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CONSTRUCTION IN DEVELOPING COUNTRIES

Selected Profiles

Prepared by
Agro-Based Industries Branch,
Department of Industrial Operations

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PREFACE

The United Nations Industrial Development Organization (UNIDO) was established in 1967 to assist developing countries in their efforts towards industrialization. Wood is a virtually universal material which is familiar to people world-wide, whether grown in their country or not. Wood is used for a great variety of purposes but principally for construction, furniture, packaging and other specialized uses such as transmission poles, railway sleepers, matches, and household woodenware. UNIDO has the responsibility within the United Nations' system for assisting in the development of secondary woodworking industries, and has done so since its inception, at national, regional, and interregional levels through projects both large and small. UNIDO also assists through the preparation of a range of manuals dealing with specific topics of widespread interest which are common to most countries' woodworking sectors. 1/

The chapters of this document were contributed by participants at the three-week Timber Engineering Workshop held in Australia, May 1983. Although these were prepared some time before being printed, it was felt that their publication would make a useful contribution to the available information on building materials and methods used in the countries covered; and that this would be of continuing relevance.

The lectures presented at this training workshop have been reproduced in five parts comprising over 900 pages:

Part 1	Introduction to Wood and Timber Engineering	UNIDO/IO.606
Part 2	Structural Timber and Products	UNIDO/IO.607
Part 3	Durability and Fire Resistance of Timber	UNIDO/IO.608
Part 4	Strength Characteristics and Timber Design	UNIDO/IO.609
Part 5	Applications and Constructions	UNIDO/IO.610

and are available upon request.

1/ A fuller summary of these activities is available in a brochure entitled "UNIDO for Industrialization, Wood Processing and Wood Products", PI/78

The workshop was organized by UNIDO with the co-operation of the Commonwealth Scientific and Industrial Research Organization (CSIRO) and funded by a contribution made under the Australian Government's aid vote to the United Nations Industrial Development Fund. Administrative support was provided by the Australian Government's Department of Industry and Commerce.

The lectures were complemented by site and factory visits, discussion sessions and assignment work done in small groups by the participants following the pattern used in other specialized technical training courses in this sector - notably in furniture and joinery production[1/] and on criteria for the selection of woodworking machinery[2/].

The use of timber for construction is not new and, in fact, has a very long tradition. This tradition has unfortunately given way in many countries to the use of other materials whose large industries have successfully supported the development of design information and teaching of engineering design methods for their materials - notably concrete, steel and brick. This has not been so much the case for timber despite considerable efforts by certain research and development institutions in countries where timber and timber-framed construction has maintained a strong position. Usually their building methods are based on the use of only a few well-known coniferous (softwood) species and a limited number of standard sizes and grades. Ample design aids exist and relatively few problems are encountered by the very many builders involved.

Recently, computer-aided design has been developed along with factory-made components and fully prefabricated houses with the accompanying improvement in quality control and decreased risk of site problems. Other modern timber engineering developments have enabled timber to be used with increasing confidence for an ever wider range of structures. This has been especially so in North America, Western Europe, Australia and New Zealand.

1/ Lectures reproduced as ID/108/Rev.2

2/ Lectures reproduced as ID/274/Rev.1

UNIDO feels that an important means of transferring this technology is through the organization of specialized training courses and shorter seminars aimed at introducing engineers, architects and specifiers to the subject and especially drawing to their attention the advantages of wood (as well as disadvantages and potential problem areas) and reference sources so that for particular projects or structures, wood may be fairly considered in competition with other materials and used when appropriate. Cost comparisons, aesthetic and traditional considerations must naturally be made in the context of each country and project but it is hoped that the publication of these lectures will lead those involved to a rational approach to the use of wood in construction and remove some of the misunderstandings and misapprehensions all too often associated with this ancient yet modern material.

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BANGLADESH: THE CONSTRUCTION INDUSTRY

Present situation of the construction industries

Bangladesh (area about 54,000 square miles and population about 100 million) emerged as an independent country in the last part of 1971 after a liberation war of about nine months. As war ravaged the country, the whole economy was shattered and there were practically no resources at hand.

