command area".

R.K. Morchhale, "Present status of RMP door shutters".

M. Prasad, "Rock phosphate and its enrichment"

D.P. Patil, "Shear flocculation"

S.P. Narayan, "Studies on deformation behaviour of Nd-Fe-B magnets"

J. Prabakar, "Proto-type construction of houses using alternate building material developed at RRL".

APPENDIX - 8**SEMINARS/WORKSHOPS/CONFERENCES
ATTENDED BY RRL STAFF**

- * **Dr. Mohini Saxena and R. K. Morchhale** attended National seminar on "New materials and technologies for buildings (Focus : Wood Substitute)", organised by CPWD and The Institute of Engineers (India), Bombay, March 6-7, 1993.
- * **Dr. O.P. Modi** attended the Seminar on "Artificial intelligence in the mineral sector" at Dept. of Mineral Resources Engg., University of Nottingham, organised by the Institution of Mining and Metallurgy, April 20, 1993.
- * **Dr. A.K. Jha** attended a meeting under Mission thrust area project of Planning Commission on "New and improved tool materials through P/M route" at IIT, Kanpur, June 18, 1993.
- * **Dr. A.K. Jha** attended a meeting on "Technology mission", Metal Matrix composites convened by IIT Kanpur, June 18, 1993.
- * **Prof. T.C. Rao, S.K. Bose, Dr. R.N. Yadava, Dr. C.B. Raju and P.D. Ekbote** attended Debate on "Technology Policy Statement 1993" organised by MPCOST at RRL, Bhopal, June 25, 1993.
- * **Dr. Arati Roy and Rupa Dasgupta** attended a two days meeting of Heads of CSIR Libraries, organised by NAL and INSDOC, at Bangalore, July 22-23, 1993.
- * **Dr. Mohini Saxena and R.K. Morchhale** attended Workshop on "Construction Management" organised by M.P. Housing Board, Bhopal, July 23-24, 1993.
- * **Dr. A.H. Yegneswaran, Dr. A.K. Jha, Rupa Dasgupta, K. Venkat and T.S.V.C. Rao** attended Seminar on "Lubrication", organised by SEI and IOC at BHEL Bhopal, Aug. 14, 1993.

- * **Dr. A.H. Yegneswaran** attended a meeting on "Surface engineering programme" at DMRL, Hyderabad, Aug. 28, 1993.
- * **Dr. S. Das and Dr. A.H. Yegneswaran** attended a meeting on "Technology evaluation and norms study for secondary aluminium sector" at DSIR, New Delhi, Sept. 8, 1993.
- * **Dr. O.P. Modi** attended the "7th International Conference on Coal Science", at Banff, Alberta, Canada, Sept. 12-17, 1993.
- * **Dr. R.N. Yadava and Dr. M.V.R.L. Murthy** attended Seminar on "The development of strategies for effective implementation of sanitation programme in M.P.", organised by Science Academy, Bhopal, Oct. 5-6, 1993.
- * **Dr. R.N. Yadava** attended Workshop on "R&D Priority setting at NISTADS", organised by CSIR-CSIRO, New Delhi, Oct. 29, 1993.
- * **Dr. A.H. Yegneswaran** attended CBIP meeting on "Remnant life estimate of thermal power plant" RSOP, New Delhi, Nov. 16, 1993.
- * **Dr. A.K. Jha, Dr. S. Das and B.K. Prasad** attended "47th ATM of IIM" at Hyderabad, Nov. 17-19, 1993.
- * **Dr. M. Saxena and S.R. Karade** attended "National Seminar on Environmental aspects of Thermal power stations", organised by NTPC R&D Centre, Noida (U.P.), Dec. 9-10, 1993.
- * **Dr. M.V.R.L. Murthy, Dr. R.N. Yadava and B. Tirupati** attended Workshop on "Lift Irrigation", organised by NABARD, Bhopal Dec. 21, 1993.
- * **Dr. K. Basu, Dr. A.H. Yegneswaran and P.D. Ekbote** attended Workshop on "Intellectual property rights and patents", organised by CSIR Patents Unit, Feb. 17-18, 1994.
- * **Dr. K. Basu** attended CSIR-APCTT training programme on "Technology evaluation and pricing", at SERC, Madras, March 14-18, 1994

