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INTRA-REGIONAL COOPERATION IN DEVELOPMENT OF PLANTATION-BASED FOREST INDUSTRIES (PTA)

DU/RAF/87/117

Report on the technical course on timber construction held in Harare, Zimbabwe, 18-27 March 1992*

Prepared for the Preferential Trade Area for
Eastern and Southern African States (PTA)
by the United Nations Industrial Development Organization,
associated agency of the Food and Agriculture Organization
of the United Nations, which acted as executing agency for
the United Nations Development Programme

Backstopping officer: Robert M. Hallett
Agro-based Industries Branch

* This document has not been edited.

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1. Introduction

The *Technical Course on Timber Construction* was conceived in 1983 and originally intended as a separate project to promote rational use of wood in construction and to take advantage of the new timber research laboratory and lecture facilities at the University of Zimbabwe founded by the Government of Norway. Considerable correspondence was exchanged during the intervening years and it was only in the autumn of 1990 that agreement in principle was reached with FAO project staff and PTA Secretariat in Lusaka to include the course in the UNIDO part of the project. The amended Inter-Agency Letter of Agreement allocating the necessary training funds was signed on 11 June 1991. A staff member of the Agro-based Industries Branch of the Division of Industrial technology, was responsible for the development of the concept since 1983 and travelled to Zimbabwe from 15 - 28 March 1992 to conduct and lecture at the course.

2. Preliminary activities

Even prior to the official agreement with FAO, Mr. C.R. Francis, UNIDO Consultant engaged to survey the use of timber in construction in the PTA countries in June 1989, visited the Civil Engineering Department to check on the facilities and discuss the programme of such a training course and the local inputs necessary. It was hoped that the course could be held in late 1990 but for various reasons, including delayed approval of the host Government (on 4 September 1981) it was finally agreed with the Civil Engineering Department of the University of Zimbabwe to hold it from 18 - 27 March 1992.

The invitations were finally sent out on 8 November 1991 with the Aide-Mémoire. (See Annex I).

A total of 37 full nominations were received with 3 others received by telex without the accompanying nomination forms.

3. Participants

A total of 21 nominations were accepted although 2 did not show up for the course. 1 from Zambia was withdrawn at the very last minute - too late for a substitute - and 1 from Rwanda was accepted very late but was informed that a visa was required from Zimbabwe and would not be issued in time. However Mr. Hallett was informed by the Embassy of Zimbabwe in Nairobi on 16 March that no visa would be required for a Rwandan national.

Most were civil engineers but 4 were architects and some were senior managers of integrated factories producing structural wood products. Most occupied senior positions. There were two official observers from Zimbabwe and several others attended for part of the time.

The list of participants and observers with addresses forms Annex II.

4. Programme

The original programme proposed by Mr. Francis was amended in consultation later with him and the other consultant/lecturer Dr. R.H. Leicester, CSIRO, Melbourne, and even this was changed as time and circumstances dictated. The final programme is given in Annex III. The

laboratory demonstrations were not as successful as hoped owing partly to the inexperience of the laboratory staff in testing and the fact that the CIVIL ENGINEERING DEPARTMENT was unfortunately short staffed at the time.

It was fortunate that the TIMBER COUNCIL OF ZIMBABWE took a keen interest in the course and their executive officer Mr. John Young presented an overview of the industry emphasizing the wide support from all sub-sectors involved in building and construction work, took responsibility for three other local lectures and organized and accompanied a field trip to Mutare were the industry is located.

A representative of a truss rafter licensor and supplier of systems and hardware presented an extra lecture on design and computer use including a demonstration during one lunch hour.

A short summary of each presentation in the programme is appended to Annex III.

5. Documentation

A large quantity of documents including many standards from South and Central Africa, Australia, New Zealand, the United Kingdom and the United States of America were sent in advance from Vienna. Additional documents were brought by both consultants and the UNIDO staff member and made available on a borrowing basis during the course. In all, there were some 20 UNIDO technical reports and manuals, 13 standards and codes of practice, 10 miscellaneous papers and extracts, a 2-volume design manual with ample coloured illustrations of structural use in Australia and one set of Wood Information sheets on timber technology from the UK plus a range of commercial literature available for reference.

Copies of some 12 documents were distributed to all participants. The documents that were sent in only a few copies were distributed to those requesting them at the end of the course. A list was made of requests for further copies that would be distributed from Vienna.

Many participants requested copies of design manuals from TRADA UK and the Australian Association of Standards but it was explained that these and other standards had to be ordered by the participants upon their return to their home countries.

It was clear that the demand for such technical documentation was great and that more exchange of such information and experience must be supported.

6. Administration matters

Special arrangements were made with the CIVIL ENGINEERING DEPARTMENT for the use of their lecture and laboratory facilities and for copying and liaison. The lecture facilities were excellent.

A small amount was paid to the lab technicians for over-time work on Saturday and transport by bus to Mutare was arranged by the TIMBER COUNCIL OF ZIMBABWE but included in the fee paid to the CIVIL ENGINEERING DEPARTMENT.

The payment of daily subsistence allowance was authorized to be made available to Mr. Hallett who distributed it to participants. Hotel accommodation, breakfast, lunch, teas and coffees at Harare and Mutare were paid from the DSA with 35% of the respective rates being paid directly to the participants plus one day DSA in US dollars for regional travel.

There was a serious problem in the payment of this dollar allowance and it took 3 ½ hours the afternoon of 25 March for all participants to change their dollar cheques into dollar travellers cheques plus a small amount in cash instead of receiving dollars in cash for the total amount.

Lunches, teas and coffees were catered by the Holiday Inn and were of an excellent standard. Likewise the hotel accommodation at the Bronte Hotel was very good and suited perfectly the needs of a residential course such as this.

7. Press coverage

An interview was given to the new journal "Black Enterprise" whose correspondent showed a keen interest in supporting the aims of the course which were to promote rational and efficient timber construction in the country and the region. Unfortunately, he never returned and it is not known whether any publicity eventuated.

8. Evaluations

The UNIDOs form for the evaluation of group training courses was handed out to the participants and observers on 24 March although it was announced at the beginning that such an evaluation form would be required to be filled in. A total of 23 forms were returned and discussed during the closing session on 27 March and a compilation of the replies is shown in Annex IV. These replies and the feeling of the consultants and staff member indicated that the course was valuable and provided a significant stimulus to better and more efficient use of timber in construction in the PTA and to collaboration between participants as well as to the organization of professional groups in each country that would carry on with these objectives.