But reconstruction was a necessity and the construction industries which were partially or completely damaged were repaired/replaced/re-established to meet the needs of the country for construction materials. These industries include cement factories, steel mills, timber sawmills, brick manufacturing plants, etc. There are presently two cement factories in the country, one steel mill, about 70 steel re-rolling mills, a few automatic brick manufacturing factories, a good number of brick manufacturing kilns (privately owned), about 18 Government-owned (BFIDC) timber industries and many private sawmills.

These industries supply the country with most building materials requirements, but good quantities of cement and corrugated galvanized steel sheets need to be imported from outside to meet the total demand of the country. These industries provide about 50% of the total employment of the country which includes employment by traders of these goods.

In Bangladesh, about 90% of the population live in rural areas and about 10% live in the urban areas. Three types of houses can be considered:

(a) Masonry multi-storey buildings: these buildings are mostly located in major cities of the country;

(b) Semi-masonry houses: this type of building is mostly found in small towns (subdivisional and thana towns) and these are constructed with corrugated galvanized steel sheets over masonry brick walls and floorings;

(c) Village type houses: this type of house is mostly constructed with corrugated galvanized steel sheet roofing and thatched roofing over timber columns, brick columns and mud walls having masonry or mud flooring.

Public buildings comprise multi-storey houses for Government employees and multi-storey office buildings. The public buildings which were constructed by the Government and the public bodies can hardly accomodate more than 10% of their employees (about 1.5 million), the rest find their accomodation in rented privately-owned buildings in cities/towns which again cannot provide accomodation for more than 40% of the total requirements. In the building industry, the construction contractors play a very important role, mainly in public sector construction works. The size of these firms varies widely with a minimum employment of about 10 to 50 persons. Exact statistics about these firms are not readily available, but their total number would not be less than 1,000 and would probably be more than 1,500 considering all different categories.

Most of the construction industry faces problems of raw material supplies (local and imported), fuel (whose price is going up day by day) and trained manpower. Raw materials for cement, steel, corrugated galvanized steel, etc. are imported and there is a real shortage of timber in the country. Trained technical personnel exists in the country, but demand always keeps its upper hand on their availability.

Building materials

Timbers

Bangladesh, with only about 3,25 million acres (only 9%) forest area, faces great difficulties in meeting its total demand of 170 million cubic feet of timber and fuelwood (timber 70 million cubic feet and fuelwood 100 million cubic feet). At present, total production is only about 70 million cubic feet of timber and fuelwood (timber 30 million cubic feet and fuelwood 40 million cubic feet). As the forest area is much smaller than required (instead of 25%, it is only 9%), the present supply situation cannot fulfil the total demand. However, efforts are being made by the Government to increase the forest area up to 22% through aforestation.

The main timbers used in construction works are: teak (Tectona grandis), chapalish (Artocarpus chaplasha), chickrassi (Chukrasia tabularis), garjan (Dipterocarpus spp.), gamari (Gmelina arborea), Sundries (Heritiera floribunda), etc. In addition to these, there are many other known and unknown timber species which are available in Bangladesh and used in different types of construction.

Bangladesh seldom imports timber except for some special purposes.

Timbers are mainly used for the manufacture of doors/windows, in the construction of wooden frames for corrugated galvanized sheet roofing, in small bridge girders and deckings, and for electric transmission poles after proper seasoning and preservative treatment.

Due to the lack of technical knowledge, the country faces problems in making proper economic use of its scarce timber resources.

Concrete

In Bangladesh, cement is widely used in almost all masonry construction works, (a meagre volume of work is also done with lime mortar). There is a definite shortage of cement in the country with an annual production of about 0.50 million tons against a total demand of about 1.5 million tons. The remaining quantities are imported to meet the demand. The main agregates bricks, stones and sand are available in the country, though nowadays costs are very high due to high fuel and transport costs.

