VISIT TO FRI, INDIA, FEBRUARY 2005

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SUMMARY

On 17th and 18th February 2005, I visited the Forest Research Institute (FRI) in Dehradun accompanied by Michael Swain from the NZ High Commission and N. Ravindran from NZ Trade and Enterprise. Also present from NZ were Bobby Gill from Tenon, Neil Mythen from Ramsey Roundwood and John Reelick from Tuakau Timber Treatment. The project to evaluate radiata at Dehradun is almost finished, with some durability studies yet to be completed. The results have largely confirmed all our claims about radiata although it was deemed to be not suitable for window and door frames, poles, and plywood unless a very high pressure is applied. It was deemed suitable for door/window shutters, furniture and packaging provided corewood was excluded and the timber was treated. These "failures" are more to do with the arbitrary and prescriptive nature of Indian Standards (IS), than with failures of the timber. The FRI proposed several projects that extend the studies done so far. I recommend those on window and door frames, training of the Indian timber processing industry, and studies on LOSP treated radiata. An approach should be made to the Bureau of Indian Standards (BIS) to amend some timber standards to allow for the nature of plantation-grown timbers.

NOTES ON THE EVALUATION PROJECT

At the meeting on the afternoon of the 17th, Dr Jain presented a summary of the results from each subproject. Their "highlights of findings" is appended.

Subproject 1 – WM – evaluation for windows, doors and poles

The wood mechanics evaluation consisted of sawing as many defect-free specimens (clearwood) of 2x2 inch cross section as could be obtained from the logs supplied. These were tested in both the green and dry condition to determine their properties in static bending, impact bending, tension parallel and perpendicular, compression parallel and perpendicular, shear, hardness, cleavage, nail and screw holding, torsion, toughness and shrinkage. The results were divided by reference values for teak and combined with various weightings according to IS standards for various applications. For the different applications the results indicated:

1. Door and window frames - a rating of 62% was obtained but the minimum acceptable is 65%. This is a difference of 5% which in practical terms is nothing but in terms of the rigid way the Bureau of Indian Standards (BIS) approach things is everything. The deficiency is caused by low bending strength and stiffness results, while all the other properties match NZ data. Once I obtain a copy of the detailed results from Andres Katz of CHH I can see whether or not the differences in testing procedure have caused this. It may be necessary to prepare another sample of test specimens, doing the sawn and drying in NZ to avoid any possibility of fungal attack. Their results show the typical improvement in properties from pith to bark in radiata, and while they accept that appropriate quality timber can be found by selection according to position within the log, this is not recognised by the IS. It is clear that IS were written around the evaluation of slow-grown indigenous timbers, not plantation-grown timbers. It was pointed out that future timber supplies will come from plantations mainly, so there is a need to revise IS to recognise this. They also enshrine the idea that teak is 100% suitable in every property, which is a nonsense. John Reelick had learned that normal construction practice is

to build doorways and window openings without regard to standard sizes (there are none), so standardisation in this area would be helpful.

2. Their results also disallow the use of radiata for poles, again according to IS standards – 35MPa green MoR vs required 45MPa which is a difference of 22%. This is a problem with the standard since radiata poles are used widely in other parts of the world. It was pointed out that the size of a pole can be specified to suit the intrinsic strength, so as to give the required performance. No simple solution to this one except to ignore it and trade in poles anyway.
3. For door and window shutters radiata just makes the grade provided corewood is excluded and the wood is preservative treated. This is a reasonable result.
4. Likewise for furniture and cabinets. I fail to see the need for preservative treatment unless termites are a serious hazard.
5. Likewise for packaging uses. I fail to see the need for preservative treatment of packaging since this is usually a very short term use of the timber and preservative treatment could very well conflict with the needs of the goods being packaged.

Overall the results of sub-project 1 do not show radiata to be as good as we claim it to be, but there is as much a problem with the prescriptive nature of the IS, as with the timber itself. Direct evaluation of window and door frames made from radiata should prove that it is a satisfactory timber and this will by-pass the unsatisfactory result using IS 12896.