The Director of Agriculture of the PTA and the Project Manager both from Lusaka had intended to attend the course for part of the time but unfortunately were not able to. This would have been particularly important since they could have discussed directly with participants the value of the course and heard from them their recommendations for further work in this area. Instead, a representative of the Division of Agriculture showed up after lunch on 27 March and was available to answer questions before the course closed at 15:00.

9. Future activities

One participant from Kenya promised to write an article for his country's Institute of Professional Engineers and agreed to circulate it to each country's representative on the "action group" as a basis for similar action in their own country.

With a similar view, the UNIDO official agreed to have 8 copies made of the video on the Zimbabwe Timber Industry (1 for each country) to show how important collaborative effort is to developing a sound industry.

Annex V is a copy of the questionnaire on infrastructure for timber engineering prepared by Mr. Leicester which was mostly completed by participants during the course. The summary of replies was completed later by him and is expected to form the basis for a proposal for further technical assistance in this field, either on a subregional or an individual country basis.

ANNEX I

AIDE-MEMOIRE

Technical Course on Timber Construction

Organized
by the
United Nations Industrial Development Organization (UNIDO)

as part of the project
Intra-regional Cooperation in Development of Plantation-based Forest Industries

Executed
by the
Food and Agriculture Organization of the United Nations (FAO)

for the
Countries of the Preferential Trade Area of Africa (PTA)

in
Harare, Zimbabwe, 18 - 27 March 1992

Purpose of the Technical Course

The Course is intended to give participants from PTA countries an insight into the various factors to be considered in designing and producing building components and structures and in construction itself using timber. It is expected to familiarize these participants with wood technology and raw material sourcing and processing, design considerations and prodecures, as well as management aspects, such as quality control, costing, promotion and training. It will also provide an opportunity for participants to exchange information and experiences amongst themselves and to obtain ad-hoc technical assistance from the resource persons. Furthermore, it is hoped that, during the Course, the needs for technical assistance on a national scale will be further identified. The provisional Programme is attached.

Organization of the Course

The Course will be organized by the United Nations Industrial Development Organization (UNIDO) and the Department of Civil Engineering, University of Zimbabwe, Harare (UZ). The Department of Civil Engineering, will be responsible for local organization (P.O. Box MP 167, Mont Pleasant, Harare, telephone: 303211; Telex: 24152 ZW); Fax: (263-4)732 828.

Participants

Up to 25 fellowships will be awarded to candidates [1] from the member

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[1] Both male and female candidates can be nominated. In this connection, attention is drawn to General Assembly Resolution 3010 (XVII) designating 1975 as International Women's Year, and 3342 (XIX), calling for the full integration of women in the development process.

countries of the PTA. Governments are invited to nominate up to 6 candidates who should be fully qualified civil engineers or architects directly responsible for design, specification and production of building components or for construction projects.

Candidates are requested to complete items 12 and 14 of the nomination form in some detail referring to the Provisional Work Programme of the Course (attached to this Aide-Mémoire). The Fellowship Nomination Form, duly completed in three copies, should be returned as follows: one copy to the project office in Lusaka for screening by the FAO Chief Technical Adviser and the PTA Secretariat; and two copies to UNIDO in Vienna.

The addressees are:

Mr. Francis Kamau
C T A - Project RAF/87/117
c/o UNDP Office
P.O. Box 31966
Lusaka
Zambia

Mr. R.M. Hallett
Industrial Development Officer
Agro-based Industries Branch
UNIDO
P.O.Box 300
A-1400 Vienna, Austria

UNIDO will, in consultation with the CTA and PTA Secretariat, select participants from among the nominations received, taking into account professional qualifications and other relevant considerations.

Participants will attend the Course in their individual capacity although they will have been officially nominated by their respective Governments. They must attend the whole Course, according to the schedule prepared by the Host Authorities and comply with the rules and regulations laid down. They are expected to contribute to the training programme whenever possible, eg. in technical discussions and in any group work assigned. In this context, participants will be expected to be reasonably well informed about the conditions of the sector in their own countries and be prepared to take part in a brief "country presentation" during the Course. Emphasis should be given to the problems which could be addressed within the context of this regional project and by follow-up projects at the national level.

A limited number of qualified observers, attending at no cost to UNIDO, FAO or PTA will be welcome to attend the Course and participate in the discussions. All interested persons must submit to UNIDO a nomination form duly filled out and UNIDO will notify those that qualify of their acceptance as an observer.

The Course will be conducted in English and those candidates whose mother tongue or whose language of higher education was not English must submit, together with their nomination forms, a language certificate indicating their proficiency in English before being considered eligible for participation.

Financial and administrative arrangements

A. UNIDO will provide:

1. Round trip air transportation for the most direct and economical route between the airport of departure in home country and the airport in Harare, Zimbabwe, in accordance with the existing arrangements between United Nations and the country receiving technical assistance.

2. A daily subsistence allowance (DSA) to cover board, lodging and incidentals at the prevailing United Nations rate for Harare at the time of the Course. One additional day DSA will be paid as a contribution towards travel/stopover expenses, transport to and from airports, etc. No further claims can be considered.

3. Lecturers, training materials and reproduction of documents.

4. Internal travel related to the Course.

B. The University of Zimbabwe (UZ) will provide:

1. Organizers and lecturers.

2. Conference facilities and secretarial support.

C. The participant's Government or his/her employer will be required to bear the following costs:

1. All expenses in the home country incidental to travel abroad, including expenditures for passport, visas, medical examination, inoculation and such miscellaneous items as well as internal travel to and from the Airport of departure in the home country.

2. Salary and other benefits for the participants during the period of this Course.

D. UNIDO, FAO, PTA and UZ will not assume responsibility for the following expenditures in connection with the participants' attendance at the Course:

1. Costs incurred by participants with respect to any insurance, medical bills and hospitalization fees.

2. Compensation in the event of death, disability or illness.

3. Loss of or damage to personal property.

4. Purchase of personal belongings and compensation for damage caused to them by climatic or other conditions.

NOTE: PARTICIPANTS ARE NOT ALLOWED TO HAVE FAMILY MEMBERS ACCOMPANYING THEM.

Before submitting an application, each candidate should be fully aware of the content of this Aide-Mémoire.

