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15598

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.447/17
27 May 1986

ENGLISH

Expert Group Meeting on
Timber Construction
Vienna, Austria, 2-6 December 1985

REPORT. (Meeting on timber construction).

V.86-56748

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Annexes

INTRODUCTION

1. Wood is nature's gift to humanity. It is renewable if properly managed; it is extremely versatile; and wood construction materials are energy efficient in production and use. Timber has an important role to play in construction, but there are many artificial barriers to its use and many misconceptions about its physical and mechanical properties and how it can perform. Professionals involved in the building industry often lack familiarity with timber.

2. The aim of UNIDO in this field is to make careful studies of the situation in each country, identify these barriers, whether emotional, legal or technical, and assist interested representatives of industry, institutes and universities and Governments to evaluate alternatives through comparative cost studies and so to make more rational and proper use of timber as a building material. In its expert group meetings, UNIDO brings together experts with practical and theoretical knowledge of various fields to assist it in achieving its aims.

3. Since 1969, UNIDO has convened six meetings in the field of wood processing on: wooden housing, panels from agricultural residues, the selection of woodworking machinery and wood processing for developing countries, adhesives used in woodworking industries and timber stress grading and strength grouping.

4. The Expert Group Meeting on Timber Construction, held at Vienna from 2 to 6 December 1985, is the most recent in the series of meetings on wood processing industries. It is a direct follow-up to the Expert Group Meeting on Timber Stress Grading and Strength Grouping, held at Vienna in December 1981.

RECOMMENDATIONS

Stress grading

5. UNIDO should draw the attention of the Andean Group and other countries to the desirability of using a strength grouping and stress grading system that has design stresses that are compatible with the one used in other codes and that is likely to gain more international support.

6. UNIDO should initiate a project with a view to carrying out trials of the model stress grading rules in several countries on a range of timber types and to developing documents on training in stress grading.

7. UNIDO should improve the model strength grading rules by added coherence between softwoods and hardwoods (the lower and upper pairs of grades), by removing anomalies in defining wane and fissures and by making the definitions of knots more systematic and related to tree growth. UNIDO should encourage official use of dry, graded and preserved timber for structures and frames and advise on the preparation of specifications, documents of purchase and contracts incorporating such rules.

Timber design and construction

8. UNIDO should formulate basic requirements for housing in disaster-stricken areas and develop basic designs for such housing.

9. UNIDO should prepare: (a) a simplified model code for timber structures; (b) a manual to be used to introduce timber engineering design in developing countries; and (c) a set of model standards.

10. UNIDO should produce a "UNIDO textbook for timber design", an "ideas book" that would be both a manual of structural form and a "how to do it" book.

11. UNIDO should initiate a project for the preparation of guidelines for producing manuals on low-cost timber housing for rural areas and on roofing and guidelines for producing a manual of good practice for the construction of timber frame buildings.

12. UNIDO should produce a short brochure on common structural forms of houses.

Timber bridges

13. UNIDO should, possibly in co-operation with an institution having experience in planned bridge construction and maintenance programmes, such as Colorado State University in the United States, organize a proper inventory of countries' bridges and follow up their maintenance needs with a view to producing adequate documentation.

Promotion

14. UNIDO should continue to identify opportunities to present complete packages (software, expertise, hardware), introduced and accompanied by suitable promotional material, for specific types of projects, such as timber building systems and bridges, having a high probability of success in developing countries and regions.

15. UNIDO should make greater use of contacts with other United Nations organizations and international bodies for promotional purposes.

16. UNIDO should convene, at suitable periods, short expert workshops or group meetings of a less formal and more working session nature to continue the promotional analysis and planning work started at the Expert Group Meeting on Timber Construction. The benefits of carrying out such activities in developing countries themselves should be borne in mind. The value of regional training courses should also be borne in mind.

I. ORGANIZATION OF THE MEETING

17. The Expert Group Meeting on Timber Construction, held at Vienna from 2 to 6 December 1985, was convened by the United Nations Industrial Development Organization (UNIDO) to bring together experts from universities, institutions, and the private sector in the field who were involved in such activities as stress grading and timber selection, engineering design and framing codes, computer aids and the design and building of housing and bridges. The Meeting was attended by 15 participants, 7 observers and a representative of the United Nations Centre for Human Settlements (HABITAT) (see annex I).

18. In his opening speech, the Director of the Division of Industrial Operations reviewed the programme of UNIDO in the wood products and wood processing industries sector and the role of the Organization in meeting the needs of the developing countries. He drew particular attention to the UNIDO prefabricated modular wooden bridge system, which was being used in many countries. Other projects related to timber engineering included: finger jointing and glue laminating technology applicable to rubber wood, the development of strength data and grading rules for coconut wood and low-cost housing designs and prototype construction. He noted the many misconceptions about the physical and mechanical properties of timber and the lack of familiarity with timber among professionals. Wood was, however, versatile and energy efficient if properly used, and it was the goal of UNIDO to counteract such misconceptions and to promote the use of timber in construction in order to assist the developing countries in meeting their various building needs.

19. The agenda, as amended during the course of the Meeting, is given in annex II.

20. The Meeting elected the following officers: Amantino R. de Freitas (Brazil), Chairman; R. H. Leicester (Australia), Vice-Chairman; and Peter Campbell (Australia), Rapporteur.

21. A list of documents presented to the Meeting is given in annex III.

22. The report of the meeting was adopted on 6 December 1985.

II. SUMMARY OF PRESENTATIONS AND DISCUSSIONS

A. Introduction by the secretariat of UNIDO

23. In his introduction, the representative of the UNIDO secretariat emphasized that there were two aspects of construction: materials and design. In order for timber construction to be accepted, materials had to be well produced. The importance of sawmills and appropriate equipment was stressed, because traditional sawmills were not equipped to handle materials that were difficult to saw (e.g. certain indigenous hardwoods) or coconut wood, and the high costs often attributed to timber construction were often due to the poor quality of materials being produced in sawmills or to excessive wastage..

24. One major concern of potential timber users was durability. It was often difficult to estimate durability because timber from mixed or unidentified species was unpredictable. Therefore, the identification of wood species and knowledge of their treatability was important. In that connection, developing countries might consider plantation species.

25. The need for quality control of preservative treatments was stressed. Developing countries might consider domestic production of preservatives, but it was pointed out that preservative treatments should be avoided as much as possible by using appropriate construction designs and detailing.

26. Two considerations were important for designers: cost and confidence. In order to make timber acceptable, there was a need for consistent standards so that the quality of materials produced by sawmills would be "taken for granted" as they were in other industries, e.g. the steel industry.

27. One problem that had been encountered in promoting the use of timber as a construction material in developing countries was that of the small-scale and fragmented nature of the industry. Another was the fact that decisions on construction might be made in a number of various ministries - e.g. forestry, health, housing, public works, agriculture, defence - in a single country.

28. While the Meeting would be discussing houses, especially low-cost rural housing, as well as storage buildings, factories and bridges, there were other uses for timber, e.g. temporary works, retaining walls, water or cooling towers, utility poles, walkways and bus shelters. A natural tendency of architects was to create new and different designs. Since there were similarities around the world, for example in tropical climates, the representative of UNIDO maintained that more emphasis should be placed on selecting and adapting existing designs according to the culture and available wood species in a country and on designing for durability.

29. Traditional housing often involved labour-intensive construction methods. To eliminate this problem, the representative of UNIDO suggested the separation of the structural frame from embellishments. Mortgage costs could be reduced because they would cover only the frame.

30. In the discussion that followed, Mr. Erichsen and Mr. Collins questioned the validity of promoting excessive use of tropical hardwood in some countries, e.g. those with hardwood species that were virtually non-renewable. There might be better uses for such woods, and plantation species should be developed for housing. Another participant said that the use of domestic

hardwoods was certainly justified in some countries, and asked why good species should not be used for housing, which was badly needed in some countries. It was generally agreed that there was no general solution; each country had to develop a formula suited to its needs.

31. The use of bamboo, which was quick-growing and fairly inexpensive, was discussed. It was noted that there was a great deal of information available, and it was recommended that UNIDO should contact the International Development Research Centre (IDRC) (Canada), the Houtinstituut TNO, Delft, and the Technical University-Eindhoven, Netherlands, the Tropical Products Research Institute (China) as well as major bamboo producers (for example, the Taiwan Province of China) with a view to producing an annotated bibliography on the use of bamboo in construction. The use of rattan was also mentioned and should be investigated.

32. In a discussion of the advantages of prefabricated components versus on-site training and construction, a point that had been introduced by the UNIDO secretariat, it was noted that prefabricated elements were bulky and that countries often lacked the infrastructure to transport them. In times of disaster, both prefabricated elements and on-site construction had been used, for example in Peru. Stockpiling prefabricated housing elements for disasters was suggested, but it was considered impractical because of storage costs and because the stocks were unlikely to be located where they were needed. It was recommended that UNIDO should formulate basic requirements for disaster relief and develop designs. The best method to deal with disaster relief and with the existing situation in many countries would be: to make timber more popular; to have sufficient amounts of timber available; to make designs available; and, most importantly, to "stockpile" skills (i.e. to train local people in timber-building techniques).

