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Indian Plywood Industries Research and Training Institute (IPIRTI), an autonomous organisation of the Ministry of Environment and Forests, GoI., is an unique multi-disciplinary research centre in the field of composites from wood and other lignocellulosic materials. The core mandate of this Institute is to carry out Research and Development, Training, Testing, standardisation and dissemination of research findings. In order to fulfill the vision, this Institute undertakes multidisciplinary research, provides technical advice to practical problems and disseminates information to the various stakeholders, end users and the public.

Effective utilization of short rotation plantation timbers, wood substitutes from bamboo and other natural fibres/agro residues, development of adhesives from renewable materials, new challenges in detection and reduction of formaldehyde and VOC from panel products, development of Fire retardant panels, studies on life cycle analysis and carbon footprints of new-generation engineered wood products are the focal areas of current research.

Institute provides a broad spectrum of scientific and technological activities extending from basic laboratory scale research to plant level operations in the field of wood and other renewable lignocellulosic materials. Thus, IPIRTI is a multifaceted institution wherein the inhouse research findings are further upscaled for adoption by the industries.

Well equipped laboratories, pilot plant facilities with advanced equipments, and availability of expertise from all fields of science and engineering are the unique features of IPIRTI. The mechanical and chemical laboratories of this Institute have obtained NABL accreditation. This Institute is committed in taking the nation to a new horizon of knowledge and development in the field of lignocellulosic based panel technologies. This Institute has been able to attract International and national organizations like FAO, UNDP, IDRC, INBAR, TRADA, MOEF, BMTPC, NMBA, COIR Board, etc., as well as number of wood based industries to sponsor funding of research work.

I greatly appreciate the contributions made by scientists, technologists and other supporting staff of this Institute for maintaining a high performance level as well as their commitment to meet the future challenges and expectations of the target group.

IPIRTI in FOCUS highlights the important R & D and Training activities carried out in this Institute in the recent past.

Dr. C. N. Pandey
Director, IPIRTI

October 2011
IPIRTI IN FOCUS

ABOUT IPIRTI

STATUS

♦ The Institute is a Society registered under the Karnataka Societies Registration Act, 1962; Union Minister for Environment & Forests is the ex-officio President of the Society. Statutory members include Secretaries to Government of India in Ministries of Environment & Forests, Agriculture, Science & Technology and Planning Commission, Director General of Forests-MoEF, Chief Secretary-Government of Karnataka, Director General-ICFRE and representatives of scientific organizations like CSIR and regulatory bodies like BIS. Membership is also open to industries. It is recognized (since 1989) as a Scientific & Industrial Research Organization by the Government of India under the Department of Scientific and Industrial Research Scheme, 1989.

♦ It is also recognized (since 1999) as a nodal centre by Forest Research Institute, Dehra Dun for pursuing Research programme for award of Ph.D. degree.

♦ The Institute has its headquarters at Bangalore spread over an area of about 7 hectares where the most modern R & D, testing & training facilities are housed. It has outreach field station (FS) located at Kolkata. Recently a IPIRTI Centre has been established at Mohali in Punjab to cater the needs of the industries in the North West region.

MANDATE

♦ Research on all aspects of production of sawn timber, manufacturing of plywood and other allied engineered and reconstituted wood or lignocellulosic products, including improvement in manufacturing processes, machines and appliances, time and motion studies, standardization of methods of working in factories.

♦ Training in connection with forest products utilization for panel and allied industries. Imparting technical education and/or training at undergraduate, postgraduate, and/or any other level in technology of forests products, adhesives and paper laminates, and/or synthetic finishing, testing and preservation.

♦ Testing and standardisation of all forest products viz. plywood, wood, hardboard, particleboard, chipboard, furniture, glue-lam, compreg, doors, panel doors, block boards, flush doors, veneered panels, veneers, laminated panels, composite boards, and the products of allied trade including resin, chemicals used in the manufacture of panel products and also in treatment of wood.

♦ Transfer of technology to the industries for commercialization. Assist the industry or entrepreneur to update the process and product. Organize seminar/workshops and participation in exhibition to create public awareness about eco-friendly products.
VISION

♦ IPIRTI’s Vision is to be an apex institution of international repute for conservation of natural forests through research and development and adoption of efficient technologies in the field of wood and panel products from renewable fibres including plantation timbers and bamboo, while meeting the vital needs of the developing society.

HISTORY

1962 : Indian Plywood Manufacturer’s Research Association (IPMRA) was formed as a co-operative research laboratory under the umbrella of Council of Scientific and Industrial Research (CSIR) for undertaking applied research on PLYWOOD, an important wood based panel material.

1970 : The Institute was re-designated as Indian Plywood Industries Research Institute (IPIRI)

1978 : Administrative control was transferred to the Ministry of Industry, Govt. of India so as to bring it under user Ministry

1988 : Realizing the need for trained manpower for wood based panel industries, training facilities in Mechanical Wood Industries Technology were established with the assistance of Food and Agriculture Organization (FAO)/United Nations Development Programme (UNDP)/Government of India (GoI).

1990 : As recognition to the greater role of the Institute in conservation of natural resource, the administrative control was transferred to the Ministry of Environment and Forests, Govt. of India.

1992 : As a reflection to its premier position in training for Mechanical Wood Industries Technology as a centre of excellence, the name of the Institute was changed to Indian Plywood Industries Research and Training Institute (IPIRTI)
IPIRTI
(Autonomous body of the Ministry of Environment & Forests, Govt. of India)

PRESIDENT
Union Minister of Environment & Forest, Govt. of India

CHAIRMAN
Board of Governors, Secretary, MoEF, Govt. of India

DIRECTOR

Head Quarters & Central Laboratory, Bangalore
Field Station Kolkata
IPIRTI Centre Mohali
INDIAN PLYWOOD INDUSTRIES RESEARCH AND TRAINING INSTITUTE
(AUTONOMOUS BODY OF THE MINISTRY OF ENVIRONMENT & FORESTS)

Head Quarters & Central Laboratory, Bangalore
- Biology
- Physics
- Chemistry
- Process Development, Engineering, Saw Milling & Sawdoctoring
- Product Application
- Information Technology

FIELD STATION KOLKATA
- Centre for Bamboo Development
- Centre for Testing and Evaluation of Wood Composites
- Extension
- Training

IPIRTI CENTRE MOHALI
- Extension
- Training
- Testing
IPIRTI Field Station Kolkata

IPIRTI, Field Station Kolkata is a specialized National Laboratory recognized by Bureau of Indian Standards under the certification scheme for testing of wood & wood based panel and other lignocellulosic material since 1970. It has NABL accredited laboratories.

It is having well equipped laboratories for testing of plywood, particle board, block board, flush door shutter, synthetic adhesives for wood and panel products, identification of timbers, preservative in composite products and in raw materials. Samples received from various agencies like BIS, CPWD, Department of Atomic Energy, Garden Reach Shipbuilders, Port Trust, Naval Department, wood based industries and Govt. / Semi Govt organizations are tested as per relevant Indian standards. It is also equipped with modern facilities like Digital door testing equipment, Trinocular Microscope, 10 Ton Digital UTM, Fire retardancy test equipment etc. It has facilities for evaluation of preservative chemicals against borers, fungi and termite attack for timber and panel products.

With a view to enhance the highly intrinsic qualities of entrepreneurs, to build confidence, refresh and to upgrade the skill of practicing industrial personnel in wood based industries, regular short term training courses are organized in several areas of plywood, resin manufacturing and preservative technique. Facilities are also extended to chemical, mechanical and science graduate students to undertake short term projects.

This field station takes up multidisciplinary and applied research projects on problems identified by the industries. In addition to in house projects, sponsored projects funded by Industry, Govt. agencies are also taken up with top most priority.

This field station provides extension services like technology transfer, publication of newsletter, visit of scientists to industries on request, consultancy service, publication of article in journals etc. The field station has a unique library dealing with various aspects of wood, wood based panel products, adhesives, journals, research reports, BIS standards.

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IPIRTI Centre, Mohali

IPIRTI Centre, Mohali is a specialized laboratory recognized by the Bureau of Indian Standards (BIS) under the Laboratory Recognition Scheme. Also process for obtaining NABL accreditation is underway.

It is fully equipped with the latest test equipment and is manned by trained personnel to facilitate testing of wood and wood based panel products such as plywood, block board, flush door, particle board, MDF, veneers, resin, chemicals etc., as per relevant Indian and other National Standards besides providing solutions to the floor level problems of the industries in the region and upgrade skills of technical manpower through short-term courses on manufacture and testing of wood based panel products.

IPIRTI-Centre at Mohali was accorded recognition by BIS for testing of panel products as per IS 303, 710, 4990, 1659, 2202 & 1328.

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Tel No: 0172-5095875
STAFF POSITION

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REVENUE GENERATED

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IPIRTI has been closely associated with the development of panel industry in the country and also instrumental in growth from its infant stage of producing tea chest grade plywood ninety years ago to the present level of technical competence to produce not only high quality general purpose plywood but also special grades of panels including marine, structural, aircraft, decorative plywood, and a host of other panel products like block board, particle board based on wood and other forest and agro residues.