In comparing the costs, it is seen that building with bricks, cement and concrete is less costly than building with corrugated galvanized sheets and timber.

Steel

There is one steel mill in the country which produces steel billets which are re-rolled in about 70 small mills to produce M.S. rods of different sizes as per requirement of the construction works of the

country. This production has been found to be adequate against the demand of the country. The steel mill also produces corrugated galvanized sheets which are widely used in all reinforced concrete construction works. A metric ton of steel costs about US$ 48 to US$ 55.

This sector is not experiencing many problems worth discussing.

Others

Generally, in place of reinforced concrete construction roofing, people are accustomed to use corrugated galvanized sheet roofing fastened with screws and nails to the timber or bamboo frames. Bangladesh imports most of these materials. Finishing materials such as paints, etc. are produced from imported raw materials. Few items of finishing materials are also imported.

Construction

Due to their inherited tradition, the people of Bangladesh are familiar with construction using bricks, lime mortar, wooden/steel beams, wood/steel bracings and burnt tiles. With the introduction of cement, this tradition has changed drastically and modern construction techniques are presently practiced in Bangladesh to keep pace with the development activities of the rest of the world. In construction design work, generally, the ACI code is commonly used in Bangladesh and accordingly average standards are maintained. The cost of modern construction techniques is found to be not very much higher than that of traditional construction and people have accepted it due to its simplification.

In Bangladesh, the House Building Finance Corporation finances, on a long-term basis, loans to construct houses based on the total estimated cost of the building. The rest of the investment (about 20 to 80% of the cost) is borne by the borrower. In that case, the house and its land are mortgaged to the corporation. There is a problem of financing by the said corporation since total demand is much higher than its ability to finance. Sometimes banks also finance the building of houses with short-term loans.

Labour

In Bangladesh, there is a scarcity of trained manpower although there are more than 20 vocational training centres in the country. There are about 20 mid-level technical institutions, four engineering colleges and one engineering university in the country.

Industrial Infrastructure

Bangladesh has a building research, a road research and a forest research institute. These organizations do research in their respective fields and advise the concerned organizations/persons in respect of quality control and standards. There is an existing standards institution which mainly deals with standardization of products to be used in the country.

BRAZIL: THE CONSTRUCTION INDUSTRY IN BRAZIL

Construction industry

Brazil is now undergoing a serious economic crisis, as in other developing countries with inflation rising to 100% per year. During periods of crisis, construction is the most important economic activity, because of the large number of jobs it can offer and because of the several building material industries it needs to support.

Its importance is shown in the following figures about the participation of constructon in Brazilian industry:

Items	1979	1980	1981
Industrial production	14,78%	15,36%	17,04%
Employment	28,77%	29,28%	29,52%

Another aspect that must be mentioned is the size of the construction firms. Even in developed countries, the great majority of this industrial activity is composed of small and middle size companies. Around 95% of the capital, the technology and workmanship utilized are national.

Building materials

Concrete

All the components are produced, or can be found in Brazil as: cement, granite, sand, timber (for formwork). Concrete is used predominantly in construction, even in small buildings, bridges, etc.

Cost composition:

(a)	Materials			
	Cement	330 kgs	0,07	23,10
	Granite	0,8 m^3	13,50	10,80
	Sand	0,6 m^3	7,55	4,53
	Timber	12 m^2	6,40	76,80
	Steel	100 kgs	0,35	35,00
				150,23 (69,8%)

(b)	Workmanship			
	Mason	8 h	1,30	10,40
	Carpenter	20 h	1,30	26,00
	Steelbender	12 h	1,30	15,60
	Labour	22 h	0,60	13,20
				65,20 (30,2%)
		Total =	US$ 215,43 per m^3	

Timber, used as formwork, is the most expensive component of concrete work and represents about 35,6% of its cost, more than the whole of the workmanship component and more than 50% of all materials. The prices given are for the city of Sao Paulo, in the most developed region of the country.