33. Mr. Francis prepared a written statement with respect to disaster relief in which he noted that the extreme strength of timber framed houses had not been sufficiently emphasized. Following the recent Inanguhua earthquake in New Zealand, complete timber frame houses were found intact 2-3 m from their foundations; likewise during the Abbotsford Dunedin, New Zealand, mud slide a liquefaction deposited complete houses at crazy angles at the bottom of the valley. Following the Anchorage, Alaska, earthquake, apparently intact timber-framed houses were shown spanning chasms formed by the earthquake. On the other hand, in Agadir, Algeria, and Skopje, Yugoslavia, buildings of masonry construction had been reduced to fine rubble. The important point was that the basic structure of wood houses could be placed on new foundations and be re-used.

34. With regard to basic needs for housing following disasters, Mr. Francis suggested that the basic components of prefabricated or pre-cut houses - packets of pre cut studs, 8 ft (2-4 m) x 4 in. x 2 in. (10 cm x 5 cm), an appropriate amount of flooring grade of plywood or particle board, joists and basic carpentry kits and nails - could be transported to the disaster area. Construction would be labour intensive, but since a large number of people were likely to be unemployed following a disaster, such construction kits could be a practical solution. The exact composition of the packets of studs, which would weigh about 1.5 tonnes, and the tool kits would have to be considered for each individual case. Cladding was of secondary importance, since following an emergency cardboard, blankets etc. would at least keep the weather out. If the timber frame was good, the addition of appropriate cladding at a later stage would turn the house into one of greater value.

35. Mr. Francis recommended that UNIDO should make those suggestions available to the United Nations and bilateral disaster relief organizations.

36. The representative of the International Council for Building Research, Studies and Documentation (CIB) drew attention to the fact that the application of up-to-date knowledge in a number of industrialized countries has been the result of continuous co-operation and exchange of experience between experts. It could be expected that similar international co-operation between experts in developing countries (in addition to UNIDO activities) would yield beneficial results and should therefore be supported. CIB offered its framework (see ID/WG.447/CRP.2) for such co-operation in studying and promoting the use of tropical timbers in construction.

B. Stress grading

37. In introducing the subject of timber selection, strength grouping and stress grading for developing countries, Mr. Mettem pointed out that while important, those topics were only an aspect of the whole task of bringing that important natural resource into structural and constructional use. Discussions at conferences and expert group meetings should be aimed therefore at achieving consensus on reasonable methods by which to deal with the subject, so that work could proceed on further important stages, such as agreement over structural design codes for developing countries, further design information that was more general than that given for prefabricated wood bridges and so on.

38. Reference was made to accompanying papers ID/WG.447/1, 2, 4, 7 and CRP.1. In paper ID/WG.447/2 existing strength grouping systems were reviewed and it was recommended that UNIDO should adopt, for the purposes mentioned above, the Australian system detailed in SAA MP45. That system had already been adopted for the manuals on wood bridges (particularly detailed in part 4). It was a well-established, documented system and included tolerances and recommendations on their application in the classification system. For the purposes of their work, the Andean Pact group (and some other countries) had adopted somewhat different strength grouping and stress grading classification systems. UNIDO should draw their attention to the desirability of following more closely a system having greater international support.

39. It was emphasized that stress grading should not be regarded, particularly when manufacturing components in projects in developing countries as a one-time operation. Rather it was an ongoing procedure, which should be applied at several stage during the various processes. The actual grading operation *per se* was, furthermore, only one link in the complete timber selection and implementation process.

40. In paper ID/WG.447/2, reference was made to the procedure used to draw up strength classes for softwoods and hardwoods in the drafting of BS5268, the British design code. The relation between strength properties and dry nominal specific gravity of the species included in the hardwood timbers given in BS5268 was, as would be expected, very similar to that found in the grouping work carried out by the Australians. With experience it was now possible, knowing the Australian strength group of a timber, to place it in a BS strength class, provided its appropriate stress grades were also designated.

41. The basis for deciding on a stress grade (Australian terminology, i.e. "F" number) for a timber type and quality in the bridge manuals was the as-

sumed "grade ratios" (performance of in-grade, structural-sized pieces) compared with that of small, defect-free specimens. There was some supporting evidence for those ratios, however, such as results of structural-sized testing of tropical hardwoods carried out by the Timber Research and Development Association, UK (TRADA) and older work referenced in the Australian papers on grouping, for example those by Pearson. In the case of softwoods, there was sufficient information on the ratios, such as those for European pine and spruce used by Princess Risborough Laboratory, UK, to draw up the BS5268 recommendations. More testing on tropical plantation species would be desirable, however, but costly.

42. The assumed grade ratios that were adopted for the bridge mannual and on which the model stress grading rules given in CRP.1 were based, were intended to be in the order of a 35, 50, 67 and 80 per cent "quality factor". The values were related to the ratios traditionally adopted in the Pacific region and also gave rise to target qualities that were considered to be appropriate for softwoods (first pair of ratios) and high-class, straight-grained hardwoods of, or similar to, the Malaysian types (second pair of ratios). Lower grade hardwoods would also be fitted into the scheme, for example by making use of the 50 per cent quality class.

43. The desirability of amalgamating the lower and upper pair of grades more completely (omitting labels "softwoods" and "hardwoods") in the description of defects and the table of limits was mentioned in the presentation and agreed upon in subsequent discussions.

44. It was emphasized that even with a well-documented strength classification system, such as that given in MP 45, judgement was often required in practical situations. In deciding upon the strength classification for Pinus caribbea in Honduras, 1/ several apparently quite good sets of strength data from reputable sources were available. They gave rise to three different possible strength classes ("S" numbers), however, and eventually a judgement was made.

45. Varying terminology for the unmodified stresses used as a starting point in design, following various codes (e.g. CP112, BS5268, AS1720), was mentioned as a practical problem in drafting documents and providing training for developing countries. It was recommended that UNIDO should take cognizance of this in its projects and that it should not be influenced to change its terminology too rapidly to accommodate the latest thinking of various international code committees, whose own ideas on the subject tended to change from year to year.

46. The version of the model stress grading rules that appeared in the bridge manual contained more text and diagrams on hardwood features, such as interlocked grain and compression failures, than the original version proposed at the 1981 expert group meeting. Experts were asked to note those aspects and to comment if further improvements could be suggested.

47. The simplified method of dealing with knots in the rules was explained. It was felt that the knots section of the International Organization for Standardization (ISO) TC 165's draft N101, which had less than one page of

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1/ UNIDO project DP/HON/81/002.

explanation and was based on the knot area ratio (KAR) projection technique, was too concentrated and sophisticated for direct use in documents for developing countries. Conceptual difficulties in understanding the axonometric projection diagram given in documents such as BS4978 and in the Economic Commission for Europe and ISO KAR rules had been experienced both in industrialized and in developing countries. The emphasis in the model stress grading rules was therefore to include a larger number of more traditional diagrams of various types of knot but at the seme time to train graders to understand tree growth and its relation to the sawn wood product (shape of knots, position of pith etc.). It was mentioned that during the early stages of drafting the KAR rules, it had been claimed that the knot projection technique was reflected in some of the rules given in the North American

Dimension Lumber Standards. That was not very apparent, however, and KAR was not heavily emphasized in those widely applied rules.

48. The type of knot giving greatest difficulty when translating KAR grading objectives back to knot appearance diagrams was the arris knot. The methods used to accomplish this in drafting the rules was described, and it was suggested that more trials were required on the applications of the current draft rules.

49. General-purpose versus particular member type rules were discussed. KAR rules such as BS4978, and the ECE and ISO softwood rules tended to be aimed at stress grading material in the mill or timber yard before the application of the particular piece of timber (beam, joist, tie, strut) was known. The older knot surface measurement rules were related to specific member types and were no longer considered useful in that respect. The model stress grading rules were intended to be general purpose.

50. The draft rules had been tried out in a limited way on Honduran pine, and important points that arose were the care needed over sloping grain in this type of pine, on both the faces and edges of the piece, plus the need for better, more fully documented training on the overall approach to controlling the quality of the wood. That was not mainly a matter of achieving a very high standard, such as was expected in sophisticated industrialized country markets, but rather more importantly of eliminating waste and avoiding useless transportation costs. It required medium- to long-term training of supervisors and carpenters at the workshop level.

51. As a result of the discussions following the presentation, a UNIDO project was recommended in which the training documentation aspect would be covered and trials would be carried out of the model stress grading rules on a wider basis in several countries and on a range of timber types. Tropical timber features such as interlocked grain and compression failures needed further trials and testing. Those features were difficult to detect in sawn timber. Also, plantation tropical conifers had not been exposed to the draft rules.