APPENDIX - 9**STAFF NEWS****ASSESSMENT**

Dr. R.N. Yadava,	Scientist	Gr.IV(3) to Gr.IV(4)
Dr. Navin Chandra,	Scientist	Gr.IV(3) to Gr.IV(4)
Dr. Arati Roy,	Scientist	Gr.IV(1) to Gr.IV(2)
H.N. Rao, Lab.	Supervisor	Gr.III(1) to Gr.III(2)
R.K. Chouhan,	JTA	Gr.III(1) to Gr.III(2)
Abhay Kumar,	Reneo Operator	Gr.II(1) to Gr.II(2)

VISITS ABROAD

Dr. A.H. Yegneswaran visited Germany during June 13-20, 1993 to attend INDO-German Workshop at Dresden, on surface engineering and visited industries and research organisations in Germany.

Dr. S. Das visited Philips, Almento, The Netherlands from June 28-July 2, 1993 for the training on application course on PC-APD software packages X-ray diffraction and TADD, which is a retrieval programme for the JCPDS PDF-2-level database on CD-ROM.

Dr. Navin Chand visited Technical University, Berlin under CSIR-DAAD Exchange programme as Senior Fellow for two months from August 20, 1993.

S.P. Narayan is to visit Naval Research Laboratory, Washington, USA under Indo-US Fellowship from April, 1994.

HIGHER EDUCATION

Dr. O.P. Modi awarded Ph.D by IIT, Kanpur.

J.P. Pandey awarded AMIE from Institution of Engineers, Calcutta.

P.K. Satyanesan awarded B.A. from Osmania University, Hyderabad.

RECOGNITIONS

Prof. T.C. Rao has been elected as president for two years for Madhya Pradesh Vigyan Sabha.

Dr. Mohini Saxena has been elected as Vice-president for two years for Madhya Pradesh Vigyan Sabha.

L.C. Mohan has been re-elected the Hony. Secretary of The Institution of Indian Foundrymen Bhopal chapter for the year 1993-94. On 26.06.1993, the Bhopal chapter of the IIF was awarded the best chapter award for the year 1992-93, in the western region conference held in Hotel Holiday Inn, Juhu, Bombay. Mr. L.C. Mohan received the award on behalf of the Bhopal chapter.

P.K. Satyanesan awarded a certificate by M.P. Voluntary Blood Donors' Association, Bhopal for donating blood ten times so far.

RETIREMENT

Sikandar Sultan, Stores & Purchase Officer - Nov.'93

B.C. Pal, Assistant (F&A) passed away on 13.9.1993 at an young age of 31. RRL, Bhopal deeply mourns the loss.

APPENDIX - 10

STAFF LIST AS ON 31.3.1994

Prof. T.C. Rao, DIRECTOR

BUILDING MATERIALS DIVISION

S.K. Bose, Scientist F & Head

Dr. Navin Chand, Scientist EI

Dr. Mohini Saxena, Scientist C

R.K. Morchhale, Scientist B

Alka Meshram, Scientist B

S.A.R. Hashmi, Scientist B

J. Prabakar, Scientist B

S. Srimanth, Scientist B

R.S. Ahirwar, Scientist B

P. Asokan, Scientist B

Ajay Kulshreshth, JSA

R.K. Chauhan, STA

S.R. Karade, JTA

Ajay Naik, STA

Antony. V, Technician

Shyamla Soman, Sr. Steno.