Cement production

The statistics shown in the following table were produced by cement industries on October 1982 and compare industrial production and construction needs, estimated for 1983 and the next years:

	1000-ton				
	1981	1982	1983	1984	1985
Production	28,532	29,745	33,868	37,708	42,034
Needs	26,090	26,873	28,350	30,557	32,506
Balance	2,442	2,872	5,518	7,151	9,528

Steel

All the steel used by the construction industry, for concrete reinforcement is produced in Brazil and there is no supply problem. It is available in 12-meter rods with the following diameters and prices per ton:

Diameter	1/4 "	US$ 321
	1/16"	306
	3/8 "	300
	1/2 "	288
	5/8 "	288
	3/4 "	283
	7/8 "	283
	1 "	278

The allowable tension of this kind of steel is 5.000 kg/ cm^2. Higher capacity steel for prestressed concrete is also produced.

Timber

The country prossesses large forest resources and many indigenous timbers that can be used in the construction industry. The great majority of forests are in the north and northwest regions, far from urban areas, with the exception of pine forests that are found in the south.

Timber, in the construction industry, is mainly used as formwork and is generally available in planks (1" x 12" or 1" x 6") and plywood (1,10 x 2,00 m). It is also used in windows, doors and roof frames.

Construction

Traditional practices utilize masonry and concrete in the large majority of our construction activities, using traditional technology (bricks, concrete blocks and mortar).

Building frames are often made by preparing the formwork, the steel-bending and then by pouring the concrete.

The following figures give the building cost, per square meter of houses and apartments (two bedrooms) depending on the number of floors and the quality of finishing:

	Finishing quality (US$ per m^2)	
Floors	Low	Normal
1	154	173
4	134	151
8	131	147
12	129	144

Labour

Brazilian workers have a great capacity to adapt to new techniques and workmanship and are available everywhere in the country.

Usually they learn their job on the construction sites over a period of several years and are very experienced.

They are protected by 'labour laws', with insurance and medical assistance and retire after 35 years of work. The amount of 'labour laws' is around 99% of its cost. This means that for each dollar the companies pay to the worker, they must pay US$ 0,99 to the Government.

Industrial Infrastructure

SENAI (National Service for Industrial Apprenticeship)

This is a teaching organization created in 1942 and dedicated to the development, improvement and specialization of human resources necessary to fulfil industrial labour requirements.

The course, on a first grade level, is designed for minors aged from 14 to 18, hired by firms as apprentices or for those not yet employed. Also courses for adolescents and adults are given, as improvement and specialization.

ABNT (Brazilian Society of Technical Standards) and IPT (Institute of Technical Research - University of Sao Paulo)

These associations can offer all kinds of advice on technical matters or do research for the construction industry. Engineers are compelled to respect their recommendations in professional activities.

COLOMBIA: THE BUILDING INDUSTRY

Present situation of the construction industry

Importance of the sector

The present Government has given to the housing construction industry the importance it deserves. The importance it has is due to the following:

- the housing deficit is somewhere near 1,000,000 units. This deficit is concentrated in the type of housing costing less than US$14,000
- an increase in the construction activity is the best way to reactivate the economy of the country. There is a surplus of raw material for the construction industry, so prices will not increase;
- the mass construction of houses do not have serious inflationary consequences;
- it is the fastest way to generate mass employment for unqualified workers.

For houses costing less than US$10,000 the Government does not contemplate giving a contribution. Therefore, the initial request is going to increase. It is important to point out that the ratio of effective demand is less for the lower income bracket (16,5%) than for those with medium to high incomes. National construction activity, measured by the total square meters per year, was as follows:

Year	Construction m^2
1978	5,928,499
1979	4,689,399
1980	4,574,117
1981	4,895,006

According to the statistics for the first six months of 1982, construction activity was less than that of 1981.

The housing programme goal is to build 100,000 houses per year. This means that for 1983, the figure should be over 4,500,000 m^2 for houses only.

The construction industry generates 140,000 jobs in direct employment and 140.000 in indirect employment. These figures correspond to the 1980 building activity.

To reach the housing programme goals, it is necessary to mix all the construction methods we have, i.e. industrial, self construction and cooperative systems.