Since its inception, research projects were carefully selected based on the perceived needs of the panel industry. Research projects were approved by the Program Advisory Committee chaired by DG, ICFRE and consisting of representatives from leading plywood industries of the country and also from other Govt. Institutes/Organizations. Consequent to transfer of the Institute to the Ministry of Environment and Forests, the research agenda is set and monitored by the Research Advisory Committee headed by the leading plywood industrialists and has representatives from other major R&D organizations, under various Ministries of the GoI, apart from the Industry. The projects are formulated based on the needs of the industries. Such projects are reviewed in the Internal Research Committee meetings and are then presented to RAC for approval. Projects sponsored by different national agencies like BIS, BMTPC, DST, NRDCL and international agencies like DFID/TRADA, INBAR, ITTO are also undertaken. Global concern for protection of environment and conservation of bio-diversity are reflected in the research programmes. Multidisciplinary and applied research projects based on problems identified by the Institute, industries and other interested organizations are taken up. All programme are approved and supervised by the Research Advisory Committee.

Guided by the shortage of prime timbers from forests, the Institute is pursuing three pronged strategy for bridging the gap between demand and supply for industrial round wood, namely:

i Development of appropriate processing technologies for efficient utilization of plantation grown timber species for manufacturing quality wood and panel products including plywood of different grades, block boards, flush door shutters, particle board and medium density fibre board.
Evolving technologies for using non-wood renewable fibers to manufacture alternatives to wood, including development of environment and people friendly products from bamboo. In recent years bamboo has emerged as an important source of renewable fibre for manufacturing industrial products, some of which are excellent alternative to wood.

Enhancing service life of composite products made from wood and other lignocellulosic materials. The Institute continues to work for evolving suitable treatment regimes and code of practices using environmental friendly chemicals.

The result oriented approach in executing R&D projects has enhanced the confidence level of sponsors of the projects. As a consequence there is a spurt in increase in the number of projects being sponsored over the years.

Institute is currently focusing on the following thrust areas:

1) Development of natural fibre reinforced bio-composites.
2) Development of bio-adhesives for panel products
3) Formaldehyde and VOC emission free binder for panel products
4) Enhancement of service life of panel products by eco-friendly preservatives
5) Fire retardant panel products
6) Energy auditing, Carbon footprint and LCA study on all next generation engineered wood products.
7) Formulation of environmental standards at par with International Standards for plywood and panel industries.
8) Cost effective and energy efficient bamboo based housing

Ongoing Research Projects during the period including sponsored are classified in following categories:

1) Wood and Wood Composites
2) Composites from bamboo & other non-wood ligno cellulosics
3) Enhancing Service Life
Considering the rapid growth of plantation timber which will be the major industrial round wood raw material in the country, main focus of research related to wood and wood composites is on development of efficient technologies for effective utilization of such wood. Important areas of R&D are: effective saw milling and veneering techniques for small girth plantation logs, modifications to band saws for enhancing yield of quality sawn wood, finger jointing, edge jointing and glue lamination techniques, LVL, treatment of veneer, glueline poisoning, and preservative treatment for enhancing service life of plywood.

**Indigenous Finger Jointing Machine - IPIRTI & BMTPC**

**Demonstration Facility for Finger Jointing of Plantation Timber**

Finger-jointing of timber is more relevant in the present context of non-availability of traditional timbers. Most of the rapid growth plantation species have higher proportion of juvenile/reaction wood and growth stresses which can cause development of cracks, bending and twisting during sawing and further processing. Due to these inherent characteristics it is not possible to get good grade timber even in lengths exceeding 1 meter. However, from such short girth wood it is possible to produce dimensionally stable long length timber using finger-jointing techniques.

Building Materials & Technology Promotion Council (BMTPC), New Delhi had got developed Indigenous Finger-Jointing Machines. A complete finger jointing facility comprising of BMTPC developed machines, dust extractor and glue applicator has been established at IPIRTI in collaboration with BMTPC, for demonstration, Training and R & D.

A study was also undertaken at the Institute to evaluate strength of finger-jointed wood produced from various plantation grown species such as eucalyptus, silver oak and rubber wood using the indigenous machines. It was found that finger-jointed timbers have strength in the range of 60-73%.
Effective Utilization of Small Girth Logs

There is sizable production of Sal (Shorea robusta) poles of girth around 1½–2’ in South West Bengal. Because of the presence of rock bed in that area, the growth of the girth is restricted to the above size even after 6 to 7 years. In its efforts to better utilization of sal poles, the West Bengal Forest Corporation approached Institute to explore the possibilities of making door/window frame from such poles.

Though from Sal poles, a few straight poles of the lot, 100 mm x 75 mm and 75 mm x 50 mm sections were obtained, undesirable surface cracks have been observed. By sawing logs of diameter equal or more than 100 mm, into thin sections of 25 mm thick and adopting finger-jointing and glue lamination techniques, these poles can be effectively utilized for the fabrication of standard door and window.

Instruments Developed at IPIRTI to Measure and Adjust Lathe Setting Parameters

In rotary cutting, the quality of veneer peeled depends to a large extent on the lathe settings. These are mainly pressure bar compression, or the associated horizontal and vertical gaps between the tip of the knife edge and the pressure bar, knife angle, knife bevel and knife edge height with respect to spindle centers. Among these variables the horizontal gap and the knife angle are the most critical ones which require careful adjustment to get a better peel quality of veneer. Veneer characteristics which depend mainly on lathe settings are uniformity in thickness, tightness and smoothness.

A horizontal gap indicator and a feeler gauge instrument were developed by IPIRTI to adjust the horizontal and vertical gap respectively. Also to adjust the knife angle, a knife angle indicator was developed by IPIRTI and for all these instruments the license for manufacture and supply has been granted to M/s. Kalyan Industries, Yamunagar.

Veneer Tenderizing Machine

A Veneer tenderizing machine was developed to tenderize veneers in order to reduce the tendency of bending, warping and twisting of veneers and plywood panels made from fast grown plantation timbers. The technique adopted in developing the machine is based on slit method of tenderizing which is different from the conventional method of tenderizing done by making incisions on veneer.
Veneers from rubber wood which is highly prone to develop twisting and warping due to juvenile nature of wood were tenderized with the help of this machine. Plywood panels of 13 mm thickness and 1.2 m x 2.4m size were produced and tested for evaluating the performance of this machine. The study showed that veneer tenderizing machine is very effective in controlling the warping of panels.

**Laminated Veneer Lumber from Plantation Timber (LVL)**

LVL is a layered composite and is manufactured by gluing thin veneers together with the grain direction of all plies oriented parallel to the length of the billet. Using of veneers result in higher recovery available from small girth logs.

Laminated veneer lumber (LVL) is one of the evolving new types of wood composites that possess reliable and high strength for various design purposes and allow for superior utilization efficiency of timber resources and is an alternative to wood. It provides not only larger and convenient sizes but also higher and more reliable engineering properties.

Panel door manufactured using LVL as stiles and rails withstood 100 slams without any damage when subjected to slamming test as per the relevant Indian specification that prescribes only 50 slams.

**Veneer Flexi Ply**

The currently available plywood of minimum 3mm thick cannot be moulded to desired shapes. To have aesthetic appearance of the products everyone would prefer to give their design pattern and also choose a product which can be moulded to their desired patterns. Hence a study was undertaken to develop Veneer-bamboo Mat flexi ply.

The process parameters for the manufacture of Veneer-bamboo mat flexi ply of 8mm thick have been optimized. The strength properties are satisfactory.

The product developed will be architectural friendly in various end uses mainly due to their flexible pattern to any shape with adequate strength property.
Development of Technique for the production of Face Veneer from reconstituted Plantation Timber

At present, imported timbers like Keruing/Gurjan are peeled to make 0.23 to 0.28 mm thick face veneers for making plywood. The sources of supply of these imported species are getting depleted drastically, day by day. Hence, there is an urgent need to find out alternate methods of making face veneers to meet the challenges posed by the shortage of face quality veneers.

At IPIRTI Flitches of size 2.5 m x 0.15m were made using plantation species viz., Poplar, Eucalyptus and Rubber wood. Sliced veneers were produced with different grain patterns. Quality of face veneer produced was satisfactory.

Alternate Test Method to 72 Hours Boiling Test Prescribed for Plywood and Block Board in Indian Standard Specifications

Currently 72 hours boiling is prescribed for higher grades of plywood and BWP grade blockboard to determine their resistance to water by wet glue shear strength and adhesion of plies[knife test]. As 72 hours boiling is time consuming, development of an alternate test method was taken up to reduce the duration of testing. This will facilitate industries to have better control on the quality of their products. In this method samples are subjected to constant steam pressure for a definite duration after initially creating vacuum inside the chamber. Vacuum Pressure Test [VPT] apparatus was designed and got fabricated.