Subproject 2 – CW – use for plywood and blockboard

Plywood was made using three levels of pressure in the press (normal, +40% and +70%). Radiata has excellent gluing properties so it was an unwelcome surprise to have it declared not to meet IS standards at the two lower pressures. The result has nothing to do with adhesion but with the strength value required to be achieved in the tests. The tests measure a rolling shear strength, not the strength of the adhesive bond. The high pressure combined with high temperature actually densifies the veneer and this is what makes it achieve the required strength in the samples pressed at the highest pressure. Not sure how to tell them I think their test is not measuring what they think it is. Possibly they are quite aware of that fact, it's just that they are required to blindly follow the prescriptive IS.

Subproject 3 – WS – seasoning tests

An entirely satisfactory result, from our point of view, was obtained from this sub-project. The warning about prophylactic treatment and drying as soon as possible after felling and/or sawing is good. It is possible to anti-sapstain logs before export but a serious educational effort is required to ensure that this advice is carried through once the logs reach India.

Subproject 4 - WWF - wood working, carving and finishing properties

A very satisfactory result was obtained in this sub-project too, confirming our claim that radiata pine has exceptionally good woodworking properties.

Subproject 5 – WP – evaluation of natural durability and treatability

This project has not yet been completed. The ease with which radiata can be treated was clearly demonstrated, although heartwood showed patchy penetration. As expected, termites made a quick meal of untreated radiata samples. The trials were done using creosote and CCA which is fine for outdoor applications but many of the uses are likely to be ones that involve direct manual

contact. Therefore trials with preservatives used with the Light Organic Solvent Process (LOSP) make sense, since this is the more likely preservative treatment method.

Subproject 6 – TE - suitability of Pinus radiata as structural timber

I thought their recommendation that radiata was suitable for trusses up to 4 metres span was ridiculous, and told them so. That was the span of the trusses they tested but engineering calculations justify the construction of trusses, beams, buildings, whatever, far larger than has ever been tested. I pointed out that in Rotorua the greatest span of trusses we have tested is 6 metres but in practice these are made with spans up to 40 metres. This conclusion will be deleted or modified in the final report.

RESEARCH PROJECTS PROPOSED BY FRI

These were presented at the meeting on the 17th and discussed further at the meeting on the 18th. It was determined that the proposals have come from FRI alone – i.e. there has been no industry request for this work. Tenon and CHH or NZTE should determine what need for this work exists in the Indian timber industry. I asked FRI to assist the NZ industry by providing data to show what is the potential improvement in market access for radiata that should accrue from the proposed studies. Even if no need currently exists, there are always the aspects of the use of this information in training the industry and the need to keep FRI "on our side" when they make recommendations to BIS. The proposal is given in Appendix 2. No undertaking was given regarding the proposed projects except to discuss them with the NZ industry but some comments were made, as noted below.

1. Development and Performance Testing of End Products

1. No need to study door/window shutters since it has already been determined that radiata is suitable for those items.
2. The more important item is door/window frames, so that should be included instead of shutters.
3. The use of radiata for packaging, furniture and cabinetry has already been recommended but the requirement for preservative treatment should be questioned before any go-ahead is given for these.
4. It is difficult to see what use studies on the use of radiata for panelling, flooring (they know it is soft), or for shingles could serve. Reports on these topics can be supplied from NZ.
5. Cooling tower use is a demanding application, both structurally and for durability, and possibly a large consumer. Again, studies have been done in NZ. More detail should be obtained from FRI as to the work intended so that it can be seen what information is already available.

2. Durability of LOSP Treated Wood for Different End Uses

This is probably an important topic since the studies done so far have been with CCA and creosote whereas LOSP is the more likely treatment method for out-of-ground uses such as door/window frames where termites will be the main hazard.

3. Suitability Studies for Block Board, Particle Board and other Panel Products.

The tests done so far proved nothing except that radiata has a lower rolling shear strength than whatever species the target value refers to. I think the IS used is irrelevant. In the NZ context the work proposed would normally be done in a pilot scale at Forest Research then followed up with

mill trials. I see little point in doing studies to show what can be more easily seen from a visit to NZ factories.

4. Studies on Property Improvement

It was explained that the Indurite process for hardening radiata is in commercial use and therefore subject to IP restrictions. Information on the use of other agents like UF, MUF, styrene and MMA is readily available from the literature so although the softness of radiata pine is a recognised deficiency, to do these studies at FRI would simply verify what is already known. Their diagram shows the polymer filling spaces between cells. In fact there are no spaces that can be filled between cells – it is the space within the cells (lumens) that can be filled. It sounds as though they do not know what they are talking about but I am sure they do. The discussion re the merits of filling the lumens vs impregnating the cell walls is valid but it reveals that the project is one of basic research, rather than one aimed at improving market access.