S.K. Botham, Helper

METALLURGY & MATERIALS DIVISION

Dr. Kunal Basu, Scientist F & Head

Dr. Navin Chandra, Scientist EII

Dr. A.H. Yegneshwaran, Scientist EI

S.P. Narayan, Scientist C

L.C. Mohan, Scientist C

R.S. Solanki, Scientist C

Dr. A.K. Jha, Scientist C

Dr. S. Das, Scientist C

Dr. O.P. Modi, Scientist C

Dr. S.S. Amritphale, Scientist C

Dr. A.K. Gupta, Scientist C

B.K. Prasad, Scientist C

V.S. Muneshwar, Scientist B

Dr. R.K. Rawlley, Scientist B

A.K. Singh, Scientist B

Rupa Dasgupta, Scientist B

S.P. Pathak, Scientist B

D. Mondal, Scientist B

N. Saha, Sr. Draftsman

K. Venkateswarlu, STA

J.P. Pandey, Foreman

T.S.V.C. Rao, JTA

P.K. Rangari, JTA

U. Mukut Lakra, SLA
Ramesh Kosthi, SLA
R.K. Gurjar, Lab. Asstt.
P.N. Patil, Lab. Asstt.
A.K. Asati, Technician
Bharat Patil, Mechanic
M.L. Gurjur, Plumber
L.N. Mehra, Helper
L.N. Sahu, Helper
Indraj Yadava, Security Guard
G.B. Gurang, Security Guard

MINERALS DIVISION

Dr. C.B. Raju, Scientist EI & Head
J.P. Barnwal, Scientist C
Dr. B. Govindarajan, Scientist C
Dr. D.P. Patil, Scientist C
Murari Prasad, Scientist B
L. Sanjeeva Rao, Scientist B
A.K. Majumdar, Scientist B
K. Udaya Bhaskar, Scientist B
B. Kujur, SSA
P. Banerjee, SSA

Manoj Kumar Ban, JSA

Jayant Konar, JTA

K. Kosala Rao, JTA

B.L. Pradhan, Helper

RESOURCES DEVELOPMENT DIVISION

Dr. R.N. Yadava, Scientist EII & Head

P.D. Ekbote, Scientist EI

Dr. M.V.R.L. Murthy, Scientist C

Dr. Arati Roy, Scientist C

Minimol R, Sr. Steno.

Devilal Rathore, Security Guard

ENGINEERING SERVICES DIVISION

B.K Saxena, Scientist F & Head

K.K.S. Gautam, Scientist EI

R. Dubey, Assistant Executive Engineer

M.K. Jain, Jr. Engineer (Elect.)

Manik Chandra, STA

P.C. Meshram, SLA

Akhtar Ullah, Electrician

S.K. Suryavanshi, Jr. Electrician

D.K. Singh, Mechanic

S.K. Raikwar, Helper

LIBRARY

Rishi Kumar, Librarian

Abhay Yadava, Reneo Operator

Dayaram, Safaiwala

DIRECTOR'S OFFICE

T.P. Prasanan, Sr. Steno.

Manisha Dubey, Jr. Translator

Vishwanathan N., Sr. Steno.

Sathi Vijayan, Sr. Steno.

R.N. Pradhan, Security Guard

ADMINISTRATION

G. Simhachalam, Controller of Admin.

B.N. Dikshit, Section Officer

Vinod Dahate, Section Officer

H.N. Rao, Lab. Supervisor

R.N. Ram, Assistant

S.K. Chaudhary, Sr. Personal Asstt.

Anita Daniel, Receptionist

Vishakha Ramteke, Jr. Steno.

Swagatika Pal, Reneo Operater

Asha Trivedi, LDC

Jaipal Kujur, LDC

N.K. Pethari, LDC
Devtanand Prasad, Tea-maker
Md. Rafiq, Driver
Ramcharan Malvi, Driver
G.S. Yadav, Driver
Ram Kishore, Driver
Arun Saxena, Guest House Keeper
Vijay Golait, Messenger
Anil Gond, Messenger
K.P. Tripathi, Security Guard
G.D. Sootha, Cook-cum-Bearer

FINANCE & ACCOUNTS SECTION

A.D. Bhardwaj, Sr. F&AO
S. Chandrahas, Section Officer (F&A)
P.K.Satyanesen, UDC
C.V.B.Subramanian, LDC
N.S. Jadav, Messenger

STORES & PURCHASE SECTION

Mukesh Khanna, Dy. SPO
Girish Chand, UDC
D.M. Chilbule, S/P Asstt.
R.N. Sharma, Record Keeper
Harihar Singh, Watchman