Based on the results, 6 hour steaming by VPT apparatus can be used as an alternative to 72 hrs boiling for higher grades of plywood and block board. Recommendation has already been made to Bureau of Indian standards in this regard to include 6 hour steaming by VPT apparatus as an alternative to 72 hrs boiling for higher grades of plywood and block board.

Life Cycle Assessment of Plywood and Bamboo Composite Products

All Bamboo and Plantation wood based products are biodegradable, hence the life span study is a vital necessity for these new generation products. Keeping this in view, the project on life cycle assessment of plywood and bamboo composite products was taken up. This study would help in the development of an analytical framework for evaluating life cycle, environmental and economic impacts for alternative materials.
PIRTI IN FOCUS

PIRTI has carried out the energy audit and the Carbon Emissions study of plywood and Bamboo Mat based composites at different manufacturing units. It has been found that the carbon emissions for the manufacture of one ton Bamboo mat based composites, a total of 1.308 tons of carbon dioxide emission equivalent is obtained, compared to the emissions produced by steel being 3.8 tons and for Aluminium and plastic being 1.5 tons and 3.0 tons respectively. Studies have revealed that the processing of wood to panel products leads to a net carbon gain of 0.140 tons equivalent carbon dioxide per ton of plywood, while the measurement of carbon footprint of bamboo products from procurement of raw material to finished products indicates that there is a net gain of carbon in the process resulting in substantial storing of carbon.

Improving Productivity and Quality of Plywood by Pre-Pressing Techniques

Cold pressing of veneer assemblies into temporary bonded sheet before hot pressing is a very common practice in plywood industry all over the world. Sufficient number of veneer assemblies up to a height equal to the opening of the cold press are assembled together and taken for prepressing. The process is regarded as an inseparable part in plywood manufacture.

Benefits of prepressing:
1. Overall improvement of quality of plywood with respect to blister and delamination. Face defects can be reduced to almost zero level through repairing after prepressing.
2. Manufacture of higher thickness plywood up to 40 mm, which, so far, could not be done as the total assembly thickness of veneer is higher than the opening of daylights in hot press.
3. Manufacture of overlaid or decorative plywood in a single hot pressing cycle. At present double hot press cycle is used for such product.
4. Economy in plywood production: There is economy in resin consumption, overhead for production comes down with increase in production (about 20%), and there is a decrease in defective products.
5. Use of aluminium cauls can be partially or totally avoided.

Technology package for adoption of pre-pressing technique in the existing plywood mill is available at PIRTI.
Recent earthquake devastated Japan, causing unprecedented havoc, claiming lives and property on a scale hard to imagine. However, seismologists observe that few died in the Island nation due to building collapses, given that the Japanese have perfected the technology for quakeproof constructions. It was the ensuing tsunami that cost most lives.

India may not be prone to earthquakes of the same intensity, but there are regions that require earthquake proof housing. The Indian Plywood Industries Research and Training Institute (IPIRTI) has developed and tested a bamboo-based house suited to disaster-prone areas.

The Bamboo based House built by the institute based on IPIRTI -TRADA Technology was tested in the institute premises for the efficacy of the structure recently. The Bamboo house was tested by mounting it on a ‘shock table’ and delivering a series of base shocks through a simple pendulum device, the impact of which was comparable to earthquakes.

The Bamboo house resisted seven repetitions of a typical Zone 5 earthquake, the highest in India and equivalent to over 7 on the Richter scale, showing no signs of falling apart, in contrast to a concrete structure. There were only a few cracks showing at the end of the most intensive of shocks.

The house has split bamboo grid and wire mesh, plastered with cement mortar for walls with bamboo columns providing support. The ceiling is made of light bamboo mat corrugated sheets developed by IPIRTI, Bangalore.
NON-WOOD COMPOSITES

Development of panel products from non-wood renewable lignocellulosic materials is an important area of research. Technology for manufacturing rice husk particle boards, developed in mid seventies, being commercialized by the National Research Development Corporation, GoI, has been transferred to a firm in Malaysia. In recent years bamboo has assumed great importance as a source of renewable fiber for manufacturing industrial products, some of which are excellent alternate to wood. IPIRTI has developed successful technologies for manufacturing several mat based industrial products from bamboo i.e. bamboo mat board, bamboo mat veneer composite, bamboo mat moulded products, bamboo mat corrugated sheet for roofing. Technologies for bamboo wood (laminates) and bamboo match sticks have also been developed at the institute and mat based technologies have already been commercialized and strip based technologies are ready for commercialization. Works on structural panel products from bamboo strips are in progress. Another new research area is utilization of agro-forest residues like coir, pine/casuarina needles for manufacturing composite boards suitable for specific end uses in place of plywood/wood particle/fiber boards.

Bamboo Mat Board and Bamboo Mat Veneer Composite

Bamboo, with over 170 genera and 1250 known species occurring in the world, is one of the most important non-wood forest products. It’s importance as a highly versatile renewable fibre resource and as an industrial raw material is being rediscovered all over the world. IPIRTI is actively pursuing research for developing bamboo composites to substitute wood products for over a decade now.

The Bamboo Mat Board Technology developed at the Institute during the nineties under a project funded by the International Development Research Centre, Canada was recognized to be a practical demonstration of implementation of Agenda21 by the International Selection Commission of the EXPO 2000 at Hannover, Germany. Consequently the technology was registered as a “Project around the World”.

The MoEF sanctioned a project in March 2000 on “Field Demonstration and Development of Bamboo based Laminates and Panels for housing in North Eastern Region”. The project

Shri. A. K. Bansal, IFS, as Director, IPIRTI receiving EXPO 2000 Award

Bamboo Mat Board
aimed refinement of the technology for manufacturing BMCS and installation of pilot production facilities at an existing bamboo mat factory in the north-eastern region; development of bamboo laminates and construction of demonstration houses in Mizoram.

**Bamboo Mat Corrugated Sheet**

Since corrugated sheets are most versatile for roofing, development of corrugated sheets from bamboo mats was taken up at IPIRTI, under a project sponsored by the Building Materials and Technology Promotion Council of the GoI. Sinusoidal wave platens have been designed for hot pressing phenol formaldehyde resin coated and preservative treated bamboo mats into corrugated sheets. BMCS is environment friendly, energy efficient and possesses good fire resistance. Material developed is first of its kind in the country. Technology on Industrial upscaling of BMCS was transferred to M/s. Timpak Pvt. Ltd. Meghalaya.

**International Green Apple Award**

The prestigious International Green Apple Award for Environmental Best Practice 2005 was conferred to Indian Plywood Industries Research and Training Institute, Bangalore (India) by The Green Organization, U.K., which is an independent, non-political, non-activist, nonprofit environment group dedicated to recognizing, rewarding and promoting environmental best practice around the world.

A Certificate and trophy have been presented to IPIRTI in a glittering Presentation Ceremony at the House of Commons, London on November 8th 2005. The Green Apple Awards ceremony was hosted by the Rt. Hon. Patricia Hewitt MP, Secretary of State for Health.

On behalf of the Institute Director Dr.C.N. Pandey received the Award on 8th November 2005 at the House of Commons, London, U.K. The Award was given to IPIRTI for development of technology in the manufacturing of BMCS, a substitute for asbestos cement, galvanized iron and aluminium corrugated roofing sheets.
Bamboo Mat Ridge Cap for Bamboo Mat Corrugated Roofing Sheet

The main raw material for the production of Ridge cap is mats from Bamboo which is the fastest growing plant, suitable for plantation and occurs naturally in the forest. Bamboo is to be converted into mats that are woven by rural/tribal people. The product is both environment and people friendly.

A Technology was developed at IPIRTI in collaboration with BMTPC for the production of Bamboo Mat Ridge Cap which is compatible with BMCS and is suitable for a wide range of roof angles.

Development of Compreg from Bamboo Mat and Veneer from Plantation Timber or in Combination

The importance of this project was to develop high strength specialty product from bamboo mat/plantation timber.

A high tonnage capacity hot press was installed and commissioned. Compregs were made using three different construction viz., bamboo mats, veneers from plantation timbers (Silver oak & Eucalyptus) and combination of bamboo mats with veneers of plantation timbers. The panels were tested for general purpose compregs as per the relevant specification given for the wood veneer compregs. The strength properties meet the requirement of the relevant specification in all the three constructions.

The compregs developed can find application in railway coaches and for electrical grade compreg.

Development of Cellular Core Flush Door from Solid Bamboo

The importance of this project was the replacement of timber in the core frame with bamboo ring and maximum utilization of bamboo with virtually no waste.

Cellular Core flush door developed using bamboo rings reduces the wood consumption in the manufacture of solid door frame to an extent of 70–75%.

The bamboo rings thickness required for making cellular core flush door were optimized so as to have uniformity in the rings. Cellular core flush doors were made using the bamboo rings as an infill material and the outer surfaces were 3mm thick BMB. The panels were subjected to different test conditions to compare its strength properties with the existing flush door specification. The strength properties were encouraging. Resin formulation and process parameters have been optimized.
Development of Floor Tiles-Glazed and Mat Finish from Bamboo Strips

The institute has developed an ideal flooring material as an alternative to conventional flooring material, where high load and stretches are encountered.