The building and housing industries have the following problems:

1. There is no continuity in Government policies, so the private sector has no incentive to make large investments;
2. There is not enough research into construction methods and materials, and technological transfer is lacking;
3. The materials used are not standardized;
4. There are not enough training centres;
5. There is a great deal of uncoordinated intervention by public bodies in the urbanization process;
6. Procedures related to urbanization and the selling of houses are very cumbersome;
7. Only some of the most important cities of the country have urban development plans.

Building materials

Timbers

Colombia has 572,800 km^2 of tropical forests (50,5% of its total area), and 68,850 km^2 of mountainous forests. There are 300 wood species which can be used for industrial and construction purposes. Thirty-six percent of the productive area is covered by coniferous species: the other 64% of the area with broad-leaved species. According to Acevede and Pinilla, the tropical forest can be divided into three zones:

1. Amazonia: an area of 378,800 km^2 located between the Orinoco and Amazonas rivers - there are a great deal of oleaginous palms (*Mauritia*, *Oenocarpus*, *Otbignia*, and others), *Leopoldinia piassava*, indigenous cacao tree, and so forth:

2. Magdalena: in the Magdalena river basin there is a forest area of 32.280 km^2. It has an irregular distribution due to the clearances of the forest by settlers. This region has a lot of mahogany, ipecac, pita and so forth;

3. Pacific Coast: there are 94,000 km^2 covered by wet tropical forests with a great variety of trees.

Since 1969, the country has had a Forestry Law regulated by the National Institution for Renewable Resources (INDERENA) which controls both exploitation and reforestation. Production changes from area to area: there are regions that can produce 160 m^3/ha while others only produce 30 m^3/ha.

The following table shows the production of the most important indigenous timber species for 1972:

Species		Gross volume (m^3)	Basic density
Cuangare	Dialyanthera Gracilipes	539,687	0,32
Cativo	Prioria copaiera	189,885	0.54
Cedro	Cedrela odorata	114,090	0,50
Sajo	Camprosperma panamenesis	99,205	0.37
Abarco	Cari iana pyriformis	78,435	0.68
Amarillo	Nectandra Spp	69,878	0.41
Eucalypto	Eucalyptus Spp (mostly Eiglobulus)	69,627	0,55
Guamo, Pacay	Inga alba	47,937	0.51
Roble	Querus Spp	44,787	0.90
Sande	Brosimum utile	37,817	0,42

The export of manufactured and sawn timber in 1979 amounted to US$23,000,000.

Timber is used in construction work for roof joists, in formwork and falsework for concrete construction, electric and telephone transmission poles, rural bridges, doors and for plywood production.

The Instituto de Crédito Territorial has established a special programme for using timber: the Malhabar Project, Manizales. In this programme bamboo was used in a square pattern of 50 x 50 cm with diagonals of the same material to produce self-constructed houses. The terrain was very steep and bamboo was used to reinforce the mortar walls for greater seismic resistance. The problems relating to timber production are the following:

- there is not enough working capital;
- it is difficult to obtain spare parts for the equipment;
- only small profits can be made by the producer;
- there is a lack of quality control;
- there are inadequate transportation facilities from the production centres;
- deterioration of quality occurs during transportation or storage.

Concrete

The following statistics show the installed production capacity of cement in the country and the demand for this raw material:

Year	Portland Cement Production (tons)	Internal Consumption (tons)
1978	4,200,000	3,482,470
1979	4,700,000	3,565,571
1980	4,900,000	3,841,075
1981	5,995,000	3,873,210
1982	Production increased by 6,2% for the first four months of the year.	

The supply of mineral aggregates fluctuates with the dry and rainy seasons, but can be considered enough for the planned consumption.

The use of precast elements is increasing; beginning with precast joists for floors or roofs and progressing now to using precast panels and complete slabs.

Concrete is the most commonly used construction material in Colombia. A cubic meter of concrete with a strength of 210 kgs/cm^2 costs US$50 at a central mixing station.