5. Demonstration cum Training Unit for End Products made from Radiata Pine

This proposal has considerable merit in my mind since one of the biggest problems is ignorance in the Indian timber processing industry. I suggested that it would be more appropriate to set up a facility at Kandalah, where the logs are imported. As a joint NZ/Indian industry venture this would be self-supporting commercially (hopefully), and could be used as an educational facility for the Indian industry to demonstrate and train workers in the correct processing of radiata pine. Their response was to explain that FRI is the national authority on all aspects of the timber industry and is already set up to run training courses at Dehra Dun. The implication is that they would not support at training facility elsewhere than Dehra Dun. The structure and terms of reference for such an activity needs to be carefully defined as it could be a black hole for expenditure.

CONCLUSIONS

- The evaluation project has largely verified our claims for radiata pine but with some disappointing exceptions that have as much to do with the prescriptive nature of the IS standards as with the properties of radiata pine.
- Once I have examined the detailed mechanical test results, there may be a need to conduct some retests on bending strength and stiffness on dry specimens, although a more quicker and definitive result might be obtained by evaluating actual frames.
- For some uses radiata is deemed suitable provided corewood is excluded, (which is reasonable), and it is preservative treated (which is not reasonable).
- Direct tests on door/window frames should overcome the disappointing result from the clearwood evaluation.
- The prescriptive nature of the IS is a problem and the BIS should be approached about this – such as recommending closer alignment with the performance-based ISO standards, and revising standards to take account of plantation-grown timbers which represent timber supplies of the future.
- Results of drying and woodworking trials were very pleasing and this information needs to be disseminated to the Indian industry.
- Treatment/durability studies should be repeated using timber that has been treated by the LOSP process.
- I see little justification for the proposed projects on panel products and wood hardening.

- Training and education of the Indian timber industry in the correct processing of radiata is important and FRI is regarded as the fount of all knowledge on timber in India so it is probably appropriate that the task of training be carried out by and through them.

APPENDIX 1– HIGHLIGHTS OF FINDINGS BY FRI

Sub-project 1. Timber mechanics

- The growth of radiata pine tree in early years is very rapid and tapers off in subsequent years.
- The sapwood percentage (82%) by volume was found to be significantly higher than the heartwood percentage (18%) and hence may need proper preservative treatment before being put into use.
- The scantlings obtained from the inner zone, which corresponds to a central core of around 125 mm in diameter surrounding the pith contained many knots.
- The central core which corresponding to about 4 – 5 years of rapid growth was found to warp, twist, slightly check and shrink excessively during air-drying of scantlings meant for preparing test specimens for testing in the dry condition having limited scope and therefore, detailed studies on these aspects are desirable.
- The central core was found to be of low density and inferior strength properties; increased outwards. The increase was found to be statistically significant at 5% for many of the studied properties. But, the increase was insignificant for properties evaluated in tension perpendicular to grain test and torsion tests.
- Radiata pine can be grouped as a moderately heavy, weak, not tough, moderately stable and soft timber on the basis of the present study.
- The average modulus of rupture in bending in green condition was found to be 34.8 MPa. This value is significantly lower than the minimum prescribed (45 MPa) for use as wood poles in IS 876 (1992).
- The strength coefficient of radiata pine was found to be 62. This value is lower than the minimum prescribed (65) for use as door/window frames in IS 12896 (1990). As any wood species is classified on the basis of average strength coefficient as per Indian Standards, no allowance can be considered for any part of the log discarded from utilisation.
- The strength coefficient and weight of radiata pine for use as door/window shutters was found to be 62 and 71 together with many knots in central core portion. The minimum value of strength coefficient and weight has been prescribed as 60 and 65, respectively. The central core was also found to be liable to twisting, warping and excessive shrinking during drying. The logs were found to consist of 82% sapwood by volume, which may further increase if the central core is discarded from utilisation. In view of these considerations, radiata pine was found to be suitable for use as door/window shutters as a group III timber provided material from the central core is excluded from utilisation and the timber is pressure treated as per the requirements of IS: 12896 (1990).
- The strength coefficient and weight of radiata pine for use in furniture and cabinets was found to be 53 and 71 together with many knots in the central core. The minimum value of strength coefficient and weight has been prescribed as 50 and 60, respectively. The central core was also found to be liable to twisting, warping and excessive shrinking during drying. In view of these considerations, radiata pine was found to be suitable for use in furniture and cabinets as a group III timber provided material from the central core is excluded and the timber is treated with preservatives as per IS: 401 (1982).
- Radiata pine was found to be suitable for use in packaging as a group III timber from suitability coefficient point of view provided material from the central core is excluded and the timber is treated with preservatives as per IS 401 (1982).