The resin formulation and the process parameters for manufacturing floor tiles from bamboo strips have been optimized. Two different surface finishing for the tiles were studied. It was observed that the strength properties were encouraging and found that bamboo strip based tiles with melamine finish can be used as flooring tiles.

The outcome of this study led to the development of flooring material from bamboo which can replace ceramic tiles or marbles with improved surface design to make the product attractive to users.

Design and Development of Bamboo House Construction Techniques

Development of best construction techniques for house using bamboo and its composites and plantation wood was carried out at the Institute in collaboration with TRADA Technology, UK. It is meant to promote the techniques through regulatory bodies/housing associations/NGO’s, etc.

A prototype house has been constructed at IPIRTI campus and detailed testing of components including wall, roof trusses, roofing sheets, joints etc. has been conducted. A demonstration house has also been constructed at Karnataka Nirmiti Kendra, Chikbettahally, Bangalore.

Two Bedroom Guest House

A two bed room residential house was constructed at IPIRTI premises, Bangalore using IPIRTI-TRADA bamboo housing technology (developed by IPIRTI in collaboration with TRADA Tech. of UK under the DFID funded KAR project R7140)

Two Storey Bamboo House

IPIRTI has demonstrated the feasibility of creating affordable, safe, secure and durable shelter using bamboo in construction with other locally available materials. This is very much suitable for hill stations. The challenge now is to demonstrate that the technologies are equally viable for other structures, typically two storey buildings, community centers etc. in areas where there was no exposure to the new thinking that bamboo construction offers.
Pre-Fab House for Disaster Mitigation

Utilizing bamboo composites in the form of structural wall panels and roofs in combination with steel, it would be possible to design pre-fabricated shelters or huts. Design and development of shelters utilizing bamboo composites are easily transportable, erectable and re-usable at a reasonable cost.

A pre-fabricated Twin House was constructed in the month of May, 2007 using Bamboo based composites at Matana Palla Forest area in Randhikpur Range under a project funded by Baria Forest Division, Gujarat.

The house was constructed in a remote forest on the slope of a hill at 50ft above ground level having the most economical dimension of 20ft x 24 ft x 8ft. It is resting on a cement concrete platform having Bamboo Mat board as wall panels and Bamboo Mat Corrugated sheet as roof cladding. The panels are fixed to the steel framed structure which resists wind load and dead load in both directions. The structure completed in all respect was erected at site in 2 days by trained manpower.

Moulded Skin Board from Bamboo Mat for Door Shutters

The Institute has developed several eco-friendly panel materials from bamboo and other forest and agro based residues. Popularization of the new generation eco-friendly materials needs development of good quality utility furniture and joinery products using these panel materials.

Under this project, work was undertaken to develop bamboo mat skin board for making hollow core doors.

It was observed that the hollow core door made with bamboo mat moulded skin conformed to the performance requirements as specified in IS-15380. The trials taken for overlaying the door with PVC foil in a membrane press was also found to be satisfactory for imparting wood like appearance.

The present practice of making hollow core doors in the country using moulded skin boards made out of high density fibre board which were imported, could be replaced to some extent with bamboo mat moulded skin. The BMMS has better mechanical properties and flexibility compared to HDF which are more brittle and has low resistance to impact load and susceptible to breakage.
Rice Husk Particle Board

Among all the agricultural residues, the most abundantly available is rice husk. It is the by-product of the most important agro-based industry in the country, namely paddy milling. Rice husk is available in the country to the extent of 2 million tones per annum. Research work to find ways and means to utilize rice husk for the production of useful materials is under way for the past two decades or so. However due to its high silica content, the conventional process of making particle board was not successful.

The RHPB technology developed by IPIRTI was transferred in 1985 to National Development Corporation (NRDC) of New Delhi, India, A GoI Enterprise, for further development and commercialization.

As on date, NRDC has licensed the technology to seven other units in the country. The technology was adopted internationally through establishment of a unit in Malaysia, namely Rh Sdn Bhd. Another unit in Indonesia is reported to be in the pipeline.

IPIRTI has refined a technology for manufacturing multilayered particle board using modified phenol cardanol formaldehyde resins. The strength properties of the panels meet the requirement as per relevant specifications. The boards possess high termite decay and fire resistant.

The proposed technology has a high environmental impact, since utilization of rice husk in one way prevents deforestation.

Development of Technology for the Manufacture of Corrugated Roofing Sheets from Coir Non-Woven Felt

To meet the growing demand of roofing sheets especially for building, investigations were carried out at IPIRTI to develop cost effective, energy efficient and eco-friendly technology to make corrugated sheet from Coir non-woven felt.

The studies carried out under this project clearly indicates that coir felts can be efficiently and effectively used for manufacturing corrugated sheets in combination with bamboo mats that will be ideal for roofing and other structural applications. A cost effective resin adhesive based on Phenol Cardanol formaldehyde resin of 42% solid content was developed in which preservative chemical was also added so as to enhance service life and to improve decay and insect resistance.
Development of Technology for Manufacture of Particle Board from Bagasse

Bagasse is the residual pulp from sugar cane (Saccharus officinarum L.) after the juice has been extracted. A considerable amount of excess bagasse generated from sugar mills are only left to rot or burnt as fuel for boilers. As a fire and an environmental hazard, this waste material possesses a challenge in waste management to the sugar mills and a concern to the environmentalists pose a serious disposal problem. Bagasse waste attracts scientists and researchers with a greater challenge to utilize and convert this waste material into useful and low-cost marketable products. The widest application of bagasse is in the manufacture of particleboards as low-cost construction materials and for the furniture industries. IPIRTI has developed a technology for the manufacture of Bagasse particle boards which emits less formaldehyde and meets the requirement of strength properties as per IS: 3087- “Specification for medium density particle boards”.

The presence of pith in the bagasse has an unfavourable effect on the quality of board produced as it decreases the value of mechanical properties. Hence depith bagasse have been utilized in the studies.

Development of Wheat Straw Pulverized Board

Wheat is a major cereal and extensively grown in North India. A research was carried out at IPIRTI to develop cost effective particle board from wheat straw. Resin formulations and the process parameters were optimized to manufacture wheat straw pulverized board on laboratory and pilot scale. Panels of size 2’ x 4’ were made and tested for the specified properties. The panels meet the requirements of strength properties.
Development of Low Cost Phenol Formaldehyde Adhesive

In order to reduce the cost of existing phenol formaldehyde resin a three stage processing method for phenol formaldehyde resin was developed. Under this project the resin formulation and the process variables for the manufacture of 3 stage resin for making BWP grade panels using different species have been optimised.

The outcome of this study was the development of cost effective PF resin for BWP grade panels.

Partial Replacement of Phenol Formaldehyde resin by Para Phenol Sulphonic Acid

This study was under taken to overcome the phenol crisis in the panel industry.

Different percentage replacement of phenol by para phenol sulphonic acid phenolic resin were worked out. Panels were manufactured using these resin and tested for its glue shear strength properties. The work under this project has indicated that maximum 40% of phenol in conventional phenol formaldehyde resin could be replaced to make resin suitable for making BWR grade plywood as per IS:848.

The outcome of this study was the partial substitution of phenol by paraphenol sulphonic acid in phenolic resin for making BWR grade panels and thereby reducing the cost of the final product. A low condensed PF resin system developed to bond veneers of M.C. 6-16%. The strength properties of the panels conforms to ‘BWP’ grade as per relevant specification.

Development of Phenolic Resins for Bonding High Moisture Content Veneers

The importance of this study was to bond high moisture content veneers. Also this study increases the production capacity and input of less energy for drying.

First a low condensed PF resin system extended with tanin slurry was developed to bond veneers of M.C 6-16%. The strength properties of the panel conforms to BWP grade as per revelant specification.
Development of Phenol Lignin Formaldehyde Resin/Adhesive suitable for Industrial Plywood Production as per Indian Standards

Partial replacement of phenol in phenol-formaldehyde resin by renewable material of natural origin was attempted at the Institute.

The quality of the Phenol Lignin formaldehyde resin is dependent on the quality of the lignin used to replace phenol partially. Earlier several attempts were made to develop Phenol Lignin formaldehyde resin adhesive. But because of the non-availability of uniform quality of lignin, the PLF resin could not meet the requisite strength properties of the panels. Keeping this in view, M/s. Asian Lignin Manufacturing subsidiary of a Swiss Company approached IPIRTI to develop phenolic resin by partially substituting phenol with a branded powder lignin product viz., Protobind 1075.

Lignin [Protobind-1075] powder supplied by M/s. Asian Lignin Mfg. was used to substitute phenol in phenol formaldehyde resin. Upto 30% replacement of phenol in PF resin has been found to yield sufficiently good quality resin to manufacture boiling water resistant plywood conforming to relevant BIS specification.