ANNEX 2

TECHNICAL COURSE ON TIMBER CONSTRUCTION

Harare. Zimbabwe. 17 - 28 March 1992

LIST OF PARTICIPANTS AND OBSERVERS

COUNTRY AND NAME	FUNCTION AND COMPANY NAME	MAILING ADDRESS (+TELEX/FACSIMILE)
ETHIOPIA		
DESSALEGN BEZABIH	Civil Engineer/Team Leader Development Main Department Ministry of Agriculture	P.O. Box 62347 Addis Ababa Ethiopia Tel 151842 Telex:21390 MINAG ET.
AYENEW MEKURIA	Civil (Project) Engineer) National Metalworks Corporation Ministry of Industry	P.O. Box 30623 Addis Ababa Ethiopia Tel. 120794
MOHAMMED-SANNI OMER	Building Engineer Rural Infrastructure Development Main Department Ministry of Agriculture	Central South Ethiopia Rural Infrastructure Department P.O. Box 441 Nazeret Ethiopia
KENYA		
R.K. CHEPKWONY	Structural Engineer Structural Department Ministry of Public Works Nairobi	Structural Department Ministry of Public Works P.O. Box 30260 Nairobi Kenya Tel. 723101 Ext. 3489
P.M. MUNG'OO	Structural Engineer Structural Department Minsitry of Public Works	Ministry of Public Works Structural Department P.O. Box 30260 Nairobi Kenya
EMANUEL J. NJAU	Production Manager Prefabrication Wooden Houses and Furniture Manufacture	Economic Housing Grouf Ltd. P.O. Box 18128 Nairobi Kenya Fax (2542) 724680

MALAWI		
SHANIE L. CHIPENI	Project Manager promotion of Wood Based Industries Utilizing Plantations	VIPEYA CORPORATION LTD. P.O. BOX 1252 BLANTYRE MALAWI
WONGANI MKANDAWIRE	Wood Industries Corporation - Sawmilling - Furniture - Wood preservation	WICO BOX 30359 CHICHIRI BLANTYRE 3 TEL. 670144 FAX 670676
HUTCHSON HENRY M. MTHINDA	Structural Engineer Buildings Department Ministry of Works	MINISTRY OF WORKS P/BAG 316 LILONGWE 3 MALAWI TEL. 733188/733207
SUDAN		
M.A. MOHAMMED	Civil Engineer Designer/Const. Eng. Sudanese Sugar Co.	SUDANESE SUGAR CO., ASSALAYA SUGAR FACTORY RABAK SUDAN
A.K. MOAWIA EL SAEED	Architect: Designer Co. Ltd.: Sudanese Industrial Association	P.O. BOX 8274 AMARAT KHARTOUM SUDAN TELEX: (011)-22150 FLIC SD KHARTOUM
D.M. EL TAYEB	Architect: Ministry of Works Architectural project administration	MINISTRY OF WORKS P.O. BOX 300 KHARTOUM SUDAN
I.M. EL TAYEB	Architect Investment Department Ministry of Industry	P.O. BOX 2184 KHARTOUM SUDAN
TANZANIA		
MARCEL K.M. KIIMU	Civil Engineer SmallIndustries Development Organization (SIDO) (Promotion Development of Small Industries)	SIDO P.O. BOX 2476 DAR-ES-SALAAM TANZANIA TEL. 27691-4/051 TELEX: 41123

EDWARD M. NANYARO	Engineer SIDO Construction Unit (Promotion and Development of Small Industries)	SMALL INDUSTRIES DEVELOPMENT ORGANIZATION S I D O P.O. BOX 2476 DAR-ES-SALAAM TEL. 24015, 27691-4 TELEX: 41123
UGANDA		
FREDERICK MUSISI	Civil Engineer National Housing and Construction Corporation	P.O. BOX 659 KAMPALA UGANDA TEL. 257461/3 FAX. 258708 TELEX. 61156
SEITH O. OTIM	Senior Architect National Housing and Construction Corporation	P.O. BOX 659 KAMPALA UGANDA TEL. 241977 FAX 258708 TELEX 61156
ANTHONY G. SOZI	Senior Architect Ministry of Lands Housing and Urban Development	P.O. BOX 7122 KAMPALA UGANDA TEL. 242931 FAX 241977 TELEX 61156
ZAMBIA		
CORNWELL M. HAMPANDE	Civil Engineer ZAFFICO Ltd. Timber Products, Plantations	P.O. BOX 71566 NDOLA ZAMBIA TEL. (02) 613848
ZIMBABWE (Observer)		
JAMES RODZE	Associate Structural Engineer - Building Division Ove Arup and Partners Consulting Enginners	P.O. BOX 984 HARARE ZIMBABWE TEL. 700666 TELEX 24138 ZW FAX 722425
PHILIP KARIWO	Timber Processing Manager Forestry Commission of Zimbabwe	P.O. BOX 322 MUTARE ZIMBABWE TEL. 64515
TENDAI JAMBWA	Structural Engineer Ministry of Public Construction and National Housing Responsible for design and supervision	MINISTRY OF CONSTRUCTION BOX 8081 CAUSEWAY HARARE ZIMBABWE

G. DONGO	Civil Engineering Technician INTERCONSULT (Zimbabwe) Consulting Engineers	157 CHINHOYI STREET P.O. BOX 4710 HARARE TEL. 792877
J. NAYAMBAYO	Civil Engineer INTERCONSULT (Zimbabwe) Consulting Engineers	157 CHINHOYI STREET P.O. BOX 4710 HARARE TEL. 792877
U.H. SCHLÜTER	General Manager Mitek Zimbabwe (Pvt) Ltd. Software and hardware for truss rafters	P.O. BOX BW 654 BORROWDALE HARARE TEL. 882074
A. BLANCHARD	Technical Services Manager Johnson + Fletcher Truss rafter fabricators	BOX 588 HARARE TE. 705401

ANNEX 3

Programme

Wednesday, 18 March 1992

a.m.	- Registration	
	- Opening: M. Sanders, Forestry Commission M. Grant, Civil Engineering Department A. Hauge, UNIDO, Harare R.M. Hallett, UNIDO, Vienna	
	- UNIDO activities in technical assistance in wood processing and timber construction	R.M. Hallett
	- Properties of structural timber	R.H. Leicester
	- The timber industry of Zimbabwe	J. Young
p.m.	- Beams, columns and ties	R.H. Leicester
	- Introduction to lab work and testing	C.R. Francis
	- Introduction of participants[1]	Participants

Thursday, 19 March 1992

a.m.	- Metal connectors and hardware	R.H. Leicester
	- Derivation of design properties	R.H. Leicester
	- Stress grading and proof loading	R.H. Leicester
	- Design of trusses	C.R. Francis
p.m.	- Lab work (beams and fingerjointed beams)	C.R. Francis
	- UNIDO's modular, prefabricated wooden bridge system	R.M. Hallett

Friday, 20 March 1992

a.m.	- Wood preservation, durability and design	C.R. Francis
	- Global use of timber in construction	R.M. Hallett
	- Panel products - their production, properties and use	A. Robertson
p.m.	- Free	

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[1] The 4 Sudanese participants arrived on 18 March and introduced themselves and their work at 8:35 on 19 March.