The mean per capita cement consumption in Colombia is 140 kgs per year; the cement cost is US$60 per ton.

The prices of mineral aggregates change substantially from place to place. In Bucaramanga a cubic meter of sand or gravel costs US$6, but in Vélez, located 200 kms away from Bucaramanga, it costs US$24. The cost of construction per square meter in Bucaramanga is US$70, roughly finished, but in Vélez it is US$120.

The use of concrete blocks is increasing. In Bucaramanga where there is enough alluvium and a cement plant in the neighbourhood, a hollow concrete block 40 x 20 x 20 costs US$0,30. But in the rural areas, it will cost twice as much or more. Due to the cost of raw material for concrete in the rural areas, it is necessary to investigate the use of other materials in order to reduce building costs.

Steel

Steel production is indicated in the following table:

Year	Production (metric tons)
1976	252,253
1977	209,011
1978	265,207
1979	233,708
1980	262,875

The steel production capacity is good enough for the housing programme. In the last year a stock equivalent to a four-month production capacity was held.

The steel is especially used for reinforced concrete and not structural framework, which is used for industrial purposes only. The following table presents the price list for steel in round corrugated bars:

Diameter (inches)	Strength (PSI)	Price (US$/kg)
1/4	37,000	0,73
3/8	37,000	0,69
5/8	60,000	0,64

Construction

The following construction practices are used in Colombia:

- Traditional: Brick or cement block construction. With ceramic roof tile over bamboo and clay sheet as a cover. This cover is usually replced by a fibre cement sheet. Bamboo covered by mud or mortar in walls, with ceramic roof tiles or straw cover. In situ reinforced concrete beams, slabs and columns with brick or cement blocks used for partitions;
- Modern practices: Skeletal system - in situ reinforced concrete with precast slabs. Tunnel system - this system uses special formwork and the bearing walls and slabs are poured as a whole. For the

partitions, cement blocks or hollow tricks are used. Joint system - the whole building area is formed by precast panels and slabs joined in place. Hoisted system - the walls and slabs are poured horizontally one over the other, then the whole slabs (90 m^2) are lifted and at the same time the walls are turned from the horizontal to the vertical. Reinforced concrete blocks with precast slabs.

The cost per square meter of constructed area is about US$54 for industrial methods and US$87 for traditional ones. The productivity of the systems is as follows:

Method	Productivity m^2/day
Reinforced concrete blocks	77
Joined systems	450
Skeletal systems	400
Tunnel system	500
Hoisted system	300
Traditional	20

The price components of a housing unit are

Materials, equipment, labour costs	45%
Indirect costs (taxes,project elaboration, etc)	30%
Land and urbanization costs	20%
Financial costs	5%
Profits	+20%

The item "materials, equipment, labour costs" is composed of the following elements:

Preliminaries	0,789%
Cementation	6,31 %
Structure	11,447%
Walls	15,279%
Impermeable layers/coatings	0,576%
Roofs	8,289%
Floors	10,131%
Walls finishing	6,841%
False Roof	3,552%
Water supply and drainage system	13,947%
Electric installations	4,473%
Facade	6,315%
Carpentry	8,947%
Exterior works	1,315%
Special installations	0,526%
Cleaning up	1,315%

Any measure that is taken to reduce the construction cost must affect more than one of the variables indicated before in order to be effective.

There are three principal channels to finance housing construction:

Instituto de Crédito Territorial: Government office dedicated to the construction of houses for the low income people. Its resources have a mean financial cost of 20%.

Banco Central Hipotecario: This state-owned bank is dedicated to collecting public savings to finance housing construction and public works. The resources it generates have a financial cost of 30%.

Corporaciones de Ahorro y Vivienda: These private corporations also collect public savings to finance housing construction and the construction industry. The mean financial cost is 34%.

Labour

According to the Bowcentrum, the productivity of the Colombian labour force is as good as that of Europeans. Nevertheless the time lost due to delays in the supply of materials, the lack of coordination in the designs and modifications, reduce this productivity.