52. The limits recommended on various types of distortion in the rules had been based on European and Malaysian standards. They should be checked for practicality. The rules should include them as recommendations rather than mandatory requirements.

53. During the discussion Mr. Collins mentioned that it was a great disadvantage to impose a growth-rate restriction on plantation softwoods, since he claimed that the scientific basis for such restrictions was ill founded. Although it had been impossible to remove such restrictions so far in rules for industrialized countries (e.g. in the ISO rules), their omission from the model stress grading rule should be considered. There was disagreement among the experts on that topic.

54. Mr. Campbell drew attention to the need to cater to, both in the rules and in design, users of "mill run" or average low-quality timber with corresponding rules that would yield few rejects from such consignments. That topic was discussed further by the working group on model stress grading rules. It was pointed out that the objective of catering for low-quality materials was included during the drafting of BS4978. The grade corresponding to the GS/S6 grade in the European standards, structural No. 4 in the draft rules, was only a 38 per cent "quality factor" grade, which could cope with such very low performance timber provided that the obvious "worst" pieces were rejected before use.

55. Mr. Francis pointed out that during prototype projects, there was often only just sufficient timber available to build the components and structures intended. Experience and skill was required to make use of the pieces that would normally be rejected in commercial practice in industrialized countries.

56. The entire timber selection process, as applied in the UNIDO wooden bridges project, was reviewed in ID/WG.447/7. In answer to questions from the representative of UNIDO, it was agreed that the system could be completely general in its application and that UNIDO projects could continue to make use of the model stress grading rules improved as necessary, provided they were based on MP45; "F" number stress grades or strength classes. They could be adopted for projects aimed at producing simplified codes, for building system manuals and so on.

57. In his comments, Mr. Leicester said that the model grading rules appeared to be a bit complex for use in developing countries. They might also be more complex than the accuracy of "small clear" basis would warrant. (Recall that ECE carried out in-grade testing to evaluate their material.) He believed that the use of a low-cost proof-testing machine had considerable value in a low-technology mill: it could be used to check a visual grader, thus taking the emphasis off training a visual grader to be highly accurate, and it could be used to actually train a visual grader, who would soon learn how to recognize the sticks of timber that would fail a proof load. A proof tester could be used for checking the setting of a mechanical stress grader or any other type of grading machine, which would eliminate the necessity of high-quality training in setting the machines. For mills that wanted to upgrade their grading procedure, he said, mechanical stress graders were too difficult for low-technology situations; a solution was to develop low-cost non-contacting, sealed black box systems, such as for example microwave methods.

58. A wide-ranging discussion took place on non-visual grading methods, such as grading machines, proof-loading and non-destructive evaluation techniques. Mr. Mettem emphasized the need for caution in introducing inappropriate methods to developing countries. There was a danger that equipment could be provided that would use up scarce project funds and could not be maintained in operation by the project after the expatriates and counterparts had left.

59. Some explanations of the attitude of UNIDO towards the supply of such equipment were given. There was obviously the possibility of introducing sealed black box equipment, which could be designed, manufactured, calibrated and serviced outside the recipient country; however, the appropriateness of that form of technical assistance needed to be kept under constant review.

60. Mr. Larsen commented that proof testing should not be regarded as a means of checking visual grading; the visual grader's job was to grade visually not to recognize pieces of timber that would fail a proof load.

61. It was recommended that improvement of the model stress grading rule system should be directed towards:

(a) Coherence between grading of softwoods and hardwoods;

(b) Removing ambiguities and anomalies in definitions of characteristics (wane, fissures etc.);

(c) Making the definitions of knots more systematic and related to tree growth.

62. Mr. Larsen noted that grouping and gradings in his opinion should not have been confused in the discussions. The Australian system had the following drawbacks:

(a) It was linked to one safety system only and to a prescribed safety level. Even in developing countries, such systems were being replaced by more modern ones for other materials. He was not opposed to the use of the permissible stress system, only to the exclusion of others;

(b) It was based on small clear testing, which had been abandoned in industrialized countries. Again he did not propose that this should be excluded, merely that it should not form the basis.

C. Hazards to timber in use

63. Mr. Francis, in presenting ID/WG.447/11, pointed out that hazards to timber deterioration merged gradually into each other with few sharp boundaries. So also did the efficiencies of main preservative systems. Hazard descriptions seemed to follow similar patterns, but even where a one-to-one correspondence could be deduced, there might be large variations in the corresponding prescriptions. He suggested that a reliability-model approach could reduce the existing confusion, but that approach had to be understood by the researchers and so was for the future. However numerous parameters could be coped with by the reliability method.

64. He stated that the only non-subjective numerical hazard classification available was Scheffer's Climate Hazard Decay Index, which was limited to one hazard range only and even then was a rather uncertain figure which required subjective interpretation.

65. The UNIDO field expert required figures to describe the various interactions of hazard, wood preservative and quality control, e.g. 95 per cent survival after 50 years. Only with such data could an expert convince unwilling or disbelieving recipient Governments or organizations. That informa-

tion was almost never given in codes. Therefore, unfortunately reliance still had to be placed on experience and judgement.

66. In the discussion that followed, Mr. Campbell noted that the process had been working in reverse: Preservatives and processes were being chosen first and then a hazard limit was assigned to them. Every effort should be made to avoid hazards through design, and he recognized four levels of protection or means to ensure longevity:

Design and detailing

Species selection

Permanent preservation treatment

Maintenance

67. Mr. Collins mentioned that leachable boron preservatives tended to be considered for protection against insect attack only but in fact gave good protection against fungi in places were wood was exposed to high humidity but not to rain, e.g. in subfloors close to damp earth.

68. Mr. Gutkowski suggested using terms such as "service life" and "safety index" instead of the more negative "failure probability". He also said that in the United States of America some scientists were interested in developing methods to predict the useful remaining service life of existing bridges. A practical concern was that that could lead to a requirement for guaranteeing a client a desired service life as an outcome of the design process.

69. Mr. Campbell said that the audience must be aware that the New Zealand situation was unique in that they used four times the amount per capita of preservative as the next leading country (Finland), and their knowledge of preservatives was extensive. Countries with plantation programmes should give information on requirements for preservable species to silviculturalists.

70. Timber should not be used in situations where the designer knows it would not last, and Mr. Leicester proposed that where the hazard was high, the use of timber should be avoided since the quality control possible in most developing countries was inadequate for protection in such situations, and failure only gave timber a bad name.

D. Preservation specifications

71. Mr. Francis, in his paper (ID/WG.447/14), made the points that there must be enforcable regulations and that the enforcement mechanism should be separate from the technical content of any specifications. The enforcement of preservation standards should be made more simple or easier to prosecute. The preservatives and processes covered should be limited to CCA, Boron, BFCA, BFA and creosote applied by vacuum pressure, diffusion or hot and cold bath. The Fijian code with some minor additions should be recommended as a suitable model for the technical code.

72. He felt that the diffusion process needed to be much more widely promoted in developing countries since it allowed the utilization of many non-durable species that are impermeable to pressure treatment.

73. There were limits to what could be achieved by treating, and those limits must not be exceeded.

74. During the discussion interest in pressure creosoting was expressed. It was noted that there might be unscrupulous commercial influence to (a) treat untreatable timber species and (b) treat inadequately seasoned timber or otherwise operate the process improperly by the pressure process.

75. Mr. Cano asked for inclusion of creosote by hot and cold bath process in preservation specifications. Mr. Francis agreed and pointed out that he had suggested that process in addition to the Fiji code, but he was against creosoting by vacuum pressure because of cost and complexity of heating requirements. Also, creosote was less and less available. Creosote that was a by-product of steelworks was not as effective as creosote that was a by-product of coal-gas works. In many cases creosote had to be imported, and transport costs were high compared with cost of transport of dry salts.

76. Mr. de Freitas was enthusiastic about creosote and said that in his experience it had been even quite easy to put excessive amounts of creosote in timber by the hot and cold bath process and noted that the diffusion process took a lot of time.

77. Mr. Francis pointed out that pressure treatment required pre-drying to 25 per cent moisture content before treatment, also with diffusion; the time required could be reduced by high temperature and/or high concentration, but at the cost of heat, equipment and additional salt. There was no one simple answer, and one had to move within the limits set by equipment, salt and working capital costs.

78. There was considerable discussion of Mr. Francis' emphasis on the enforcement of regulations. Most of the discussion revolved around breach of contract, civil law type cases. Mr. Francis said that in his opinion it was important that breach of contract should not have to be proved but rather a breach of commercial law, which was quite a different matter.

79. Mr. Erichsen raised the question of treatment of poles by the Boucherie process. Mr. Cano said that the problem was filtering the treatment solution, otherwise the end grain became clogged and screened the downstream wood from the treatment.

80. Mr. Campbell noted that retention alone was no measure of sufficient treatment since penetration also had to be adequate. He proposed more research on preservative systems, possibly the hot double diffusion process.

81. A more detailed discussion of the topic and recommendations to UNIDO for further action are contained in ID/WG.447/14.