Phenol Lignin Formaldehyde (PLF) resin was found to be 27% cheaper as compared to that of conventional phenol formaldehyde resin. Demonstrations were undertaken in some plywood industries.

The output of this study led to the replacement of phenol partially by lignin in phenolic resin for manufacturing higher grade plywood.

Development of Moisture Resistance (MR) Grade Plywood by substituting the commercial Extenders by an Additive (VISCOPLUS) in Urea Formaldehyde Resin Adhesive

Study was undertaken to replace the commercial extender by an additive viscoplus in lower percentage.

To reduce the total percentage of extenders in UF/UMF resin while maintaining the uniform quality of glue mix, different grades of Viscoplus, an amylaceous material, were studied. It was found that 5-6% addition of Viscoplus 305 and 5% addition of
Viscoplus 430 as an alternative to that of 10-12% Maida/GNCP in UMF resin adhesive formulation gives excellent results and meets the requirement of MR grade as per IS:848-2006. The total cost of the adhesive was considerably reduced.

**Development of Adhesive from Bio Materials**

Screening and utilization of various bio materials obtainable from natural renewable sources were experimented to achieve reduction in the use of petroleum based chemicals and to reduce cost and disposal of industrial wastes for better utilization, thereby reducing the pollution problems.

To achieve consistency in the characteristics of lignin extracted from black liquor, an ultrafiltration process was studied for commercial implementation.

In these investigations, the ability of industrial black liquor obtained after alkaline digestion of wood and the fractions obtained by membrane separations were used in development of phenolic resins by partial replacement of phenol.

The molecular fractions and the resin formulation for replacing phenol by black liquor were optimized for the manufacture of Boiling water proof grade plywood.

It was observed that 20-30% replacement of phenol by black liquor of molecular weights 5000-10000 and 10000-15000 in phenol formaldehyde resin is possible with cost reduction in phenolic resin adhesive in the range of 20-30%. The panels conformed to as per IS 848-2006.

Mimosa wattle [Tannin] was used for extending with PF resin for manufacture of plywood using veneers having moisture content greater than 6%. Tannin was used as additive in phenol formaldehyde resin adhesive.

The panels bonded with 6-10% and 12-16% m.c. of veneers showed excellent results with both 20% and 25% extension by tannin in phenolic resin. It was found that tannin extended PF resin adhesive is 25-32% cheaper than conventional PF resin. In addition, the energy required for drying of veneer also gets reduced thereby reducing the total cost of the product further more.
Development of Plywood for Packaging Purposes conforming to GOST Standards

The study focused on the development of cost effective phenol formaldehyde resin for the manufacture of packaging plywood that meets the requirement of International specifications such as GOST and NEFAB ASIA standards.

Species suitable for packaging plywood having light colour viz, Rubber wood and Poplar were identified. Process parameters for peeling full size veneers of size 8’ x 4’ were optimized. The drying and veneer yield studies were carried out. Phenol formaldehyde resin of 40-42% solid content was developed which meets the cost requirement of the sponsor. Adhesive formulation and process parameters for making the panels were optimized and the panels were evaluated for strength properties as per GOST and NEFAB ASIA standards.

Development of Soya Based Resin for Manufacturing Plywood

With a resurgence of high cost of phenol, partial replacement of phenol with renewable material like soya in the manufacturing of plywood was initiated.

Soya chunks were powdered to make soya flour. Denaturing of soya flour was chemically done and the process parameters for denaturing with minimal hydrolysis were optimized. Further the resin was prepared by replacing upto 40% phenol by soya flour in the phenol soya formaldehyde resin for the manufacturing of plywood and particle board.

Laboratory scale boards upto 40% replacement of phenol by soya flour was successfully developed. The panels made conforms to the requirement of BWP grade plywood as per IS:848-2006. The physical mechanical properties of the panels made on lab scale conforms to the requirement Grade 1 plywood as per IS:303 for general purpose plywood.

Setting Standard for Formaldehyde Emission in Particle Board

Study was undertaken to standardize the method for evaluation of the wood based panel product for release of formaldehyde at steady state so that the material could be well assessed before use where human habitat exists.

In this study 1m³ chamber facility was established at IPIRTI as per the European Standards (ENV 717-1). The
process parameters for evaluating the steady state emission of formaldehyde were optimized. Various urea formaldehyde resin formulations were worked out and the products bonded with these adhesives were evaluated for emission of formaldehyde by exposing the samples in the chamber. Also few samples of Urea formaldehyde resin bonded particle boards were collected from the industries and were subjected for testing to evaluate the level of emission of free formaldehyde from the product. A Standard Urea formaldehyde resin formulation with suitable scavengers to meet the requirement of E1 emission class prescribed in EN 13896:2004(E) was worked out. Draft standard for testing of formaldehyde emission from panel products were communicated to BIS.

### Chemical Treatment of Effluent Discharged in Plywood Industries for Recycling of Water

Preservative chemicals like salts of copper, chromium and boron are used for treating wood and wood panels to make them termite, borer and fungus resistant. Also resin wash water from resin plant, glue mixer and applicator are drained out from plywood factories as effluent. All these chemicals, if present above the prescribed limits in the effluent, are potentially hazardous. Therefore to comply with clean water act requirements, the waste water must be treated (i.e. contamination needs to be removed) before being discharged to water ways.

In this study an effluent treatment plant was established and the effluent discharged from the resin kettle washings, glue spreader washings and preservative tank solutions were treated with suitable absorbing agents which not only assures removal of harmful chemicals from the effluent of the plywood factory but also paves way of using these preservative chemicals for better purpose.

### Protection of Wood and Non-Wood Products

Most of the fast growing plantation timbers are characterized by lower natural durability compared to traditional timber species. Therefore, service life of wood products made from the fast growing plantation timbers is relatively short. Enhancing their durability, using eco friendly preservatives with appropriate treatment regimes, is very essential. Various projects related to wood and wood based composites including bamboo are being identified and carried out based on the needs of the industry.
Preservative Chemicals Tested and Certified at IPIRTI

1. Bifenthrin 2.5 E.C
2. Chlorpyrifos 50 WT (Dursban 50 WT)
3. Lindane 20 E.C
4. Spinosad 2.5% S.C

Efficacy of Copper-Ethanolamine-Boron based Wood Preservative against Wood Destroying Organisms

In the present scenario, Copper-Chromium-Boron (CCB) is widely used as wood preservative. But chromium is on the way to get banned as it is believed to be causing environmental pollution. Hence, it was essential to find out alternative wood preservative chemicals. IPIRTI has identified ethanolamine as a replacement for chromium as a fixative agent and this chemical combination with copper and boron have proven to be effective against wood destroying organisms.

Development of Alternative Treatment Procedure for Marine/Shuttering Grade Plywood

It is mandatory that marine and shuttering plywood should possesses preservative chemical retention of 12 kg/m3 as per relevant specification. However, it has been observed that loading of 12 kg/m3 of preservative chemicals by recommended process is very difficult and if this is done by pressure impregnation process, lot of damage takes place to the plywood. To overcome this, at IPIRTI an alternative treatment method of GLP with surface veneer treatment has been worked out.

The Observations on exposure of samples against termite, borer and fungus attack are being recorded frequently. Twenty months study has been completed and all the samples are absolutely free of attack from wood destroying bio-agents.
Training, essentially is an integral part of human life. In recent years, Human Resource Planning has assumed great significance in manufacturing sector which includes wood based panel industry.

The training centre in this Institute was established by the Government of India with the assistance of United Nations Development Programme (UNDP) and Food and Agriculture Organisation (FAO) of the United Nations in the year 1988.

Since then, the Institute is catering to Human Resource needs of the wood based panel industries through several training programmes. In this endeavour the Institute has excellent infrastructural facilities for classroom teaching, laboratory and factory simulated facilities for “hands on” training in Sawdoctoring, Saw milling, Plywood, Resin, Blockboard Manufacture and Testing. Apart from lectures by experienced in-house specialists and invited resource persons, audio-video sessions and laboratory practicals, emphasis is given to impart and improve skills through demonstration and floor level working.

a) Post Graduate Diploma Course in Wood and Panel Products Technology

One-year Post Graduate Diploma Course in Wood and Panel Products Technology is the only course of its kind available to Science/Engineering graduates who wish to make a career in wood based industries. The course covers not only the principles, but also extensive practical/hands on exercises to make the trainees highly competent professionals suited to the industry. Merit based selection of candidates for the course is done on all India basis with an annual intake of 25-30. The training schedule of Post Graduate Diploma Course includes visits to various wood based industries. The date of commencement of the course is published in Newspaper/Employment news and is also available on the Institute’s Website (www.ipirti.gov.in)

b) International Training

With the establishment of a full-fledged Training Centre, IPIRTI has acquired the competency of conducting training courses to International level. IPIRTI has attracted the SAARC countries to get their personnel trained in this Institute. Since then IPIRTI has conducted four training programmes.
c) Short Term Training Course