There is a lack of qualified administrative and support personnel. The managers do not have administrative training. The SENA (National Service of Training) is dedicated to vocational training, but is unable to satisfy the demand for qualified workforce. There are 15 centres of high technical education in civil engineering and architecture.

Industrial infrastructure

Some institutions offer industrial research and management consultancy, but these are not sufficiently available.

ICONTECT is the national institution dedicated to make technical and quality control standards.

FIJI: THE CONSTRUCTION AND BUILDING INDUSTRY

Introduction

Fiji is a developing country, therefore the construction industry plays a very important role in its development.

A special effort is made to design and build dwellings that are safer, sounder and more comfortable to improve the living conditions, as well as to avoid or minimize the cost of damages to buildings during unforeseen natural disasters (hurricanes and earthquakes). The construction of bridges and jetties all over the country is also very important. The construction of better wharves, harbours and international airports is also a necessity, for it connects Fiji to the rest of the world. This is to help keep Fiji in touch with the latest developments overseas and to try and duplicate where suitable.

Statistics

Buildings in the public sector are constructed and maintained by the Ministry of Works. This includes hospitals, post offices, Government administration buildings and any other form of Government buildings.

Buildings in the private sector are designed and constructed by local consultants and contractors, but construction does not begin unless a design is approved by the local Government or the Ministry of Town and Country Planning.

Problems facing the industry

Fiji is going through a period of replacing expatriates by locals. Gradually small numbers of new graduates are returning home with their certificates at the term of their training overseas. These new professionals are further trained on the job to replace expatriates who at the end of their contract return home. Experience is of a major importance and the local replacement cannot equal his predecessor's experience unless he is more often exposed to large scale construction projects of the same type as those carried out overseas. There are a few large projects of this scale in Fiji, but not all locals can participate in these, specially since foreign consultants and contractors are brought in to do the work.

There is still a shortage of qualified professional personnel in the construction industry in Fiji. Due to this, most construction projects are not efficiently supervised. At the moment, in some cases non-professional supervisors are expected to prepare programmes and to control the workforce, cost as well as assure that quality is maintained. Most supervisors are not aware of how vital these factors are to keep the project cost level within the estimated cost.

With new building materials appearing on the market nowadays, local builders and architects should be advised on how they could be efficiently used to reduce maintenance costs.

Building materials

Timber

Forest resources: Fiji, being in the tropics, with a high annual rainfall, has wide forest resources. The potential for timber production ultimately depends on the area of suitable land available.

There are three separate management entities, namely (i) protection, (ii) non-commercial, and (iii) production forest.

Protection forests comprise that portion of the resources on inclines over 30 degrees with shallow, unstable soils; such a forest is not normally available for commercial exploitation.

Non-commercial forests refer to areas, other than protection forests, where stocking of acceptable species is less that $30m^3$/ha.

Production forests stocking ranges from $30-120m^3$/ha and it is this category only which is of commercial interest.

Fiji comprises two main islands: Viti Levu and Vanua Levu. Close to 90% of the production forests in Viti Levu is accounted for by the 34 indigenous softwood and hardwood species available in the country. In Vanua Levu these same timbers account for over 80% of the volume.

A more recent study indicates a total overbark volume of 16,406,000m3 for the country for all species above 40cm dbh over a production forest area of 235,903ha.

A reduction of approximately 10% can be assumed for bark.

Total log production in 1981 was approximately 208,000m^3 underbark volume. To put the life of the enumerated production forest in perspective, it can be indicated that the maximum permissible annual cut is less than 300,000m^3 underbark per annum.

Fiji is committed to large afforestation and reaforestation with exotic softwood and hardwood species.

The exotic softwood plantation resource is dominated by Pinus caribaea var. Hondurensis (Fiji Pine) introduced from Central America in 1955. By the end of 1980, approximately 41,000ha of Fiji Pine had been established.

The exotic hardwood plantations totals to some 13,000ha. The main backbone of this resource is Mahogany which accounts for approximately 9,000ha.