E. International timber engineering codes

82. H. Larsen presented a paper on the current status of ISO in the preparation of international standards for engineered timber construction (ID/WG.447/3). The structure of ISO technical committees was described and in particular ISO TC165, chaired by Mr. Larsen, which was responsible for the preparation of timber engineering standards. The use of the International Union of Testing and Research Laboratories for Materials and Structures (RILEM) and the International Timber Committee (CIB) to draft standards for

ISO was noted, and the work of CIB W18 in the preparation of the ISO timber engineering design code was discussed. Mr. Larsen also described timber construction standards developed by ECE (EUROCODE 5) and stated that they were similar but not necessarily identical to those of ISO.

83. During the discussion, Mr. Leicester described developments in the Pacific Area Standards Congress (PASC), a group of roughly 25 Pacific area countries, roughly two thirds of which could be considered to be underdeveloped. None of the developing countries were represented as participating members on ISO TC165. PASC had recently formed a timber engineering secretariat to keep those countries informed of ISO developments, which could also be useful as a source of feedback to ISO on the needs of developing countries in relation to the drafting of ISO standards.

84. Later in the session Mr. Leicester presented a proposal for a manual to be used for introducing timber engineering design in developing countries (ID/WG.447/13). It was proposed that the manual should comprise essentially very simple timber classification and design sections; there would also be sections on detailing, construction and maintenance and probably also a section on elementary structural analysis. The intention of the manual would be to introduce an "instant" design capability for engineers unfamiliar with timber design, so that the feasibility of timber construction could be examined. To illustrate the idea, a draft of a manual was presented, based on simplifying the information contained in Australian standards.

85. The two presentations generated lively discussion on the relative merits of use by UNIDO of the older style of standard as represented by the Australian codes and the modern style as represented by the ISO codes. Arguments for the Australian standards included the fact that they contained a complete set of established and tested codes, that they were similar in format to several other codes currently used in developing countries, that they had been developed to cover a wide range of species that existed in many developing countries, that they could be entered from a zero data base on timber properties and that they had already been (and still were) used in UNIDO projects during the past 15 years. Arguments in favour of the ISO code style were that they represent the style of the future (and of course of ISO) and that they had a more rational format.

86. It was pointed out by Mr. Cano that many countries had no structural design code for timber and that building codes often made no reference to timber, although some allowed its use under constrained conditions, while other countries had only bad translations of foreign codes.

87. Mr. Campbell felt that too much reliance was being placed on strength-based design since most structures were governed by deflection. He felt that limit-state design should be a later stage and that simpler systems should be pursued.

88. It was felt by some that such codes represented more a philosophy than a practical approach to solving many building problems. Sizing was only a small part of the overall design procedure and should not be over-emphasized. In general, skills were lacking for sophisticated analysis.

89. The idea of an introductory manual received good support, with a suggestion that equal emphasis should be placed therein on detailing, maintenance and similar matters as on the design code itself. There was also a suggestion

that the manual should be stored in such a format that would be easily modified to suit each particular country. The aim would be to help people use timber properly. Such a manual should be developed with the full participation of engineers and architects in the countries themselves, possibly through series of workshops.

90. Other ideas discussed were: whether the ISO and EUROCODE in their present form were suitable for use in tropical and/or developing countries owing *inter alia* to their lack of reference to hardwoods and to construction using green timber; whether developing countries should be concerned only with safe and not necessarily efficient structures; and methods whereby UNIDO could influence ISO TC/165. It evolved that the code requirements of developing countries varied considerably and that a simplified code could be very useful, especially in rural areas of developing countries.

91. It was recommended that UNIDO should prepare: (a) a UNIDO simplified model code on timber; (b) a manual for introducing timber engineering in developing countries; and (c) a set of model standards.

92. The code (a) should be simple and cover the most common structures only. The basic safety systems should be so formulated that it could be used both for a permissible stress design (which would initially be the one recommended) and a partial coefficient system. The material properties should in principle be based on characteristic values of materials in structural sizes, but emphasis should be placed on methods making it possible to enter any species/grade into the appropriate group and also on testing of small clear specimen values even based only on density. The grading systems should be simple with as many features common to softwoods and hardwoods as possible and contain not more than two grades for a species.

93. The manual (b) should comprise essentially a timber classification plus engineering design standards based on simplifications of the Australian system and also a set of guidelines for detailing, maintenance and construction. (The manual would not be intended to be used as model for national standards; however, it would contain reference to the Australian standards on which these were based together with relevant ones from other countries for those who wished to engage in major design projects.)

94. With regard to (c), it was proposed that UNIDO should draft a set of model standards for use in developing countries. Those standards could be developed either by or in conjunction with ISO TC/165; the standards would comply with any standards drafted by ISO.

F. Timber framing code for developing countries

95. Mr. Collins discussed a house framing code that had been developed in New Zealand for Fiji. It had been produced in conjunction with local experts and covered local conditions such as cyclonic winds, cultural factors and various requirements related to health, safety etc. The Manual was comprehensive but did limit to some extent local options. He noted that a single model for the world would not be valid. In Fiji the upmarket houses were of concrete block; thus the object of the framing code had been to provide a timber option and promote the domestic use of plantation-grown Fiji pine. By using a "means of compliance" format, the legal requirements were separated from the technical requirements, which were contained in a technically written code of practice.

The Manual contained forms of buildings, details of construction, span tables and failure modes and included the consequences of various building defects such as lack of bracing or deficient bracing. The Manual elicited much favourable comment, particularly on the failure mode illustrations.

96. Mr. Leicester described the experience gained in developing the Australian Timber Framing Code. The code covered some 20 different grades of timber, both seasoned and green. It had been found that with a suitable computer program it was possible to easily produce tables for numerous stress grades. A similar procedure could be used to produce sizes for the many varied requirements of developing countries. He also noted that one attractive simplification in the presentation of information would be to quote span-to-depth ratios (rather than tabulated data) for typical member sizes.

97. It was generally agreed that manuals of that kind should be short. There was discussion about the demand for such manuals, and Mr. Raralio contended that there was a demand. A representative of UNIDO asked about the possibility of regional codes. He also suggested diffusion seminars for architects and specifiers. That raised the issue of model codes, the question of who wanted such codes and whether timber design societies (on the pattern of the New Zealand Timber Design Societies) could contribute to increasing the demand for structures of timber. Mr. Francis observed that housing should be a priority or "lead product" owing to the large volumes of timber used in construction. The representative of UNIDO commented that it might not be appropriate to try to "sell" all-wood houses under certain conditions; timber might not be acceptable for walls but would still have a role to play in roofs.

98. There was a discussion on whether houses should be the priority, and there was a concensus that community buildings were also important, especially for promotional purposes, as there was less scope for arguing over details of design. The suggestion made by the representative of UNIDO at the opening session on site, service and frame for lowest cost buildings was raised again.

99. The working group on a timber framing code considered that owing to the wide range of physical and social circumstances existing in different countries of the world it would be difficult to draw up a single code that would meet all the needs for guidance in the construction of small timber buildings.

100. The group therefore recommended that UNIDO should set up a project to prepare:

(a) Guidelines for the production of manuals on low-cost timber rural housing;

(b) Guidelines for the production of a manual of good practice for the construction of timber frame buildings.

101. More details of the discussion and ways for UNIDO to react, including terms of reference for guideline documents, are given in annex IV.

G. Roofing systems

102. The presentation by Mr. Cano included slides of a wide range of structures designed by him. These demonstrated a high design skill in the use and selection of structural forms adapted to particular local conditions. Such

conditions included climatic zones with insignificant amounts of rain or wind and a short economic life, leading to unusually slender and light-weight structures. Light-weight structures were of interest because, even in timber-producing countries, timber was often very expensive if the building site was far from the producing areas owing to high transport costs.

103. Other structures included three-pinned portals with spans up to 26 m, housing with hyperbolic paraboloid roofs and many others in several countries.

104. The wide range of designs for which there could be demand and the corresponding range of skills to respond to those demands were presented. The meeting was impressed with the presentation and discussion covered a number of technical matters.

105. On timber quality, many of the structures had been designed around "shorts", as long timber was expensive. Brittleheart was a problem, but by the use of furniture grades most of the problem was eliminated. Mr. Cano's practice of nail lamination meant that occasional weak pieces of timber accidently included did not affect the integrity of the structures.

106. Mr. Campbell felt that such design tolerance of poor grading, seasoning and workmanship was an excellent example of the skills needed to cope with often difficult conditions.

H. Standard designs

107. Mr. Hartl detailed some of the information that would be required in order to develop standard designs for factory roof framing (ID/WG.447/16). The primary system included such information as span, module (bay spacing), height and length, to which had to be added various information relating to dead, live, wind, snow and earthquake loading as necessary. Following that was secondary information about the purlin spacing and continuity, timber and steel grades, the choice of connections and fabrication and transport and erection considerations.

108. Some 25 different possible structural forms were displayed, all of which had some limitations on economic spans, sacing etc. and would also be influenced by local costs and conditions.