Saturday, 21 March 1992

a.m.	- Lab work (testing small clears from previously tested full-size timbers)	C.R. Francis
	- Portal frames and arches	C.R. Francis
	- Fire performance of timber	R.H. Leicester
	- Lab work (test of a trussed rafter)	C.R. Francis
p.m.	- Commercial considerations, quality and performance of timber	R.M. Hallett
	- Heavy timber and glulam construction	C.R. Francis
	- Fundamental glulam theory	R.H. Leicester
	- Poles and round timber construction	C.R. Francis
	- Stress grading timbers and load testing	R.H. Leicester

Monday, 23 March 1992

a.m.	- Wood properties and moisture relationships	J. Cookson
	- Wood processing, drying and planing	P. van de Ruit
	- Simplified timber design code	R.H. Leicester
p.m.	- Timber framing code	C.R. Francis
	- Timber codes, suite of standards, quality control and future codes (structural reliability, LSD codes, harmonization, ISO/EUROCODES and regionalization, product grading)	R.H. Leicester
	- Discussion	

Tuesday, 24 March 1992

a.m.	- Design example: 30 m. pole truss	C.R. Francis
	- Practical stress derivation and design properties	R.H. Leicester
a.m./p.m.	- Administration (Banking)	

Wednesday, 25 March 1992

a.m. - Travel to Mutare

p.m.	- Visit Forest Industry Training Centre incl. sawmills, veneer production, plywood sawdoctoring	G. Martelli, FAO Project Manager M. James, Mill Manager T. Narciso Sawdoctoring exp.
	- Design example: 45 m. bridge	C.R. Francis
	- Design example: check on beam design under fire conditions	R.H. Leicester

Thursday, 26 March 1992

a.m.	- Visit Forestry Commission Structural Timber Yard, pluss truss rafter and glulam plants	W. Johnstone Commercial Manager P. Kariwo, Production Manager
	- Visit Gluelam Factory (beams, shelving, scaffolding boards)	K. Rutherford Manager
	- Visit Border Timbers Ltd. (pole preservation yard and construction division)	W. Maggs, Roundwood Sales Manager Y. Klette, Construction Div. Mgr
p.m.	- Border Timbers Ltd. cont'd (planing and joinery mill, veneer/plywood mill)	A. Robertson, Factory Manager
	- Visit Standards Association of Zimbabwe	R.H. Chambers Manager
	- Worked example on the fire resistance of timber	R.H. Leicester
	- Presentation of CIB W18B activities	R.H. Leicester
	- Founding of PTA Action Group on Timber Construction (Reps from all 8 countries)	J. Rodze Chairman

Friday, 27 March 1992

a.m.	- Travel to Harare	
p.m.	- Presentation of Action Group recommendations	J. Rodze
	- Evaluation of course, closing	R.M. Hallett

SUMMARY OF PRESENTATIONS

WEDNESDAY 18 MARCH 1992

1. Properties of structural timber

It was explained that structural timber design codes have the same format as steel design codes. However, the design properties are modified by various factors, because the characteristics of timber differ from those of steel for several reasons. These include the orthotropic characteristics of timber, the high variability, the effect of dispersed defects and the response to the environment, particularly with respect to humidity cycling effects. Silvicultural and human aspects (eg. grading) also influence the characteristics of timber.

2. The timber Industry of Zimbabwe

The development was chronicled with particular emphasis on integration from growing trees through industrial processing to promoting wood uses through the Timber Council of Zimbabwe. This was highlighted by an excellent video film showing the entire sequence and the benefits of collaboration as a sector.

3. Beams columns and ties

The presentation pointed out that buckling is a complex behaviour, particularly if creep-buckling is taken into account. Timber engineering codes cover the design of beams, columns, plywood webs, and buckling restraints.

THURSDAY 19 MARCH 1992

4. Metal connectors and hardware

The complex actions of metal connectors were described and it was explained that they can be used in a great variety of loading configurations. To design connectors joints either each loading configuration must be tested, or a general theory must be developed for connector action. An example of the latter is the theory for dowel-type connectors (eg. nails, bolts) given in EUROCODE 5.

5. Derivation of design properties

It was pointed out that accurate design properties for stress-graded timber can be derived through structural size in-grade testing. This is accurate but expensive. Alternatively a simpler but less accurate approach is to measure the small-clear wood properties, and then to apply visual grading to derive a stress-grade and hence the design properties. If timbers are grouped with respect to design properties, then this simplifies the preparation of span tables and also makes it easier to introduce new species and grades.

6. Stress grading and proof loading

The many scanning techniques which are possible for the sorting of timber into stress-grades were described. The value of a particular technique

is related to the correlation between the grading parameter and the structural properties of the timber. The most common methods of stress grading are visual stress grading and mechanical stress grading. In addition there is a technique used in Australia termed proof grading which is useful for low technology or multiple species mills.

7. **Design of trusses**

The guiding outlines for the layout of trusses to make them simple to fabricate were explained. The merits of various connectors were discussed. A low cost simple technology type of connector was demonstrated as a possible introduction to more sophisticated truss manufacture.

8. **Laboratory - beams**

Attempts were made to break 150 x 50 sawn timbers in four point bending. This was not successful due to incomplete facilities, but it demonstrated lateral instability. This was discussed in the lecture room.

Two glulam beams 6 m X 400 mm X 100 mm were tested to destruction . Calculations showing the large reserve strength of the beams were performed.

FRIDAY, 20 MARCH 1992

9. **Wood preservation, durability and design**

The various biological hazards and appropriate preservative treatments were discussed. Various treatment processes appropriate to various preservatives were also mentioned and their interlocking with the types of hazards. Low capital processes were described together with their limitations.

SATURDAY, 21 MARCH 1992

10. **Design - portal frames and arches**

The structural analysis was briefly reviewed. The lecture concentrated on suitable connections for glulam portals and stress situations peculiar to timber. Alternative constructions including diagonal boarding, plate connected frames and nailed segmental arches were discussed.

11. **Fire performance of timber**

The presentation elaborated on how, where fire resistance is specified in terms of performance, it is possible to design timber structures to comply with this requirement. For large size timbers, the capacity to resist is due to the fact that the unburnt residual section of timber retains its original strength during the fire (because of the very insulative characteristics of timber). However, thin timber elements and also connector systems need to be protected by a cover of gypsum board, sacrificial timber or some fire resistant board material.

12. **Laboratory-trusses**

One locally manufactured gang-nail truss was loaded to 6.1 times its design load. Imminent failure due to lateral buckling was observed. Otherwise the truss showed no distress. The class seemed to be impressed with the strength and stiffness of the truss.