With a view to provide facility for skill upgradation of industrial personnel in wood-based industries, vocational training courses with period varying from 1-10 days in several critical areas of veneering, plywood/resin manufacturing, preservation techniques, testing & quality management, saw milling/saw doctoring and finger jointing of wood are conducted. Special training programmes are also organized at the request of industries, regulatory departments/organizations of Union/State governments, and non-government organizations.

d) Training for IFS Officers

Having realized the importance of Utilization of forestry wealth and their end use applications, the Ministry of Environment & Forests felt the need of training programme for IFS Officers and advised IPIRTI to hold Training Courses for its Officers from various States. Accordingly IPIRTI welcomed the suggestion and is regularly conducting courses for IFS Officers deputed from Ministry of Environment and Forests.

e) Centre for Ph. D Research

In recognition of the research facilities available at the Institute in the field of wood and non-wood composites during 1999, Forest Research Institute (FRI), Deemed University, Dehra Dun has recognized IPIRTI, as one of the Nodal Centres for pursuing research programmes leading to award of PhD.

f) Training Programme on Bamboo based Housing

Training Programme on Bamboo based housing system for the Master trainers sponsored by agencies like Institute for Vocational Education and Training (IIVET), IGNOU, NGOs, etc. are conducted at IPIRTI, Bangalore.
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<tr>
<th>No.</th>
<th>Course Description</th>
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<tr>
<td>1</td>
<td>One Year Post Graduate diploma course in Wood and Panel Products Technology</td>
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<tr>
<td>2</td>
<td>Short term courses for 1-5 days on the following disciplines</td>
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<tr>
<td>i)</td>
<td>Plywood Manufacturing Technology-I (Veneer processing, log storage, centering, peeling, clipping, drying and knife grinding)</td>
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<tr>
<td>ii)</td>
<td>Plywood Manufacturing Technology-II (Economic adhesive, resin manufacture, gluing, hot pressing)</td>
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<td>iii)</td>
<td>Veneer peeling techniques</td>
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<td>iv)</td>
<td>Peeling and knife grinding</td>
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<td>v)</td>
<td>Knife grinding practices for peeler and slicer knives</td>
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<tr>
<td>vi)</td>
<td>Flitching of logs and veneer slicing, matching and knife grinding</td>
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<tr>
<td>vii)</td>
<td>Flitching of logs and veneer slicing</td>
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<td>viii)</td>
<td>Resin manufacturing, pre-pressing and hot pressing</td>
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<td>ix)</td>
<td>Block board and Flush Door Manufacturing</td>
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<td>x)</td>
<td>Production management in plywood industry</td>
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<td>xi)</td>
<td>Trouble shooting in plywood manufacture</td>
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<tr>
<td>xii)</td>
<td>Testing of panel products</td>
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<tr>
<td>xiii)</td>
<td>Sawmilling, seasoning, finger-jointing, &amp; glulam techniques</td>
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<tr>
<td>xiv)</td>
<td>Sawmilling and seasoning</td>
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<td>xv)</td>
<td>Wood seasoning</td>
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<td>xvi)</td>
<td>Good practices in carpentry &amp; wood finishing techniques</td>
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<td>xvii)</td>
<td>Maintenance of Band saws and TCT saws</td>
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<td>xviii)</td>
<td>Bamboo primary processing</td>
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<td>xix)</td>
<td>Bamboo primary processing and Mat making</td>
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<tr>
<td>xx)</td>
<td>Preservative treatment for Bamboo</td>
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<tr>
<td>xxi)</td>
<td>Manufacture of Bamboo Mat Board</td>
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<tr>
<td>xxii)</td>
<td>Bamboo based housing system</td>
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Product testing is an important activity aiming at production of quality products by the Industry and helping consumers, including Government organisations in checking quality of goods purchased. IPIRTI is also a laboratory recognized by BIS for testing of wood and wood composites and products for licensing/certification programme. Limited test facility is also available in the Field Stations at Kolkata and Mohali.

CENTEC-Center for Testing and Evaluation of Composites, under the aegis of Indian Plywood Industries Research and Training Institute [IPIRTI] is a specialized national laboratory recognized by Bureau of Indian Standards [BIS] under the certification scheme for testing of wood and wood based panels and other lignocellulosic materials, adhesives, adhesive components, preservative chemicals, identification of timber species, etc., for conformity to Indian and other Standards.

The Institute continues to play significant role in formulating and evaluating standard specifications for wood, wood products and products from lignocellulosic materials including bamboo by serving on various committees/subcommittees of BIS, the national standards body of India responsible for formulation of standards.

This Institute has core competence in specialized testing of panel products for acoustic properties, thermal conductivity, abrasion resistance, weathering studies, formaldehyde emissions, fire check doors, surface glossiness, toxicity index, timber identification, analysis of preservative chemicals, efficacy of wood preservative chemicals, etc. as per national/international standards.

Both the Physical and Chemical Laboratories of the Institute have obtained NABL accreditation.
Saw Milling

In the present context of scarcity of traditional wood raw material it has become very much necessary to process small girth logs in an efficient manner. IPIRTI has one of the best equipped sawmill in the country for the purposes of training on production of quality sawn timber with minimum waste from small girth logs. The Institute has also developed fixtures for existing band/headrig saw machines to optimize sawing quality. Training in sawmill includes simple techniques to improve existing sawmilling practices to increase productivity, waste utilization, log and sawn timber grading. Emphasis is on processing technologies to produce acceptable quality sawn timber from commonly available plantation grown species like rubber wood, eucalyptus, poplar, silver oak, coconut and palm woods.

Saw Doctoring

Saw maintenance is an important aspect of sawmilling. The saw doctoring workshop of the Institute is equipped with modern machines for conducting training in maintenance of TCT saws and Bandsaws. In TCT section, training is imparted in (i) levelling and tensioning of circular saws, (ii) carbide tip brazing and debrazing, (iii) grinding of face, top and sides of carbide tips, etc. In Bandsaw section training is imparted in (a) levelling, tensioning and back gauging of bandsaws, (b) joining of saws by welding and brazing, (c) stellite tipping, (iv) grinding of tooth profiles, (d) swaging, shaping, spring setting, etc. Saw doctoring workshop also underakes reconditioning of TCT saws and band saws from industries.

Plywood Manufacturing

IPIRTI is equipped with a pilot plant facility to produce plywood of standard dimensions (2.4mx1.2m, in different thicknesses). Training in plywood manufacturing technology includes theory and practical classes on veneer peeling, slicing, veneer drying, preservative treatment, resin manufacture and plywood making. Short term courses emphasize on the latest technological developments related to veneer peeling/slicing techniques, economic resin systems and adhesive formulations to produce different grades of plywood including protection of wood and wood composites. The courses will immensely benefit the industry to (i) produce quality products (ii) minimize rejects (iii) conserve raw material (iv) bring down the production costs, etc.
Block Board and Flush Door Manufacturing

Block board and Flush door are two specialized panel products manufactured in many plywood factories. There are a few factories manufacturing only these products. Considering the performance requirements of the enduse and related BIS specifications, manufacture of block board and flush doors requires in-depth knowledge of techniques and high level of skill in workmanship, particularly due to increasing use of fast growing plantation timbers. Necessity has arisen to develop and use appropriate technologies, adhesive system, preservative treatment schedules for manufacture of these products using plantation timbers. IPIRTI offers an updated training course in block board and flush door manufacture which would help industries to overcome the constraints faced by them. The course curriculum includes prophylactic & preservative treatment of timber/veneer and finished products, improved sawing system of low girth, low density plantation timber for higher yield and better quality, improved adhesive formulations for bonding wood and veneers from plantation timber, mechanism to reduce glue penetration through thinner face veneer and reduce warpage in boards.

Particle Board Plant

Particle board is an alternative panel to plywood. Manufacture of particle board can be done with any type of wood and other lignocellulose material and conversion ratio of particle board is higher than plywood.

Pilot Plant for Particle board serves many purposes: (1) Exploration of the suitability of various timber species, soft and hard for particle board manufacture. (2) Development of suitable adhesive with low formaldehyde content and standardize process parameters. (3) HRD through training for supporting the industry. (4) R & D for product development.

Paper Impregnation Plant

Overlays are gaining more importance in Plywood, MDF and Particle board industries. It enhances the durability and water resistance properties for the panel products. Overlays are being made in the country utilizing the kraft paper as a base material and then impregnated with resin. Keeping this in view, IPIRTI has established a paper impregnation plant facility for carrying out R & D and training activities.
Protection of Wood and Wood Based Panels

With the advent of short rotation plantation timbers for manufacture of wood based panels treatment against wood destroying agency is essential to enhance durability. The industries have reached a stage wherein “preserve or perish” has become the slogan. IPIRTI training aims at transferring the skills with proper understanding of the principles of wood treatments for protection of wood and wood based panels against fungi and insects and thereby enhancing their service life. Emphasis is laid upon eco-friendly preservative chemicals. Treatment of raw material before processing or during manufacturing stage and treatment of finished products is an integral ingredient of all training courses offered at the Institute.