109. The problem of managing such a wide range of forms for a simple requirement led to two extreme solutions with many intermediate options. At one end there was the possibility of defining a limited and presumably popular range and developing complete standard design sheets for those. At the other end of the system was the development of a very large software package into which could be fed the necessary inputs and out of which would come optimal answers. Mr. Hartl reminded the meeting that these were extremes and that the large package did not as yet exist.

110. Mr. Wedenig referred to the Gang-Nail standard designs; about 80 per cent of requests fitted into such standard designs, leaving about 20 per cent that required some engineering design.

111. Mr. Francis pointed out that optimization required prices, and those would have to be kept up to date for each user.

112. It was suggested by Mr. Larsen that the group was pointing towards UNIDO becoming the international design centre for timber structures and perhaps that was not the objective, which should be to develop local skills. That statement was supported by Mr. Leicester and Mr. Mettem. The latter related some problems with computers in third world areas and advised caution in their use. Software was an alternative to standard designs; this should be simple, with machine and operating system independent.

113. The representative of UNIDO asked for views on whether it was feasible to produce a "decision tree for selection of design" or an "expert system" that would reduce the range of possibly applicable design solutions that would have to be costed. There was some discussion, and the consensus was that too many variables would have to be dealt with and that experience was still a better guide to such selection. Mr. Leicester suggested that while "expert systems" might not be suitable as design tools in developing countries, nevertheless they could be very useful for educational purposes, particularly for introducing timber engineering to inexperienced engineers.

114. Mr. Campbell pointed out that there were considerable variations in the level of skills within and between third world countries and that solutions would have to recognize that fact. Several speakers reminded the meeting that computers were merely tools to be used where appropriate; it was possible that the computer approach could make some countries too dependent on developed countries and overseas skills. Several speakers suggested that a manual of standard details and forms would be more appropriate.

115. It was therefore recommended that a manual on structural forms should be produced, possibly entitled the "UNIDO textbook of timber structures", showing the possibilities and various types of structures for primary and secondary systems and the ranges over which they could be used covering stability for the whole building. It should be an "ideas" book, of what could be done with timber designs.

116. Other suggestions were that a few construction sheets, showing the whole construction and details of nodes, including fasteners, joints and so on, should be drawn and included as examples. A catalogue with models of nodes and joints should follow, containing detailed alternatives and showing the most important items to be looked at in construction; the various fasteners and connectors and their possibilities should be given. The textbook should be appropriate to developing countries and should include a list of references.

117. Mr. Francis stated that standard designs were an excellent way of promoting the use of timber in building. Whether the designs were done on a computer or not was secondary, and to some extent even the details of the design were secondary; the expert and counterpart could sort that out according to local circumstances. Most useful would be the rapid calculation of prices, and a simple computer program could be a powerful tool in producing total building prices, especially where materials and labour costs tended to change rapidly. Computers and computer expertise were already available, even in some very underdeveloped countries.

I. Timber bridge types for developing countries

118. Four papers on timber bridges were presented to the Meeting. The first paper was "Timber bridges for developing countries" by Mr. Markerink (ID/WG.447/10). The author represented a timber company that had expanded into the timber bridge market. All the bridges were of West African hardwoods, predominantly Azobé (Lophira alata), which is one of the most durable timbers in the world. The author detailed visually the seven standard bridge forms that the company used. Most of the bridges were for pedestrians, but some 20 per cent of the production was for road bridges for loads up to 60 tonnes. The company also did some roof work where durability was a particular requirement. Inevitably the engineers had also to respond to foundation problems, and some of the approaches were indicated.

119. The company was responding to the demand for their services in Indonesia and had developed a check-list of information requirements which they as designers would have to work through before making any particular designs. The information included timber species and location; properties; commercially available sizes and localities; mechanical properties; the location of bridges; climatic and soil conditions; biological and chemical hazards, including acidity or alkalinity; the availability of various levels of skills; training requirements; and the available infrastructure such as roads, existing bridges and transport facilities. The wide range of influences was usually handled by normal civil engineers experienced in bridge construction. The paper ended with a list of the items that made up the cost structure of a bridge.

120. Quite a lot of interest was shown in the dowel laminated timber used in some of the bridges, consisting of pieces 70-200 mm thick laminated with steel rods 10-30 mm in diameter. With that system, arches and camber could also be available. In response to a question about the possible use of timber dowels, Mr. Markerink pointed out that the dowels had to be harder than the laminates and thus hardwood dowels might be used with conifers. In response to a question by Mr. Cano, it was explained that the bridges were waterproofed by using tongued-and-grooved timber with rubber in the grooves. Mr. Mettem raised the problem of foundations, observing that it was another area where improved expertise was necessary; UNIDO should possibly become involved in introducing new technologies such as timber piles.

121. Mr. Serra Feu described bridge systems used by large forestry companies in Central America and Central Africa which required bridges to carry substantial loads - up to 60 tonnes - for the duration of the logging contract in the particular area, which might be only a few years. When logging had been completed, the whole area was left to regenerate, and usually the bridges slowly degraded. The bridges were simple beam-type structures of selected timber species, faced on the tops and sides and covered with soil which acted as a riding surface for the vehicles. The speaker described the method of construction which was very simple and practical. During the discussion, several experts expressed concern about the additional mass of soil, which was a permanent load on the structure, and the large volume of timber used in comparison with the UNIDO bridge. The speaker pointed out that about 65 per cent of the timber logged went to waste anyway and that the amount of timber in the bridges was minute compared with the total production of timber from areas being opened up. In response to a remark that the soil on the bridge would stimulate decay, the speaker observed that the design life was only a few years. He added that there might be a need for more permanent bridges in some areas and that the UNIDO bridge could be very valid in such cases.

122. In that connection, Mr. Francis pointed out that in building the same sort of bridge in New Zealand care was taken to use large, e.g. 10 cm, crushed rock for the covering to ensure drainage and a minimum holding of water. Also the logs were adzed on two sides, not top and bottom, and spiked together with 25-mm steel to give some load sharing. Squaring top and bottom weakened the logs by interrupting the grain flow around knots (in softwood, not hardwood).

123. Mr. Gutkowski tabled the following papers:

Timber bridge technology-transfer plan (CRP.16)
Timber bridges: State of the art (CRP.17)
Standard plans for low-cost bridges (CRP.18)
Bridge design, evaluation and repair (CRP.19)
Overview of the Pennsylvania standard plans for low-cost bridges (CRP.20)
Performance and rehabilitation of timber bridges (CRP.21)
Comparative performance of timber bridges (CRP.22)

124. He described (ID/WG.447/5) a management plan that had been developed because a substantial number of bridges in the United States required repair or rehabilitation, and there was a need to assign some priority. A sufficiency rating had been developed that included parameters for structural adequacy and safety, serviceability and functional obsolescence and the degree to which it was essential for public use. There were some 570,000 highway bridges in the United States, of which about 240,000 needed attention of some sort, at an estimated cost of $50,000 million. Of that total, there were about 70,000 timber bridges, about half of which required repair or other works.

125. The author had been retained by the United States Forest Service to evaluate their bridge rehabilitation needs, and that led to an assessment programme together with studies on degradation modes so that future timber bridge design and detailing could be improved. Several studies were described, and it was shown that nail-laminated decks deteriorated faster than glued-laminated decks. Decks should be designed on wet-use allowable stresses, but stringers could be designed on dry-use allowable stresses. One of the features of the programme was a State and Private Forestry Technology Transfer (or diffusion) programme, which had as its objective the dissemination of information on timber bridges to appropriate individuals and bodies. It was intended to indicate the advantages of timber for bridges and provide guidance on the rehabilitation of existing timber bridges. A central feature of the plan was the development of a Timber Bridge Design and Construction Manual to be used by bridge designers, fabricators, contractors and specifiers. It was described as a "critical back-up document", which should contain information on existing bridge technologies for design and construction and give examples, economic information, maintenance and inspection procedures and a bibliography of useful references.

126. Mr. Mettem asked whether it was possible for UNIDO to look at a planned programme in each country for new bridges and possibly also for bridge maintenance. It was explained that that was the responsibility of the Government but that UNIDO could provide advice if explicitly requested by the Government to do so. Mr. Gutkowski recommended and the group agreed to the following actions in connection with such planned programmes (possibly in collaboration with some of those involved in the United States programme such as Colorado State University):

(a) Conduct an organized, comprehensive study of the extent of bridge problems and needs in developing countries:

(i) On an individual country basis;

(ii) On a compilation of the individual country results to develop an inventory of such;

(b) Provide a mechanism to evaluate the effectiveness of existing trans portation systems for the movement of agricultural goods to market;

(c) Given (b), determine what rehabilitation, replacement or new timber bridge construction would speed up the movement of goods;

(d) At an appropriate future time, examine and report on the structural and functional (e.g. improved movement of goods, traffic etc.) performance (in-place) of UNIDO bridges presently in use in developing countries;

(e) Disseminate results of (d) to the developing countries.