13. **Heavy timber and glulam construction**

Construction methods for these materials were shown. The major design criteria were reviewed and it was pointed out that in most cases extremely high quality specifications were wasteful and superfluous.

14. **Fundamental glulam theory**

This lecture concentrated on describing the properties of glulam which are essentially the same as that of the timber from which it is fabricated. The stiffness is unchanged. The strength is increased slightly (by 10-20%) either because of statistical "load sharing effects" between adjacent laminations or because of "local reinforcement effects" by adjacent laminations when a large defect (such as a knot) occurs within a lamination. Finger joints act as a defect of about a 70% grade of timber. For the case of laminated veneer lumber, the laminations are only a few millimetres thick, and the result is a very high strength, very reliable, structural material.

15. **Poles and round timber construction**

The suggestion that timber piles could be used for bridge and other foundations was made, with reference to the speakers earlier report "Timber Pile Driving" [1] prepared under this project, and distributed at the course. Pole construction was described as were the problems arising from the flexibility of cantilever structures.

Laboratory - Poles

Two E. saligna poles were tested to destruction. Later, small clear specimens were cut from undamaged sections and the strengths compared.

16. **Stress grading timbers and acceptance by load testing**

The lecture focused on the different applications of proof and prototype testing. In proof testing, a single structure is accepted on the basis of a load test. The test load is the specified design load with a small overload factor. In prototype testing, a total population of structures is accepted on the basis of testing a few structures, perhaps even as few as one. Here the test load factor must include an allowance for the fact that structural members may be stronger than the 5 percentile design value. In all cases, the test load must be chosen so that each member in the structure is assessed by the applied stress. Proof testing eliminates uncertainties for structural theory, both material variability and sampling effects; it is most efficient but also most expensive as it has to be applied to every structure. Prototype

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[1] IO/R. 168.

testing eliminates the uncertainties due to structural theory, but does not cover for material variability nor sampling effects; therefore it is very inefficient for materials such as timber which are highly variable. Acceptance by engineering computation eliminates uncertainties due to material sampling; in terms of efficiency it lies between the two load test methods.

MONDAY, 23 MARCH 1992

17. **Simplified timber design code**

A manual was presented which shows a procedure for a structural engineer to immediately design in timber (all be it with a high degree of conservation) in any country. Structural timber is classified on the basis of the bending strength of small clear pieces of wood, or if this is not available, then purely on density. Connector strength is based purely on density. For countries without design codes, additional assistance is provided by way of a simplified loading code, and a simplified structural analysis code.

18. **Timber framing**

The inputs into housing codes were discussed and the problems of making fair comparison between different materials were explained. The merits of a performance requirement regulation or by-law with associated"deemed to comply" detailed specifications were described.

It was further explained that for builders and regulatory authorities, the design of members in a house is best checked through the use of load-span tables. In their simplest form, these tables can be reduced to simple span-to-depth ratio specifications.

19. **Timber codes**

This lecture pointed to the considerable difficulties in terms of both procedures and resources which must be resolved in drafting effective standards and quality control procedures for timber construction. These difficulties can be mitigated if some clear and simple models of the standardization process are followed.

20. **Future codes**

It is foreseen that, in the immediate future, all structural design codes are likely to be written in a limit states format. In addition, it is likely that reliability concepts will be used to unify all design codes (both material and loading codes) with respect to providing a consistent safety level. There are also likely to be more codes related to the assessment of structural products (in addition to structural design codes). Emerging now are difficulties that will have to be resolved with respect to the harmonization of the codes of various countries; this lack of harmonization acts as a barrier to trade and also the transfer of technology between countries, including developing countries.

TUESDAY, 24 MARCH 1992

21. Two design examples were presented. One was a 30 m span roof truss to an architectural brief as may be seen in many African tourist hotels. The other was a 45 m span foot bridge as might be found on a tourist safari trail.

In both examples the emphasis was an detailing for simple fabrication with generally available materials, and the skill levels required of the workmen.

22. a. **Worked example on the derivation of design properties (No. 1)**

The class stress graded sticks of patula pine (Pinus patula) using simplified procedures. This was then combined with information obtained from small clear bending tests to provide a stress-grade classification (according to the Australian system) and hence a whole set of design properties. Using density measurements the timber was given a connector classification and hence design properties for some specific connectors.

22. b. **Worked example on the derivation of design properties (no. 2)**

The class was given test data on the bending strength of 100 sticks of a stress-graded softwood. From this data, an in-grade assessment was made (according to the Australian system) to provide an accurate value of the basic working stress in bending.

23. **Worked example on the fire resistance of timber**

This was a worked example based on the Australian standard AS.1720.84. A glulam beam of softwood, 600 x 200 mm in size was analysed. It was shown that for a 30-minute design fire, there is no need to increase the size of the timber to cope with the fire load. However, if thin beams are used (such as for example 200 x 50 mm size timbers) then these have very limited fire resistance and must be protected by a cladding that has a 30 minute fire resistance (eg. 16 mm of gypsum board, or 30 mm of timber board material).

24. **CIB W18B activities**

A brief presentation was made on the objectives and activities of this working group "Tropical and hardwood timber strength", coordinated by Dr. Leicester. This was followed by an invitation for the participants to organize themselves, with a coordinator, to promote further collaboration in this field in PTA countries.

Summary

Although the structures laboratory is well equipped with major equipment it is lacking in some pieces of necessary equipment such as lateral restraining gear. Also the staff had no previous experience in testing such large components. Most difficulties were overcome due to the enthusiasm of the laboratory staff, and even if the programme originally envisaged was not completed, sufficient was done to give the participants a sound feel for the major mechanical properties of various types of timber components. They also became aware (through not by design) of the physical difficulties involved in testing full-size components. The laboratory staff were most cooperative and

said that they were pleased to have had the opportunity of doing these full-scale tests.

The lectures and design examples deliberately emphasized those aspects of design and construction which are peculiar to timber. Structural analysis was largely glossed over since the majority of the participants were engineers. Only sufficient was covered to enable non-engineers to understand why certain procedures were followed.

Several of the lectures were subjects on which had been included in UNIDO technical assistance projects eg. portal frames, trusses, pressure treatment, piles, and these UNIDO technical reports were made available to the participants.

Judging by class questions and informed discussions it seemed that participants had grasped the major points of the lectures, and that they were very interested in trying to put these into practice in their home countries.