Sub-project 2. Composite wood

- General purpose plywood – Boiling water resistance grade. BWR grade plywood at a pressure level of 10.5 kg/cm^2 and 14.0 kg/cm^2 does not meet the IS standards. However, at a pressure level of 17.5 kg/cm^2, it meets the IS standards.
- General purpose plywood – Moisture resistance grade. MR grade plywood does not meet IS standards at all three pressures.
- Concrete shuttering plywood. Concrete shuttering plywood at a pressure level of 10.5 kg/cm^2 and 14.0 kg/cm^2 does not meet the IS standards. However, at a pressure level of 17.5 kg/cm^2, it meets the IS standards.
- Marine grade plywood. Marine grade plywood at a pressure level of 10.5 kg/cm^2 and 14.0 kg/cm^2 does not meet the IS standards. However, at a pressure level of 17.5 kg/cm^2, it meets the IS standards.
- Block board – exterior grade. Exterior grade block board at a pressure level of 10.5 kg/cm^2 and 14.0 kg/cm^2 does not meet the IS standards. However, at a pressure level of 17.5 kg/cm^2, it meets the IS standards.
- Block board – interior grade. Interior grade block board at a pressure level of 10.5 kg/cm^2 and 14.0 kg/cm^2 does not meet the IS standards. However, at a pressure level of 17.5 kg/cm^2, it meets the IS standards.

Sub-project 3. Wood seasoning.

- Radiata wood was found to be highly prone to staining, decay and insect attack.
- The wood is liable to little surface cracking, splitting or warping.
- It can be classified as non-refractory on the basis of air seasoning experiments.
- It may air season free from surface and end cracking with little care.
- Prompt conversion after felling, application of prophylactic treatment and rapid drying is recommended.
- It can be kiln dried without surface cracking, splitting and warping.
- Kiln schedule No II of IS:1141-1993 is tentatively recommended for 25mm thick planks.

Sub-project 4. Woodworking and finishing.

The woodworking quality of radiata pine was found to be better than teak in planing, sanding, turning and shaping operations. But the working quality was almost negligible in boring and mortising operations.

Overall performance and working quality index was found to be better than teak whereas ease of working was almost 10% lower than teak.

The species generally behaved satisfactorily for screen work in carving quality.

Olio resin does not ooze out on exposure to solar radiation for one year.

Sub-project 5. Wood preservation. (to be completed)

Periodic inspection to date show that:

Creosote treated samples of all logs at all concentrations and at all centres are in normal condition.

CCA treated samples showed that most of the samples of all logs were in the normal condition at Dehra Dun and Chakrata, whereas logs 12, 18, 21 and 34 are showing very slight to slight attack by termites and fungi at Jodphur.

Wood samples treated with CCA and creosote fuel oil are in normal condition at all centres.

Natural durability data revealed that untreated samples of all logs of pinus radiata are performing normally at Chakrata whereas in Dehra Dun most of the samples of all logs are in moderate to bad attack from termites and fungi.
In Jodphur natural durability data shows that most of the samples of all logs started decaying soon after installation. After 10 months of installation most of the samples of all logs are badly attacked by termites. In 25 months after installation all of the samples were destroyed.

Sub-project 6. Timber engineering
The timber is suitable for the manufacture of trusses up to 4 metres in length and the species is comparable to Chir (pinus roxburgii) of Indian origin.

APPENDIX 2 – PROPROSED AREAS OF FURTER RESEARCH

The following were presented by Dr Jain as a Powerpoint file.

Year	Imports (million cubic metre) in Round Form from New Zealand
2000	0.25
2002	0.29

Projected Demand of Sawn Industrial Wood In million cubic metres

Year	Housing	Packaging	Furniture	Miscellaneous	Total
2005	19.4	5.54	3.36	7.57	35.87
2010	22.1	6.4	4.62	10.53	43.65
2015	26.3	7.55	5.9	12.69	52.44
2020	28.5	9.0	7.53	17.13	62.16

Demand of Wood for Industrial Application is currently met as under

- Domestic – 40%
- Imports - 60%

- Housing sector (includes Door and window shutters), packaging and furniture consume 70 – 80 % of industrial wood.