127. Mr. Campbell pointed out that bridges were linked with large road programmes, and it was often too late to influence bridge design by the time the programme was publicized.

128. Mr. Mettem said that most bilateral agencies, including the Overseas Development Administration of the United Kingdom of Great Britain and Northern Ireland, required that programmes be shown to be a part of some national plan. He then inquired about American conclusions on nail-laminated decks. He pointed out that such decks contributed to the strength of the UNIDO bridge, particularly in bending and shear.

129. Mr. Campbell reported on a timber bridge seminar that had been held at Melbourne, Australia, in November 1985 (CRP.5). Australia had over 10,000 timber road bridges and over 200 km of timber railway bridges. They were 60-100 years old, and many currently required attention. Various methods of inspection had been examined, and a number of bridges had been restored to full traffic use. Timber piles that had decayed at ground level had been cut back to sound timber and capped with concrete, thus saving considerable cost. It was noted that timber bridges had significant advantages in that they could be taken apart easily for replacement, and thus they could also be strengthened to meet changing load conditions very simply. One very clear message had come from the bridge inspections and that was the importance of keeping timber dry, which meant providing waterproof decks. Concrete or steel decks had been added to some bridges; that had improved the public perceptions of timber bridges as well as protected the supporting timber structures. In the case of railway bridges, the ballast that was essential for track alignment soaked up water, which would normally contribute to the decay of the supporting timber deck. In several cases the deck had been protected with old conveyor belts.

130. Some very approximate costs relating to conditions in Australia in 1985 presented at the meeting were (in Australian dollars):

New concrete bridge	700/m^2
New timber bridge	200-400/m^2
Reconstruction	100-250/m^2

131. Preservatives were only used for maintenance - treated timber did not appear to be used as there were ample supplies of durable hardwoods. The main difficulty in rehabilitating existing timber bridges was the lack of skill in timber bridge engineering by civil engineers.

132. In the discussion that followed, the question of overloading was raised and several examples of bridge failures and substantial overloads were given. Mr. Markerink pointed out that one of the advantages of the deck-truss bridge was that it was not damaged by vehicles; a disadvantage was the additional cost of abutments to clear flood levels. Dry weather by-passes over river beds was an option to reduce the effects of overloading.

133. The problem of making wooden bridges more popular and acceptable, especially in areas where concrete or steel bridges were considered to be more modern, expensive and therefore more technically advanced, was discussed. Mr. Francis suggested that where bridges had been painted with three coats of paint like a good-quality house or a fishing boat, that had increased their popularity. People would believe that if the bridge were worth spending effort on, it must have some value. Mr. Collins noted that chipped or peeling paint could make wooden bridges look even less attractive.

J. UNIDO bridge system

134. A film on the wooden bridge system developed by UNIDO was shown to participants. That system would be discussed in more detail by a number of participants on 9 and 10 December 1985.

K. Traditional housing designs

135. The representative of the United Nations Centre for Human Settlements (UNCHS) (Habitat), Ms. Celik, discussed the current crisis in human settlements, namely the lack of housing, which had led to overcrowding and unhealthy conditions (ID/WG.447/12).

136. Development in the housing sector was often strained by lack of building materials; thus, timber, which was readily available in many developing countries, would be an answer to the needs of those countries. The representative stressed the lack of knowledge of wood technology and emphasized the need to involve suppliers and builders in the early stages of planning in order to promote the use of timber.

137. Timber housing, which had been a tradition in many countries, could be useful in satisfying housing needs. With regard to the design of timber houses, the importance of climate and culture as well as the structure were mentioned as were the limitations imposed by available building materials. There was little information about the comparative economy of different house plans, but Ms. Celik enumerated a number of guidelines. The importance of grading standards for both design and prototype testing were stressed, and she discussed the use of wood for both structural and non-structural components, as well as production and erection techniques.

138. Establishing cost comparisons for houses built with various materials and techniques was a problem owing to the difficulty of equating comparability of performance and the value to be placed on better insulation, finish etc. and to the variations in site and labour conditions. A study that had been carried out in Burma was presented as an example of such comparisons.

139. Standardization and mass production led to reductions in cost, and there was scope for further rationalization of the design of components and standardization.

140. In introducing his paper (ID/WG.447/6), Mr. Limsuwan noted the longevity of timber; some timber buildings in Thailand that were over 400 years old were still in good condition. While ample skills existed in the country for traditional timber construction using clear timber, there was a need to introduce modern technology to deal with the less clear species that were being used in increasing quantities. He noted the amount of wastage, especially of wood used for formwork, falsework and scaffolding (temporary works).

141. Structural engineers were not employed for building rural housing since there were no government regulations on it. Crafts were passed on from one generation to the next, but technology was poor. Rural houses were built on posts, 1.5-2 m from the ground. Urban housing was required to have certain facilities such as separate rooms, sanitary installations and parking. The type of materials varied, depending on the cost. Low-cost housing tended to be of concrete, with timber roof frames; medium-cost housing had a concrete or brick ground floor, the upper storey and roof being timber; and luxury housing had concrete framing and floor (covered with wood) and timber roof frame. A number of examples of timber houses adapted from rural designs, with a concrete base and light timber framing, were shown.

142. Mr. Limsuwan noted a number of constraints faced in Thailand: the desire to use only clear wood; the lack of standardization (cross sections were given in inches, length in metres); the fact that strength grading was based on clear wood; the lack of durability grading; the lack of preservation information in the industry (although studies had been made); and the need for more information on metal connectors for non-clear wood, glue technologies, wood-based panels and cost comparasions with concrete.

143. In answer to a question posed by Mr. Gutkowski, he explained that concrete was more marketable because it was considered to be more prestigeous. Mr. Limsuwan said that one method of technology transfer to rural areas was to build bridges and schools with the participation of local people.

144. In his report on traditional housing designs in the Philippines (ID/WG.447/17), Mr. Raralio noted that owing to the high cost of importing materials, it had been necessary to resort to a combination of tradition and ingenuity, and he presented a number of designs to illustrate that statement. Traditionally, houses had been raised on stilts and were constructed of a variety of materials (hardwood, grass, bamboo), depending on the region. He showed a traditional house built on posts with bamboo roofing frame and floors; walls were of bamboo mats, coconut leaves or grass. In modern housing, wood was replacing bamboo for structural members, walls and floors. The colonials had built of stone and lime with clay roof tiles, but those materials had not been resistant to earthquakes

145. One of the first government-sponsored projects to promote self sufficient communities was the "Rural Bliss" project. Because the housing problem was more acute in urban areas, the "Urban Bliss" project was also initiated.

146. Mr. Raralio showed examples of various house plans designed to use local materials; eventually, prefabricated elements would be used. He also noted the increased use of coconut wood in rural areas.

147. The "Flexihome" project had a number of advantages: it made efficient use of indigenous materials; allowed for vertical and horizontal expansions; was affordable and marketable; was acceptable to banks (for mortgages); was suitable for urban and rural use; and followed traditional designs. He noted the extensive use of plywood, which was made locally and even exported, and vinyl roofing sheets, a new product made by a local manufacturer.

148. One method of satisfying people's desire for concrete structures was to use concrete blocks to window sill level, with other components of wood or wood-based materials. The method was used in a number of models.

149. In order to overcome rising costs, the Government had initiated a self-help programme whereby people could purchase partly finished houses. Timber was an excellent material for finishing or for the step-by-step expansion of such houses. Other government measures of importance were that the granting of land development and building permits for socialized and low-cost housing was concentrated in one agency and that a certain amount of deregulation had been introduced.

150. Mr. Raralio noted the importance of correct timber detailing when designing for countries like the Philippines (with tropical cyclones, heat and humidity) and the importance of detailing and knowledge of the material used. Constraints were: the lack of durability studies; the need for more involvement of the production industry; the need for studies of non-commercial species because although wood was abundant, it was costly; the need to make more efficient use of materials; and the need for promoting the acceptability of wood.

151. In the discussion, Mr. de Freitas noted that one of the factors contributing to the success of the projects reported by Mr. Raralio was the advantage of working within an integrated government agency, which made it easier to implement the designer's ideas. He emphasized the need to distinguish between low-cost housing, which could include second homes, and housing for low-income groups.

152. The representative of UNIDO noted the need to be able to compare construction costs with minimum wage levels and noted the need for a formula for that purpose. Both Mr. Raralio and Ms. Celik said that the desirable level of payments towards the purchase of housing should not exceed 30 per cent of the family's monthly income. Ms. Celik considered that comparative cost data for houses using different building materials should be on the basis of building costs, excluding land and infrastructure costs, which would remain the same regardless of the building materials used. Only the cost of building materials, including transportation, labour and design implications, needed to be considered.

153. Mr. Collins proposed that UNIDO should develop a standard for assessing the cost of housing in relation to income; the representative of UNIDO noted that it seemed to be the consensus of the Meeting that UNIDO should develop both a manual for low-cost housing and for roofing. In that connection, Mr. Mettem noted the need for feedback from experts on detailed terms of reference before such a manual was published.