ANNEX 4

EVALUATION - GROUP TRAINING PROGRAMMES

Name of participant: Home country:

Programme: Technical Course on Timber Construction Host country: Zimbabwe

Year: 3/92

II. PRE-COURSE INFORMATION:

1. How was the introductory information you received in your home country about: (please mark an X in the suitable column)

	Sufficient	Not sufficient	Missing
Aim of the training	/17/	/4/	/2/
Content of the programme	/11/	/4/	/3/
Level of the programme	/14/	/4/	/5/

What, if any, other information do you feel should have been included:

Should be more clearly defined in advance: 1
Lodging address should be given: - (It was - to UNDP offices!)
Aide-Mémoire should have requested information on home countries.
Information on lecturers would have been useful (and their subjects):2

2. How many weeks before the beginning of the training programme did you receive the following information:

Information about the programme /__/ weeks

Being accepted to the programme /__/ weeks

Comments:

Indirect info to participants is slow: 2
Should be at least 2 weeks in advance: 1
Breakdown between UNIDO Representative and Ministry: 3
There was adequate time: 8
One or two weeks' acceptance was too short: 1 (to prepare)
Should be direct to participant: 1
Not well publicized for ZIM-Observers:

II. PROGRAMME CONTENT AND ORGANIZATION:

3. What is your opinion of the total duration of the course:

Too long /__/

Just right /13/

Too short /9/

If not "just right", what, in your opinion would be the most suitable duration for the course?

/1.5/ weeks longer (average of 10 replies)

Please comment:

Should have started 16/3: 3
Future courses could be 3 weeks: 1
Some critical topics were hurried: 2
Should have grouped for lab work: 1
Quite adequate for busy people: 2
But should be done often: 1

4. State your opinion about the daily schedule:

Too heavy /10/

Just right /13/

Too light /__/

Comments:

More discussion time between lectures: 2
Usually the daily programme was on schedule: 1
Lectures were too much although the way of teaching was very advanced: 1
Generally too tired to work evenings: 1
Should have had evening sessions: 1

5. Would you suggest any changes in the general nature of the training programme?

Plantation visits: 1
None: 2
Building sites using timber: 1
Small quizes after lectures: 1
Field staff are not used to long lecture sessions: 1
A bit more practical work: 2
Shorten lectures per day: 2
Groups of about 5: 1
More visits: 1
More truss design work: 2
Too little architectural design: 2
(an architect lecturer would have been useful)

Participants should meet more in the evenings to share views
Arrange for discussions etc. after visits: 1
Lab results should have been used in examples: 1

6. Do you feel that the training corresponded to your professional needs?

To a very large extent /9/

To a large extent /6/

To a sufficient extent /1/

To a small extent /1/ (architect)

To a very small extent /_/

Please comment:

It was a real introduction to timber structural design: 4
The course was ideal for structural engineers: 4
My horizons were widened: 2
(to other continents standards)
Grading rules/codes are essential to full utilization of timber in the country: 1
(v.l.ext.) Because we have no experience in timber designs and industries: 1
As an architect, I was more interested in performance, preservation and detailing which were not so much covered 1

7. Please give your opinion about the study visits (if any):

Very enlightening: 4
Quite adequate and eye-opening: 9
Sufficient: 2
Good factory visit especially glulam, truss rafters and grading: 3
Thery were vey supportive of lectures but too short + too few: 1
Plantation visits: 7
Construction sites: 5
Visit to structural engineering firm (at work): 1
Sawmill and felling areas: 4

8. What do you think of the general level of the training?

Much too high /_/

Too high /5/

Adequate /17/

Too low /_/

Much too low: /_/

Comments:

Generally OK:	*3*
The course brought together civil engineers and architects and so was valuable:	*2*
Just what I needed and expected from such a short course:	*2*
Course was oriented to structural engineers not architects like me:	*2*
Some overheads and slide presentations were a little too fast (global use?):	*2*
More design examples including copies of worked examples to follow:	*1*
It brought people from other countries together:	*1*

9. Which subjects of the programme did you find most valuable? (Please state reason; for example new subject, my speciality, relevant to my work, new information, etc.).

Subject		Reason	
Timber production/processing:	*1*	*Bridge design:*	*1*
Design examples:	*3*	*Housing construction:*	*2*
Design of portals:	*3*	*Beams and columns:*	*2*
Lab work:	*3*	*Timber preservation:*	*2*
Visits to factories:	*5*	*Glulam and heavy timber:*	*4*
Design courses:	*2*	*Structural properties:*	*4*
Timber grading:	*9*	*Connectors:*	*3*
Engineering codes and standards:	*6*	*Glulam design/construction:*	*2*
Pole truss design:	*5*	*Global use of wood in construction*	*1*
Timber truss design:	*5*		
Fire resistance:	*3*		

10. Which subjects of the programme did you find least valuable? State why (for example too elementary, inadequate instruction, irrelevant to my work, etc.).

Subject			
None:	*10*	*Wood properties, moisture relationships:*	*1*
		Materials: panel products:	*1*
		Metal connectors:	*1*
		Design of trusses:	*1*
All were valuable:	*2*	*Consolidation of lab work (but no time)*	*1*
		Engineering codes and standards:	*1*
		Bridge design:	*2*
		Labs were poorly organized:	*1*

11. Were there in you opinion any relevant subjects that were not adequately covered in the programme?

Yes /6_/

No /16/

If yes, what did you miss?

Timber design needed more time: *2 (prefab houses)*
More examples of use of structural timber: *1*
Species of wood and their properties: *1*
Design of trusses, portal frames and housing codes not adequately covered: *1*
Wood maintenance and preservation: *1*
Timber quality control: *1*
Slide presentations should have been slower to enable digestion: *2*
Lab experiments - direct work: *1*
More discussions: *1*

12. Which changes would you have preferred in the methods of instructions?

	No changes	More	Less	
a) Lectures	/15/	/5_/	/2_/	
b) Group work	/9_/	/10/	/1_/	(n.a.)
c) Demonstrations	/10/	/9_/	/1_/	(n.a.)