- If a consumption of Radiata pine is modestly targeted to about 5% to 6 % of the projected demand, it can be anticipated that India can absorb around 1.5 to 3 million cubic meters of wood annually during the years 2005 –2020 as against very little imports, currently.

1. Development and Performance Testing of End Products

Already carried out studies have indicated that Radiata pine is suitable for manufacture of door/window shutters, packaging items, furniture and cabinet items etc. Keeping this in view it is proposed to study the following items in detail. Various end products will be designed, developed and their performance will be tested as per relevant Indian Standards.

- Door/window shutters
- Packaging
- Furniture and cabinetry
- Light construction like wall paneling, flooring and wooden shingles for roofing etc.
- Cooling Tower Timbers.

2. Durability of LOSP Treated Wood for Different End Uses

For all purposes, following routine tests will be carried out:

1. Soil block test
2. Termite mound test

3. Accelerated field test

3. Suitability Studies for Block Board, Particle Board and other Panel Products.

Particle board (Medium density particle board), made with:

- Exterior grade adhesive (PF)
- Interior grade adhesive (UF)
- Isocynate resin

Other Panel Products:

- LVL etc.

Block board:

- The studies have been carried out as per IS 1659:1990. This specification has been revised in August 2004 and treatment of battens has been provided, which need to be studied.
- The effect of using other species like Gurjan as face and back veneers will be studied.

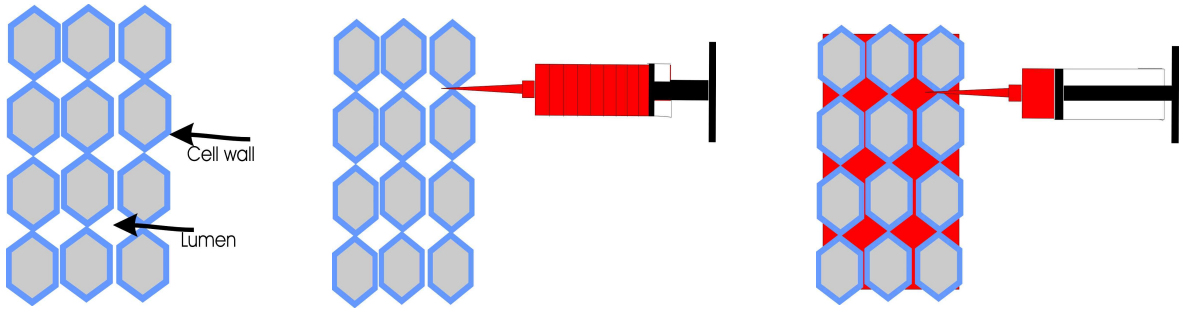
4. Studies on Property Improvement

Polymer impregnation in wood

- Water based resins like UF, MUF etc. under cold setting, slow heat setting and heat setting conditions.
- Solvent based polymers like styrene, MMA etc.
- Polymer impregnation on wood surface in order to improve surface hardness.

Polymer impregnated wood (Lumen filled)

Since wood is typically a porous material the idea of impregnating wood with a polymer is an area of great interest.



The idea being to inject the wood matrix with polymer precursor viz. monomeric and then curing the material free-radically to form a polymer network.

The variety of properties will be improved such as

- Water and chemical resistance
- Decay resistance
- Improvement of structural properties.

Polymer impregnated wood (Lumen filled + Cell wall modification)

However, bulk filling in lumen with polymer will not change the specific properties of wood drastically.

To achieve this the uptake of a monomeric material into the wood but specifically into the cell walls may also performed by picking a material that is more compatible with the makeup of the

cell walls. Since the cell wall is made up primarily of cellulose it is easy to see that a more hydrophillic type material would interact more specifically with the cell wall.

5. Demonstration cum Training Unit for End Products made from Radiata Pine

- To manufacture different products like Furniture/Cabinet items & items for light constructional activities mainly for indoor applications like Wall Paneling, Wooden Flooring etc.
- To exhibit various end products to end users.
- To train artisan/carpenters for making end products from Radiata Pine.