Testing of Wood Based Panels

For maintenance of quality, material/product testing is an important aspect of any manufacturing process, particularly for those using highly heterogeneous materials like wood. To be successful in highly competitive market, many industries try to achieve Bureau of Indian Standard (BIS) certification. Hence BIS have made it mandatory for the industries to set up a testing laboratory in their production unit to become eligible for ISI mark. Keeping these requirements in view, the Institute has established a wide range of the facilities to test wood and wood products, adhesives, adhesive components, preservative chemicals and identification of timber species, as per National/International standards.

Apart from providing testing facilities, the Institute imparts practical training on testing of wood/wood based panels as per relevant Indian Standards Specifications both in one year PGD course and short term courses. Special short term courses on “Testing and Evaluation” are also conducted on request from industries or Govt.departments and other organisations.

Short Cycle Laminating Press

A Short cycle laminating hot press of 1200 Tons capacity and 2.6 mx1.4 m platen size with conveyor system was installed in the Pilot Plant for laminating panel products.
Wide Belt Sander

A three head Wide belt sander specially designed to calibrate Particle board for obtaining smooth surfaces and thickness uniformity of panel size 1330mm x 2500mm and panel thickness of 2.5 mm to 150mm was installed in the pilot plant.

Pilot Plant Facility for Ultra Filtration of Black Liquor/Lignin

A new pilot plant facility consisting of three columns to house three different size ceramic membrane having different molecular sieve with two stainless steel (SS) tank, of 40 liter capacity has been recently established at IPIRTI. The three vertical membrane is connected with feed pump (3HP) The equipment is meant to fractionate chemical in mixture into definite molecular fractions by passing through micro-sieve of ceramic column. Using this equipment various molecular mixtures, present in waste black liquor was fractionated into various molecular weight range and the same were used for manufacture of adhesive for wood based panel products.

Xenon Weather-O-Meter

To upgrade the accelerated weathering studies with actual weather effect like sun spectrum with all range of irradiance, lower and higher range of relative humidity and also the rain effect a Xenon weather-o-meter was installed at IPIRTI. This higher version of accelerated Xenon Weather-o-meter is capable to generate data on simulated conditions as per all the national and international standards related to weathering.

Natural Weather Station

Natural weather station was installed with accessories which is capable to record the actual weather datas like sun light irradiance, rain fall, temperature and wind speed. Each day data will be summarized to the server at 23.59 hours. Sample holding rack can be tilted to any degree as per choice.
Fire Door Testing Equipment

The salient features of the door testing setup are the Vertical front open furnace structure with refractory bricks & ceramic wool blanket for best heat insulation. The chamber is fitted with Computer programmable Automated LPG burners, hot gas exhaust system with automated dumper, pillar mounted I beam jib crane with electric hoist, Test frame to hold door under test with trolley and roller skid, Thermocouple assembly with good measurement accuracy, PC based multi channel data logger; etc. The facility is used for fire rating of door as per international standards.

Tests for Door Shutters

Door shutter is an essential feature in all buildings both residential and commercial. All the door shutter manufacturing units in the country have been advised by the BIS to set up facility for test of door shutter in order to apply for BIS stamping. Since, no such equipment was readily available for the industry to purchase and install, IPIRTI designed and fabricated a prototype door shutter tests equipment. All tests prescribed in Indian Standard Specification IS:4020-1998 can be conducted using this equipment. A short term course on tests for door shutters has also been introduced.

Mechanized Processing of Bamboo

Bamboo, a high yielding renewable resource is one of the strongest building materials. In the present day crisis of shortage of timber and very fast growth of bamboo, world over attention is getting focused on development of appropriate technologies for using in several applications. Bamboo in panel form is best suited to replace wood in many applications. Therefore, bamboo is slowly gaining the importance as an industrial raw material to manufacture wood substitutes. In India, technologies have been developed for making bamboo mat based composites like BMB / BMVC / BMCS / BMRC / BMMSB which are both environmental and people friendly. At present bamboo slivering is done manually for weaving mats - which are the main raw material for bamboo composites. Some of the disadvantages of these manmade slivers are variation in thickness, less productivity. Manual slivering through nodal portions of bamboo is also difficult and results in lower yields. To overcome these limitations of manual slivering, the Institute has established facilities for mechanized processing of bamboo, with machines for cross cutting, splitting, knot removal and sliver making. Institute conducts special short term courses on mechanized processing of bamboo for the handicraft sector and bamboo composites industry.
### TECHNOLOGIES DEVELOPED AT IPIRTI

#### Adhesives

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacture of Urea formaldehyde resin</td>
</tr>
<tr>
<td>2</td>
<td>Manufacture of Urea Melamine formaldehyde resin</td>
</tr>
<tr>
<td>3</td>
<td>Manufacture of Phenol formaldehyde resin</td>
</tr>
<tr>
<td>4</td>
<td>Manufacture of Phenol Melamine formaldehyde resin</td>
</tr>
<tr>
<td>5</td>
<td>Manufacture of Phenol resorcinol formaldehyde resin</td>
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</tbody>
</table>

#### Special adhesives system

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Phenol lignin formaldehyde resin</td>
</tr>
<tr>
<td>2</td>
<td>Phenol formaldehyde resin for gluing preservative treated veneers for BWP grade plywood</td>
</tr>
<tr>
<td>3</td>
<td>Low temperature/fast curing two stage PF resin</td>
</tr>
<tr>
<td>4</td>
<td>Manufacture of light coloured Phenol formaldehyde resin for teak veneer overlay on plywood</td>
</tr>
<tr>
<td>5</td>
<td>Manufacture of cardanol phenol formaldehyde resin</td>
</tr>
<tr>
<td>6</td>
<td>Manufacture of low cost phenol formaldehyde resin (3stage)</td>
</tr>
<tr>
<td>7</td>
<td>Phenol lignin formaldehyde resin using lignin powder (Protobind)</td>
</tr>
<tr>
<td>8</td>
<td>Phenol lignin formaldehyde resin using black liquor of optimized molecular weight</td>
</tr>
<tr>
<td>9</td>
<td>Tannin extended phenol formaldehyde resin</td>
</tr>
<tr>
<td>10</td>
<td>Phenol formaldehyde resin incorporated with fire retardant chemicals</td>
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</tbody>
</table>

#### Process Development (Wood composite)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-pressing technique for plywood manufacture</td>
</tr>
<tr>
<td>2</td>
<td>Dual cycle hot pressing process to reduce compression loss and blisters in plywood</td>
</tr>
<tr>
<td>3</td>
<td>Galvanized iron overlaid plywood</td>
</tr>
<tr>
<td>4</td>
<td>Veneer Peeling and Slicing Techniques for manufacture of plywood.</td>
</tr>
<tr>
<td>5</td>
<td>Compregs using dyed veneers of plantation species</td>
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</tbody>
</table>
## Non-wood Product Composite

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Rice husk particle board</td>
</tr>
<tr>
<td>2</td>
<td>Bamboo Mat Board</td>
</tr>
<tr>
<td>3</td>
<td>Bamboo Mat Veneer Composite</td>
</tr>
<tr>
<td>4</td>
<td>Bamboo Mat Moulded Trays</td>
</tr>
<tr>
<td>5</td>
<td>Bamboo Mat Corrugated Sheet</td>
</tr>
<tr>
<td>6</td>
<td>Casuarina needle particle board</td>
</tr>
<tr>
<td>7</td>
<td>Bamboo Mat Ridge Cap</td>
</tr>
<tr>
<td>8</td>
<td>Wheat Straw Particle Board</td>
</tr>
<tr>
<td>9</td>
<td>Bamboo Particle Board</td>
</tr>
<tr>
<td>10</td>
<td>Particle Board using Bagasse particles</td>
</tr>
<tr>
<td>11</td>
<td>Bamboo Mat moulded skin board for doors</td>
</tr>
<tr>
<td>12</td>
<td>Particle Board from pulverized rice straw</td>
</tr>
<tr>
<td>13</td>
<td>Bamboo Match Sticks</td>
</tr>
<tr>
<td>14</td>
<td>Bamboo Laminates/Flooring Tiles</td>
</tr>
<tr>
<td>15</td>
<td>Products from Pine Needle</td>
</tr>
<tr>
<td>16</td>
<td>Products from coconut coir non woven felt</td>
</tr>
<tr>
<td>17</td>
<td>Affordable Bamboo based Housing System</td>
</tr>
</tbody>
</table>

## Solid Wood

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Design of Sawmills - small/medium for processing small dia - logs</td>
</tr>
<tr>
<td>2</td>
<td>General improvements in the existing sawmills for higher recovery</td>
</tr>
<tr>
<td>3</td>
<td>Technologies for processing small diameter plantation species for the production of quality sawn timbers (Eucalyptus, Silver Oak, Rubber Wood, Coconut Wood, Palm Wood)</td>
</tr>
<tr>
<td>4</td>
<td>Laminated Veneer Lumber</td>
</tr>
<tr>
<td>5</td>
<td>Finger Jointing and Edge Lamination of Wood</td>
</tr>
<tr>
<td>6</td>
<td>Products from finger jointed wood</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Title</td>
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<tr>
<td>--------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>Glued Laminated Wood: Technology for Finger-Jointed &amp; Glued Laminated Wood</td>
</tr>
<tr>
<td>8</td>
<td>Design &amp; Construction of Glued plywood components for structural application</td>
</tr>
</tbody>
</table>