Comments:

Group work/assignments would help share experiences: *1*
Lab work should have been better organized and in groups: *2*
Lectures should be spread out more: *2*

13. How did you find the general standard of the instructors with respect to:

	i) Command of English	ii) Method of instruction
Very good	/16/	/15/
Rather good	/7_/	/7_/
Fair	/__/	/1_/
Poor		
Very poor		

Please comment:

The instructors were quite experienced, some of the structural analysis were of a high standard. Professionally presented. A lot in a short time. 1
Handouts excellent: 1
Lecture aids, very good: 1
Experiments useful: 1

14. Did you have sufficient time for professional exchange of views with:

	i) The programme staff	ii) Fellow participants
Yes	/21/	/17/
No	/2/	/5/

15. How much did you benefit from these exchanges of views with:

	i) The programme staff	ii) Fellow participants
A great deal	/11/	/5/
Much	/10/	/9/
Somewhat	/2/	/6/
Little	/__/	/2/
Not at all		

Please comment:

Some participants were too tired or too apathetic after the tight schedule: 3
The course was very intensive and left little time: 1
I found a chance to exchange knowledge and information: 4
Exposed to new uses of timber in construction: 1

III. RELEVANCE AND APPLICABILITY:

16. Did you find the contents of the programme relevant to conditions in your company (institute)?

To a very great extent	/10/	
To a great extent	/7/	
To a sufficient extent	/4/	
To a small extent	/2/	- No timber industry nor standards now but we hope to via PTA (SUD)

Please state why:

In line with our country's or company's objective of promoting timber usage: 8
Mill manager, so not involved directly in design (great extent): 1
It covered by daily engagement and subjects my nation intends to go into (grading and codes): 10

17. Do you feel that by participating in this training programme you have benefitted professionally?

To a very great extent /9_/

To a great extent /11/

To a sufficient extent /3_/

To a small extent

To a very small extent

Please state why:

I now know the level of technical standards needed to maintain and expand my markets: 1
Knowledge widened about timber, more confidence in using: 6
Stress grading will most likely be required so it was useful: 1
Very much so but could benefit by further specific training: 1

18. Do you think you will have an opportunity to apply your newly acquired knowledge and experience in your present job?

To a very great extent /8_/

To a great extent /8_/

To a sufficient extent /3_/

To a small extent /1_/

To a very small extent /2_/

What difficulties, if any, would you expect to meet?

To obtain clients to get ball rolling: 1
Trainability of poorly educated workers: 2
Senior engineers who have not used timber extensively but this can be overcome: 1
To convince the public - public awareness will take time: 2
Financial: 1
Codes are not available: 2
Imported timber is expensive: 1
Technology not available in our country: 1

19. Will you be in a position to transfer your acquired knowledge to others in your home country?

To a very great extent	/6_/
To a great extent	/9_/
To a sufficient extent	/5_/
To a small extent	/3_/
To a very small extent	/__/

20. How will this transfer be done

a) In a day-to-day work to colleagues and subordinates	/19/
b) In a specific training activities inside present employment *(I will run a timber grading course in May 1992)*	/9_/
c) In specific training activities outside present employment	/3_/
d) Through professional contacts eg. Engineering Institute of Zambia	/1_/

What difficulties, if any, would you expect to meet?

Cooperation in arranging seminars within Ministry:	*1*
None:	*4*
Largely financial	*1*
Financial difficulties in introducing trussed rafters:	*1*
It may not be easy to get people together to promote timber products:	*1*
No problems with fellow engineers but architects still look down on timber construction:	*1*
Financial support from employer to hold a seminar:	*1*
Full approval not yet received from authorities:	*1*
Practical information, technology of converting softwoods and plantations are lacking:	*2*
None: Our company has a training programme for engineers that I will use:	*1*

IV. SOCIAL ASPECTS OF THE PROGRAMME:

21. Please state your opinion about the leisure time activities organized by the programme staff:

Little leisure time:	*13*	*- but we got to know each other in PTA*
We met our (SUD) embassy staff and some Sudanese trade with Zimbabwe:	*1*	
OK:	*1*	
The opening reception was adequate and appreciated:	*2*	

What additional activities would you have appreciated?

Visit a few places of interest:	*7*
Get together with embassy staff of participants' countries:	*2*
Sponsored tours:	*2*
More study visits:	*2*
Social clubs:	*1*
A tour around Harare:	*2*
Sports day:	*2*
Rural and forestry tour:	*1*

22. Please give any comments you choose on aspects not adequately covered by this questionnaire:

Governments should be guided on research needs and train to MSc. level to do the necessary work.

People from Urban Councils and local authorities should be involved in future courses since these tend to be the bottlenecks in promoting timber construction.

The US $ entitlement should have been paid at the start of the course to permit any spontaneous expenditure (2).

A DSA advance should be made to participant before departure (1).

Felt that the development of the Zimbabwe industry was sound and a good example.

What courses can be given to follow up this one?

- *Timber grading - in depth analysis.*
- *Design code - harmonization in PTA.*
- *Trade - promote use of PTA species in PTA.*

A follow-up Seminar should be arranged to check progress, etc.

ANNEX 5

QUESTIONNAIRE

1. NAME 2. COUNTRY

3. PROFESSION

4. SPECIALIST EXPERTISE, AREAS OF DAY TO DAY INTEREST

5. TIMBER RESOURCE ... WHAT SPECIES, WHAT SIZES AND LENGTHS, ANY STRESS GRADES?

6. WHAT IS CURRENT (AND FUTURE) STRUCTURAL USE OF TIMBER (HOUSES, BUILDINGS, RURAL STRUCTURES, CIVIL ENGINEERING WORKS?)

7. DO YOU HAVE A LOADING CODE?, WSD OR LSD? FLOOR LIVE LOADS, WIND LOADS, LOAD COMBINATION EQUATION?

8. DO YOU HAVE A TIMBER DESIGN CODE? WHAT DO YOU USE: WSD OR LSD?

9. WHAT STRENGTH CLASSIFICATIONS OF TIMBER DO YOU HAVE? HOW MANY STRESS GRADES? DO YOU HAVE A STANDARD OR PROCEDURE TO DO THIS? WHAT IS IT?

10. WHAT GRADING IS DONE? WHO DOES IT? ANY COMMENTS ON THE QUALITY OF GRADING?

11. ANY QUALITY CONTROL PROCEDURES OR ORGANIZATIONS BEING USED?

12. DO YOU HAVE MEMBER SIZE SPAN TABLES FOR HOUSING, BUILDINGS, CIVIL WORKS (EG. POWER POLES) WHO PRODUCES THESE TABLES? ARE THEY ACCEPTED BY REGULATORY AUTHORITIES?