154. Mr. Larsen said that the basis for success was that local people should adapt timber and structures to local tradition, and that UNIDO should support and promote such efforts. Timber construction had the major advantage of being adaptable.

155. Mr. Leicester discussed special designs for typhoon conditions and suggested a reliable engineered structure with replaceable non-structural elements, a suggestion that was welcomed by the representative of UNIDO, who had referred to the concept of separation of structure from claddings earlier.

156. There was considerable discussion of the scope of a UNIDO manual; Mr. Mettem and others believed that it should be broken down by climatic conditions (including altitude) and mode of living; Mr. Collins and Mr. Larsen, among others, believed that each country needed to develop, with UNIDO help, its own manual; the representative of UNIDO suggested common structural forms - pole houses, houses with treated timber or concrete posts and better roofs, and half-masonry houses. A wide ranging discussion ensued. In answer to a suggestion, the representative of Habitat confirmed the applicability of timber for both hot and cold climates, and she noted the standard classification of arid, hot/humid, temperate and cold.

157. It was recommended that UNIDO should produce a short brochure illustrating these common types of houses.

158. Mr. Larsen stressed the need to promote timber for medium- and high-priced houses as well as for low-cost ones. Mr. Cano noted the increased use of timber in Peru, which was supported by the Government, which was working fast to change attitudes towards house construction in urban areas, because of the need for low-cost housing. A 2 m x 3 m woven panel, based on traditional designs, had been developed for 6 m x 6 m modular houses. Politics was important in changing attitudes to reconcile needs with available means.

159. Ms. Celik asked whether it was true that soil-cement construction was being used to replace timber so as to reduce further deforestation. Mr. Raralio replied that soil-cement was being looked at as a way of reducing the high consumption of cement in concrete. Non-commercial tree species were being used in construction to fill the gap in timber production. Mr. Limsuwan said that soil-cement had not been a success in Thailand. He said that deforestation in Thailand was now critical and a new policy was being formed to use forest products more efficiently. It would be implemented in 1986 with the aim of retaining 40 per cent of Thailand's forest.

L. Promotion needs

160. Past activities of UNIDO and other United Nations organizations on the promotion of wood for construction purposes were reviewed by Mr. de Freitas (ID/WG.447/8). Main barriers against timber construction in developing countries were identified, such as lack of tradition, lack of technical information and lack of industrial infrastructure.

161. For short-term results it was recommended by Mr. de Freitas that promotional activities should be directed towards policy-makers, aiming at the implementation of complete package projects. Long-term promotion should be based on educating public authorities and the general public on the proper utilization of wood as a building material. Main agents for long-term promotion were listed as: timber technology centres, wood-loving architects and engineers, timber design societies and universities.

162. A large number of colour slides were shown depicting the use of wood in house construction. The first example was the wooden house designed by the Instituto de Pesquisas Tecnológicas for the Housing Society of Manaus (SHAM), which was the basis for the UNIDO "Popular manual for wooden house construction" (ID/330). Another example was the project developed for the township of Campos de Jordao, S.P. Brazil, with objective of using small-size lumber obtained from pine plantations. A few pictures of substandard wooden houses in Sao Paulo were also shown, followed by pictures of a number of custom built homes in which wood was used intensively.

163. After the slide presentation a number of comments were made. Mr. Cano expressed the view that hardwoods could probably be used more effectively in post-and-beam designs rather than in the framing systems that are common in the northern hemisphere.

164. Mr. Campbell suggested that UNIDO should publish two types of manual to promote timber construction: one for the engineers, describing how to design structures with wood, and another for the technical people charged with detailing such structures for fabrication.

165. Mr. Mettem and Mr. Gutkowski supported Mr. Campbell's idea on manuals; in addition, Mr. Gutkowski suggested that UNIDO should organize workshops for university professors and professionals, following the model of the "Heritage Workshops" sponsored by the Forest Products Laboratory in Madison, Wisconsin. The UNIDO activities carried out in the last 15 years regarding the promotion of the utilization of wood in developing countries, such as workshops in Australia, Costa Rica, Thailand etc., and the construction of prototype houses in Laos and in the Philippines were described in more detail.

166. Mr. Larsen supported the idea of reinforcing local research institutes to function as timber construction centres, describing the experiences in Denmark in the field. Mr. Colclough reinforced the role that could be played by local timber construction centres in promoting the use of wood.

167. Mr. Collins suggested that UNIDO could publish a picture book on wood construction for distribution among developing countries. Mr. Cano described his experience with the Andean Pact publications for promoting wood construction.

168. Mr. Gutkowski suggested that UNIDO should organize a workshop on promotion needs and priorities for wood construction in developing countries.

169. The recommendations of a working group on promotion are given in annex V.

Annex I

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Annex II

AGENDA

Opening by the Director of the Division of Industrial Operations

Adoption of the agenda

Election of officers

Presentations and discussion

1. Introduction by the secretariat of UNIDO
2. Stress grading
3. Hazard classes of timber in use
4. Preservation specifications
5. International timber engineering code
6. Timber framing code for developing countries
7. Roof systems
8. Standard designs and computer aids
9. Bridge types for developing countries
10. Traditional housing designs
11. The UNIDO bridge system
12. Promotional needs

Drafting sessions

1. Grading
2. Hazard/preservation
3. Framing code
4. Standard designs and computer aids
5. Structural codes
6. Promotion

Presentation of working group reports and other items

Adoption of the report

Annex III

LIST OF DOCUMENTS

Number	Title
ID/WG.447/1	Timber stress grading: Recommendations for national training programmes and quality assurance Timber Research and Development Association
ID/WG.447/2	Timber stress grading: Analysis of existing timber strength grouping and strength classification systems Timber Research and Development Association
ID/WG.447/3	International strandards related to timber construction Hans Jørgen Larsen
ID/WG.447/4	Timber stress grading: Evaluation of responses to questionnaire on timber stress grading and strength grouping research and development activities Timber Research and Development Association
ID/WG.447/5	Initiatives to reintroduce timber bridges in the United States of America Richard M. Gutkowski
ID/WG.447/6	Traditional housing designs in Thailand Ekasit Limsuwan
ID/WG.447/7	Timber selection, strength grouping and stress grading for the UNIDO prefabricated modular wooden bridge Timber Research and Development Association
ID/WG.447/8	Promotion needs for timber construction Amantino R. de Freitas
ID/WG.447/9	Techos de madera para países en desarrollo José Carlos Cano
ID/WG.447/10	Timber bridges for developing countries H.J. Markerink
ID/WG.447/11	Hazard classes of timber in use C.R. Francis
ID/WG.447/12	Traditional housing designs United Nations Centre for Human Settlements
ID/WG.447/13	On a manual for introducing timber engineering design in developing countries R.H. Leicester and G.B. Walford

ID/WG.447/14	Timber preservation standards C.R. Francis
ID/WG.447/15	Light timber framing codes for developing countries M.J. Collins
ID/WG.447/16	Timber for low cost housing in the Philippines Pedro M. Raralio, Jr.

Annex IV

REPORT OF A WORKING GROUP ON A TIMBER FRAMING CODE FOR DEVELOPING COUNTRIES*

Introduction

In the introductory paper (ID/WG.447/15) it was suggested that a code for developing countries should be written around the needs of a particular country, and that such were the range of climatic variations, social aspirations and available skills and materials that at best a comprehensive code could cover only a group of countries and not all countries. It was suggested that guidelines for such a code should be prepared together with an example of such a code.

During the discussion following the presentation of the paper, the experts were generally in favour of this approach and the working group has taken note of a number of points raised in the discussion to further refine and enlarge on the proposals made in ID/WG.447/15.

Rural versus urban needs

The working group considers it best that the widely differing needs should be met by two different documents.

In the rural situation there is often a total lack of formal controls on the building process, and building requirements are less sophisticated than in urban or suburban areas. Rural needs are perhaps best met by detailed instruction manuals showing step by step the construction of a range of simple houses and other small buildings used in rural areas.

In urban areas a code of practice for the construction of small timber buildings together with a range of standard designs may be more appropriate. The main difference between the proposed rural construction manuals and the urban code of practice would be that whereas the construction manuals would show all the steps in the construction of particular small building designs, the urban code of practice would contain span tables and connection details in a general form so that designs could be generated using the information contained in the code.

Role of UNIDO

With its wide range of contacts and expertise in managing projects, UNIDO is well placed to advise and assist developing countries in preparing their own manuals and codes. It was recommended that UNIDO, in co-operation with UNCHS, inititate projects to:

(a) Produce guidelines for the production of "do-it-yourself" manuals for low-cost timber rural housing;

(b) Produce guidelines for the production of a manual of good practice for the construction of timber frame buildings.

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*Prepared by M. J. Collins, J. C. Cano and F. S. Feu.