**Protection of wood & Non wood products**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>End-coats to protect green veneer logs from end-cracking</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Protective measures for plywood against insect/ borers</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Prophylactic protective treatment for veneers during storage and transit</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Protective treatment methods for plywood using chlorinated hydrocarbon in the glue line</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Protective measures for plywood using organophosphorous compound in the glue line</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Treatment schedules for veneers, plywood and core stock of flushdoors/block boards using sodium borate compound</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Economical treatment method for veneers and plywood made of non-durable and imported species with NaTCP (Sodium trichlorophenate)</td>
<td></td>
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<tr>
<td>8</td>
<td>Remedial treatment against insect attack on wood and wood based panels in storage</td>
<td></td>
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<tr>
<td>9</td>
<td>Eco friendly preservatives for treating higher grades of plywood as an alternative to conventional preservative chemicals</td>
<td></td>
</tr>
</tbody>
</table>

**Instruments developed at IPIRTI**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electronic Clipper Control System for the Plywood Industry</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Peeling lathe setting Instruments, viz:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Knife angle Indicator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Horizontal Gap Indicator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Knife Height Gauge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Micro level device</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Veneer Tenderizing machine</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Veneer Finger-Jointing machine</td>
<td></td>
</tr>
</tbody>
</table>
Patents Obtained

1. Process for making Composite Boards from Rice Husk
2. An Adhesive composition based on Natural Polyphenols
3. Development of Match Sticks from Bamboo
4. Development of Bamboo Mat Corrugated Sheet
5. A method for the manufacture of Bamboo Mat Moulded skin Board Door from woven Bamboo Mats
6. A method of manufacture for high density shuttering grade panels from Bamboo Mat/plantation timber or in combination of both.

Patents Filed

1. A Method of Manufacturing Flooring Tiles from Bamboo Strips
2. A method of manufacture of Bamboo Mat Ridge Cap (BMRC) for Roofing with Bamboo Mat Corrugated Sheets (BMCS)
COLLABORATIVE ORGANIZATIONS

Collaboration with International Organizations
- FAO/UNDP
- IDRC, Canada
- INBAR
- DFID/TRADA, UK
- MASONITE CORPORATION, USA
- Weyerhaeuser, USA
- AMERICAN HARDWOOD EXPORT COUNCIL
- WKI, GERMANY
- INTERNATIONAL HABITAT FOR HUMANITY, NEPAL
- NEFAB INDIA PVT. LTD, SWEDEN
- UNIVERSITY OF APPLIED SCIENCES(HNEE), GERMANY

Collaboration with National Organizations
Government Organizations
- BMTPC
- CENTRAL PULP & PAPER RESEARCH INSTITUTE
- MOEF – CT DIVISION
- NMBA
- COIR BOARD OF INDIA
- DRDL-HYDERABAD
- DST
- HP FOREST DEV. CORPORATION
- ICFRE-WORLD BANK
- ISRO
- PUNJAB FOREST DEV. CORPORATION
- RUBBER BOARD OF INDIA
- TAMILNADU FOREST DEPT.
- GOVT OF ORISSA
- KERALA STATE BAMBOO CORPORATION
- RRL TRIVANDRUM
- MADHYAPRADESH FOREST DEV. CORPORATION
- KARNATAKA STATE FOREST INDUSTRIES CORPORATION (KSFIC)

Private Organizations
- ADARSHA CHEMICALS, BANGALORE
- ALLIED RESINS, KOLKOTA
- BHARAT EARTH MOVERS LTD.
- BAIF, PUNE, MAHARASTRA
- CIBATUL, BOMBAY
- CENTURY PLY INDUSTRIES, KOLKOTA
- GREEN PLY INDUSTRIES LIMITED, KOLKOTA
- SARADA PLYWOOD INDUSTRIES LTD., KOLKOTA
- INDEUTSCH INTERNATIONAL, NOIDA
- NANO STEEL Pvt. Ltd.
- RALLIS INDIA Pvt. Ltd.
- FMC INDIA Pvt. Ltd.
1. Providing solutions to common problems faced by plywood and wood-based industries.

2. Visit to industries by scientists to attend technical problems in factories.

3. Transfer of technologies to industries/entrepreneur through Memorandum of Understanding (MoU).

4. Concession to member firms in fees for testing panel products, charges for saw doctoring services and training expenditure for candidates sponsored by industries.

5. Focusing on problems and needs of the industries in in-house R & D projects.

6. Formulation of specifications for new products and issue of draft amendments to the existing standards.

7. Highlighting the problems of the industry at Government level.

8. Undertaking sponsored projects assigned by the industries at IPIRTI for developing new products and processes.

9. Enlightening the members as well as non-members from plywood and wood-based industries by publication of quarterly IPIRTI NEWS bulletin and periodical updating of IPIRTI Websites.

10. Intimating the selected articles on plywood and wood products chosen from a wide range of national/international journals to user groups through “Wood Products Research Update.”

11. Testing of samples received from Members/Non-member firms, NGO’s and other Governmental department.

12. Training of industrial personnel at Floor level.
## BoG MEMBERS

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Position Details</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shri Tishyarakshit Chatterjee, IAS</td>
<td>Secretary, MoEF, Govt. of India, New Delhi.</td>
<td>Chairman</td>
<td></td>
</tr>
<tr>
<td>Dr. P.J. Dilip Kumar, IFS</td>
<td>Director General (Forests) &amp; Spl. Secretary to GoI, MoEF.</td>
<td>Vice Chairman</td>
<td></td>
</tr>
<tr>
<td>Shri A.K. Bansal, IFS</td>
<td>Additional Director General of Forests, (FC), MoEF, New Delhi.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>The Director General</td>
<td>Indian Council of Forestry Research &amp; Education, Dehra Dun.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri Kaushik Mukherjee</td>
<td>Principal Secretary Government of Karnataka Forest Ecology and Environment Department, Bangalore.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Mrs. Gauri Kumar,</td>
<td>Additional Secretary and Financial Adviser, Min. of Environment &amp; Forests, Paryavaran Bhavan, New Delhi.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Dr. B. Harigopal,</td>
<td>Adviser &amp; Head, SERC, Min. of Science &amp; Technology, New Mehrauli Road, New Delhi.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri A.K. Saini</td>
<td>Scientist &amp; Head (Civil Engg) Bureau of Indian Standards, New Delhi.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Prof. R.S. Deshpande,</td>
<td>Director, Institute for Social and Economic Change (ISEC) Bangalore.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri Sajjan Bhajanka,</td>
<td>President, Federation of Indian Plywood and Panel Industry (FIPPI), New Delhi.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri Mrutyunjay Behera,</td>
<td>Deputy Secretary, Dept. of Industrial Policy and Promotion, Ministry of Commerce &amp; Industry, New Delhi.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri A.K. Sharma, IFS</td>
<td>Managing Director, Gujarat State Forest Development Corp. Ltd., Gujarat.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri Kuldip Singh, IFS</td>
<td>Managing Director, Punjab Forest Development Corporation Ltd., Chandigarh.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Mr. Moiz S. Vagh,</td>
<td>Managing Director, Hunsur Plywood Works Pvt. Ltd.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri Jaydeep Chitlangia,</td>
<td>Managing Director, M/s. Sarda Plywood Industries Ltd., Kolkata.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri R. C. Lohia,</td>
<td>Managing Director, Merino Panel Products Ltd., Haryana</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri Amit Agarwal,</td>
<td>Managing Director, Gujarat Woodlam Products Pvt. Ltd., Surat.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri S.P. Mittal,</td>
<td>Chairman, Greenply Industries Ltd., Kolkata.</td>
<td>Member</td>
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<tr>
<td>Mr. Naresh Tewari</td>
<td>President, NIPMA, M/s. Venus Plywood Pvt. Ltd., Jalandhar</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Mr. Piare Lal</td>
<td>Technical Advisor Pragati Biotechnologies, Punjab.</td>
<td>Member</td>
<td></td>
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<tr>
<td>Dr. S.N. Rai</td>
<td>Retd. PCCF</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Shri R.K. Mehta</td>
<td>Chairman, Mozo Bamboo Technologies Pvt. Ltd., Hyderabad.</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Mr. Uday D N</td>
<td>Scientist, IPIRTI, Bangalore</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Dr. Vipin K. Chawla,</td>
<td>Scientist, IPIRTI, Bangalore</td>
<td>Member</td>
<td></td>
</tr>
<tr>
<td>Dr. C.N. Pandey,</td>
<td>Director, IPIRTI, Bangalore</td>
<td>Member - Secretary</td>
<td></td>
</tr>
</tbody>
</table>
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IPIRTI Bangalore Landmark