13. ARE THERE BUILDING REGULATIONS RELATED TO STRUCTURES? HOW ARE THESE ENFORCED?

14. ANY INSPECTIONS OF BUILDINGS, HOUSES DURING CONSTRUCTION? ANY INSPECTION OF QUALITY OF TIMBER?

15. DO YOU HAVE A STANDARDS ORGANIZATION? WHAT DO THEY WRITE? ANY LINKAGES TO PTA, EUROCODES, ISO, ETC.?

16. WHAT IS SITE QUALITY OF WORKMANSHIP, QUALITY CONTROL?

17. WHAT TRADE TRAINING, PROFESSIONAL TRAINING?

18. WHAT FABRICATION FACILITIES RELEVANT TO TIMBER STRUCTURES?

19. ANY INDUSTRY FOR COMPOSITE ELEMENTS ... EG. TRUSSES, GLULAM, PLYWOOD, LAMINATED VENEER LUMBER, BOX BEAMS?

20. DO YOU HAVE AVAILABLE PLYWOOD, GYPSUM BOARD, NAIL GUNS, STRUCTURAL GLUES?

21. DO ANY MULTINATIONAL COMPONENT PRODUCERS/FABRICATORS OPERATE IN YOUR COUNTRY?

ANNEX 6

SUMMARY OF REPLIES

INTRODUCTION

During the course of a UNIDO Workshop on timber engineering for PTA countries (March 1992), a rough ad hoc questionnaire was prepared and presented to the participants. The purpose of this questionnaire was to obtain an impression of the infrastructure available for undertaking timber construction in the PTA countries. A list of the respondents is given in the Appendix. The countries represented were as follows,

- Ethiopia
- Kenya
- Malawi
- Sudan
- Tanzania
- Uganda
- Zambia
- Zimbabwe.

The results of the survey may not be exact and are to be treated with caution; the questionnaire was quickly devised; the responses were given without benefit of access to data sources. Nevertheless, it is believed that the general impressions obtained are correct.

RESOURCE

Timber

The most commonly available resource for sawn timber products is plantation grown pinus patula and cypressus lusitanis. There is also some limited use of African hardwoods such as mahogany, mvule, musizi, nkoba and teak. In Ethiopia there is potentially the availability of something like 100 indigenous species for structural utilisation.

In addition, all countries appear to have available plantations of Eucalyptus saligna. These are currently used in the form of preservative treated poles, but there is some potential for producing sawn timber with this resource.

Sizes

Sawn timber is generally available in lengths up to 4.0 m and sometimes up to 6.0 m. Common thicknesses are 25, 38, 50, 75 and 100 mm; available widths are up to 250 mm.

Pole timbers are generally available in lengths of 6.0 m, and lengths of up to 12.0 m are mentioned. Pole timbers diameters range typically from 80 to 200 m.

End Uses

Timber usage is very limited in urban areas, and in fact is forbidden in at least one country. Apart from temporary works (e.g. formwork), the only common usage for urban construction would be for roof trusses, and power poles. However, there does appear to be some use for rural housing.

BUILDING STANDARDS

Organisations

All countries have a national standards association, although in some cases the activity of these associations are largely concerned with simple primary products and do not cover the complexities of building construction. The Standards Association of Ethiopia and Zimbabwe appear to be active with respect to building standards.

Timber Standards

Some countries use overseas standards, some have local standards that are essentially copies of overseas standards, and some have no relevant standards at all. However, no country has a truly indigenous standard, i.e. a standard developed specifically to suit the purposes of that country or region.

The following is a brief summary of the timber standards in the countries surveyed;

(a) Ethiopia use standards from Finland. This includes LSD codes for loads, load combinations and timber design. The three Finnish strength classes T20, T30 and T40 are used.

(b) Kenya uses UK codes for loads and for timber design. No strength classes are currently available. Timber is generally graded to the SS and GS grades of the UK.

(c) Malawi uses UK and South African Standards. Both WSD and LSD versions are applied. There are no strength classes.

(d) Sudan has no indigenous standards for timber engineering. However, in the design of reinforced concrete structures both WSD and LSD codes are used. There are no strength classes.

(e) Tanzania uses UK and CIB standards. Strength classes are based on UK standards.

(f) Uganda does not have an indigenous code or a set of strength classes.

(g) Zambia does not have an indigenous code or a set of strength classes.

(h) Zimbabwe has a local timber design standard SAZ.5 162 and also makes use of the South African standard SABS 0163. Both are in WSD format. It does not have strength classes (but does group timber according to visual grade classes).

Span Tables

Ethiopia and Zimbabwe make use of sets of span tables that are accepted by regulatory authorities. The other countries do not make use of such tables.

INDUSTRIAL INFRASTRUCTURE

Materials

Most countries appear to have access to plywood, gypsum board, nail guns, and structural glues; generally these materials would be imported.

Preservation

Ethiopia and Zimbabwe have preservation plants for pole timbers.

Prefabrication

There is a factory fabrication of wall panels in Ethiopia, Kenya and Zimbabwe. There is also factory fabrication of trusses and large glulam components in Zimbabwe.

Multinationals

It would appear that only Zimbabwe contains branches of multinational subsidiaries.

MANPOWER

Training

All countries have access to universities for the training of professionals. There are some trades schools, but much of the trade training tends to be done in-house by construction companies, particularly the larger ones; there is an excellent FAO training centre in Zimbabwe.

Quality of Stress-grading

Much of the stress-grading is done at the mill. The quality is assessed as ranging from poor to excellent.

Quality of Site-work

Supervision of site-work is essentially undertaken by the associated engineer, architect or local authority. Here again, the quality obtained is highly variable, and depends on the supervisor.

CONCLUSIONS

Within the PTA countries there is an excellent and adequate timber resource, primarily in the form of plantation softwoods. The infrastructure required for a satisfactory timber construction industry in the PTA countries is not generally available. The current success of

any construction depends very much on individuals with exceptional talent and ingenuity. There are difficulties associated with the supply of stress-graded material, the availability of suitable design codes, and the quality of construction.

The first step to resolving the situation should be to draft up a set of indigenous standards, i.e. standards specifically set up for the needs and existing industry infrastructure of the PTA region. This set of standards should be both simple and complete, i.e. they will be brief but they will cover every aspect of timber that needs control, e.g. timber sizes, preservation treatment, stress-grading, timber design, span tables, site quality, maintenance, etc. Once these standards are available, they can be used as a basis for personnel training and for developing a satisfactory industry infrastructure for timber construction.

APPENDIX A

LIST OF SURVEY PARTICIPANTS

Country	Name	Profession
Ethiopia	Dessalegn Bezabih	Civil Engineer
	Ayenew Mekuria	Civil Engineer
Kenya	R.K. Chepkwony	Structural Engineer
	E.J. Njau	Production Engineer
Malawi	Wongani Mkandawire	Mechanical Engineer
	H.M. Mthinda	Structural Engineer
Sudan	M.A. Mohammed	Civil Engineer
Tanzania	Marcel K.M. Kiimu	Civil Engineer
	E.M. Nanyaro	Civil Engineer
Uganda	Frederick Musisi	Civil Engineer
	Seith-O. Otim	Architect
	Anthony G. Sozi	Architect
Zambia	Cornwell Mokola Hampande	Civil Engineer
Zimbabwe	James Rodze	Structural Engineer