In general both these guideline documents should contain the following:

(a) Information that is generally applicable in all countries or regions, e.g. the protection of wood by good designs;

(b) Points that must be considered in all regions but have widely varying limits which are determined by a particular country or region, e.g. wind-loading considerations;

(c) A check-list of factors that may be relevant in the case of particular countries or regions.

Ways of carrying out this project are suggested in the body of the present report.

General comments

If UNIDO is to become directly involved in the production of documents relating to small timber buildings, then it must become involved in housing as this is of first priority. A major problem with timber houses in many regions of the world is the low status accorded them. If the status is to be raised, people's attitudes must be changed so that they aspire to a quality timber house designed to meet their physical and social needs. The structural design of a timber house cannot be divorced from these physical and social needs, which vary widely between countries and regions. It is impractical to produce a single "world manual of good practice", so at best regional manuals and codes need to be prepared. The proposed UNIDO guidelines for the preparation and manuals are intended to ensure that regional manuals or codes are prepared with a common base and that they serve to promote timber housing as an appropriate and desirable form of shelter sensitive to the cultural and physical needs and aspirations of the people who will occupy the houses. Involvement of local engineers in the preparation of such manuals is essential if they are to be accepted readily.

Annex V

RECOMMENDATIONS OF A WORKING GROUP ON PROMOTION

The group considered the primary mandate of UNIDO: to foster industrial development and to contribute to the acceleration of the industrialization of developing countries. In the field of wood construction, it is believed that this can best be achieved by promoting the appropriate use of timber in suitable situations and often in combination with other materials rather than blindly advocating its use under any circumstances. In this, as in its other relevant activities, UNIDO is primarily promoting complex solutions. Development therefore entails the fostering of employment, training and promotion of diverse skills. Furthermore, it involves the use and promotion of materials and techniques falling not exclusively in the woodworking domain.

The group believes that the entire Expert Group Meeting on Timber Construction had hinged on the need for UNIDO itself, and in turn its experts and consultants, to upgrade promotion and pursue promotion tools.

The group recommends that better promotion is required over a broad range of UNIDO activities in the timber field. This should be aimed at a diversity of "targets", including the following:

(a) Top-level politicians of developing countries;

(b) Planning and executing (technical) ministries in the same;

(c) Industry;

(d) Universities and other higher educational establishments;

(e) "Agents" with proven capability. (These are individuals already enthusiastic and having skills in the field, who serve in posts under (a) - (d) above, or who may act as UNIDO experts or consultants.);

(f) Potential "agents", including civil engineers and architects (Persons as described in (e) above, but who still need to be persuaded about the value of timber construction in meeting the needs of developing countries.);

(g) Sources of finance/mortgage authorities.

Before considering in more detail the promotional material or "tools" required by the above, the group analysed the "targets" in more depth, as follows:

(a) Politicians

Cases have arisen in small developing countries where it has been possible to expose even the prime minister to UNIDO promotional material. Opportunities to contact ministers, members of parliament or other influential individuals must be seized upon using very concise, professional and impressive information that concentrates on the social and economic benefits of industrialization in the wood field.

(b) Government ministries

The ministry structure for handling affairs that may be of concern to UNIDO can vary greatly from one region, culture and type of country to another. A common factor is that it is usual to deal with Government requests to UNIDO through either the foreign affairs or the planning ministry. Executing ministries differ, and at times it is not clear at the start of proposals which ministry or department may be most appropriate for a specific proposal. Promotional material should be prepared to allow for a flexible approach, therefore. Ministries or departments concerned can include: housing; transport; environment; health; roads; mountains, forests and bridges; natural resources; forestry; industry (and/or trade, possibly separated into urban and rural); education; trade and export; special regional development corporations etc.

(c) Industry

The group felt that dependable, expanding activity in the timber construction field in developing countries is vitally reliant on good communications and improved relations with industry in the field. It believed that, despite its organizational title, UNIDO was more inclined to maintain its links at governmental and ministerial levels rather than to become fully involved with manufacturing and constructional industries, albeit for reasons of understandable difficulties.

Ways in which UNIDO could more directly interact with industry in the promotional role include:

(a) Providing complete plans for the execution of proposed projects;

(b) Involving at an early stage parties who will actually be called upon to provide or support the infrastructure for projects through their logistics, materials and manufacturing or construction;

(c) Seeking to identify and upgrade weaknesses in local management, planning and technical competence. This entails an analysis of the national skill structure with respect to plant, factory or site managers; structural engineers and architects (designers); junior professional staff; technicians; and tradesmen.

(d) Universities etc.

A strategy should be devised to develop UNIDO promotional and educational material on timber construction for universities and other higher level academic establishments in developing countries because of the enormous "multiplier effect" that can be achieved by directing efforts in this way, in addition to the immediate benefits of better training. This sector plays a key role in expanding the knowledge of timber design and construction. The importance of fostering personal contacts is emphasized in this sector.

(e) Agents of proven ability

As stated above, there are many persons already convinced about the usefulness of timber who currently are unable to obtain adequate promotional material. Wood tends to be a medium about which people become very enthusiastic, and this feeling can be passed on, again with considerable "multiplier effects", provided the interest can be maintained by good service and information.

Many national research institutes exist with staff who are well-trained and motivated but who often lack experience and direct contact with industry. The capability of these agents should be strengthened and directed towards dissemination of technical data and information on the potential of timber in construction.

(f) Potential agents

At the same time, timber construction can potentially impinge on a wide range of activities, including those listed under (a) to (e) above. Hence the number of potential agents, who are not yet aware of the benefits that the introduction or improvement of timber construction can bring, is very large. Promotional material and effort is essential therefore to encourage and involve architects, engineers and other professionals in all of the above types of employment to become better advocates for the appropriate use of timber.

(g) Sources of finance

It is particularly important to bear in mind the potential breadth of scope in this case. International sources of finance can emanate from diverse and not always obvious channels. Promotional material is needed ranging from that appropriate for officials of the World Bank, regional development banks and other major organizations through that suitable for convincing regional and local agencies, or building societies of the soundness of investments involving timber.

UNIDO should consider the advantage of developing a data base of successful timber project case studies (not necessarily exclusively its own) to encourage investments in its projects by international, regional, national and local institutions. The potential for project co-operation and follow-up from bilateral national sources in industrialized countries should also be acknowledged and used.

The group went on to consider more specifically the type of promotional material required (the tools) to be prepared for the targets listed above. These include the following:

Targets	Tools
(a) and (b) Politicians and ministries	1. Records of interviews discussing benefits, in print and photography; on audio tape; on video cassettes.
	2. Presence of relevant persons at inauguration stages of projects, and good professional records of the same, using media listed above.
	3. Brief, colour brochures with accurate but concise technical and costing data.

	4. Records of meetings, panel discussions, promotional courses etc.
	5. Second, slightly more technical-level information for executing ministry officials, e.g. Bridge Manual, Part I.
(c) Industrialists and industrial personnel	6. As 1-5 above, plus documentation on the labour and equipment needed for production and erection during projects, with costing information.
	7. Group and/or in-house introductory and training courses.
	8. Fellowships and study tours.
<u>Targets</u>	<u>Tools</u>
(d) Universities etc.	9. Many of 1-8 are relevant, but for higher education and technical training UNIDO manuals should be as similar to textbooks as possible, since the scarcity of suitable technical material in this field is a major drawback to the development of timber construction. Other useful tools include scale models, case studies, annotated slide sets, special design competition awards, scholarships and bursaries.
(e) and (f) Agents	10. Overseas study tours and in-post training and work experience in corresponding bodies in other developing countries, as well as industrial countries, is a major investment and should only be awarded to individuals of proven capability and persistence or otherwise having a high likelihood of benefit. The absence of appropriate professional and technical journals in developing countries is a promotional problem, and counterparts and other agents in developing countries should be encouraged to author or co-author papers and articles published elsewhere. UNIDO should also consider alternative ways of publishing, where local channels do not exist.
(g) Sources of finance	11. Such agencies will be especially concerned with case studies that include costs and that correct myths and misconceptions. This group will be more closely concerned with standards documents, and promotional material must draw attention to alternatives when local needs for standardization are not met. At the highest level, material suitable for politicans will also apply here.

Finally, the group produced a number of more general recommendations. These included the following:

(a) That UNIDO should continue to identify opportunities to present complete packages (software, expertise, hardware), introduced and accompanied by suitable promotional material, for specific types of projects, such as timber building systems and bridges, having a high probability of success in industrial countries and regions;

(b) That the promotional value of regional training courses should be borne in mind;

(c) That UNIDO should make greater use of contacts with other United Nations organizations and international bodies for promotional purposes;

(d) That it must be recognized that promotion is a crucial and on-going element of the whole development process. Hence UNIDO should consider the benefits of convening, at suitable periods, short expert workshops or group meetings of a less formal and more working session nature to continue the promotional analysis and planning work started at the Expert Group Meeting on Timber Construction. The benefits of carrying out such activities in developing countries themselves should be borne in mind.