Indigenous timbers in the construction industry

For heavy construction works where strength and durability are required, the following indigenous timbers are available locally: buabua (Fagraea gracilipes), lemon scented gum (Eucalyptus citriodora), moivi (Cynometra insularis), rosarosa (Gmelina ornithocephala), sacau (Palaquium hornei), vesi (Intsia bijuga), and yasiyasi (Syzygium Spp.).

Other timbers that are more commonly used in the construction industry are: dakua (Agathis vitiensis), damanu (Calophyllum vitiense), kaudamu (Myristica chartacea), kauvula (Endospermum macrophyllum), mahogany (Swietenia macrophylla) and vaka (Dacrydium nidulum).

Imported timber

The last major import into the country was back in 1975 when 5,730m^3 of timber was imported from New Zealand and North America.

Imports were then prohibited by the Government to support the production of local timber.

Use of timber

Almost all of Fiji's indigenous timbers are used in the building industry for heavy and light construction, all frameworks, internal finishing and fittings, furniture and other joinery and building applications.

Problems

Several problems still exist in the use of Fiji timbers in Fiji.

i There has been no legislation to regulate the quality of timber coming out of the country's mills. It therefore depends on the buyer to satisfy himself with the quality of the timber he is buying.

ii Timber is generally considered as having a low status when compared to other building materials. This is mainly due to consumers using poor quality or poorly preserved timber. To remedy the situation, timber producers and traders are doing their utmost to promote the use of high and good quality timber to avoid unnecessary deterioration of timber buildings.

iii The architectural features of a timber building play an important role in promoting the use of timber. In Fiji at present there are hardly any timber buildings 'coming up', when compared to concrete buildings which are really attractive. Therefore, more and better timber building designs are still a necessity to encourage the public to build more timber buildings.

iv Insurance companies are still hesitant in issuing policies to cover timber buildings due to the high fire risk.

Costs

Timber with more modern techniques is less expensive to produce when compared with some other building materials. It has an economic advantage because it is a readily available local material.

Concrete

Cement production

Enough ordinary cement is produced in Fiji for the country to be self-sufficient. The only imported cement is special cement, for example low heat cement or rapid hardening cement, when local production cannot meet the demand.

Aggregates

Coarse aggregates locally available include crushed quarry metal and river gravel.

Crushed quarry metal from rock are produced from several centres around the two main islands. This is screened, washed and grouped in two main sizes - half and quarter inch sizes. The supply of crushed metal is sufficient to meet the local demand.

Fine sand is also obtained from two different sources; river sand and screened sand. Screened sand is coarser than fine river sand and is normally mixed together for concrete mixing. Production is also sufficient for the local market requirements.

Precasting

Precast concrete is produced and supplied by most ready mix concrete suppliers. HUMES Ltd. with an international reputation, is the most popular of these precast units on the market. All cast are available locally: e.g. prestressed/post tensioned beams, blocks, etc.

Use in construction

Concrete is just about the most popular building material to be used on any site. Ready-mixed or site-mixed concrete are considered to be on top of the list of building materials for frame buildings. Even for steel frame or timber frame buildings, concrete still plays a major role in their foundations.

Costs and problems

Concrete structures are generally considered to be slightly cheaper than steel and timber structures. This may be so when the material cost is considered, but the method of erection and construction plays a vital role in such finalization: i.e. when the cost of manpower is considered.

Cost is also vital when a structure has to be dismantled due to a fault during construction. Concrete structures therefore would be more expensive.

Concrete also faces a disadvantage during its curing period. Fiji, being in the tropics, faces a slight disadvantage when controlled curing is essential. This is overcome by keeping the green concrete surface moist to reduce the rate of heat loss from the concrete for more strength.

The cost of readymix concrete varies between Fiji $85 and 90/$m^3$. Most or all ready mix plants are located within town or city boundaries. Depending on the size and location of a project, the cost of readymix concrete will vary accordingly.

Steel

Supply situation

Reinforced deformed steel bars and round section bars are produced locally, i.e. the steel rolling mills are able to meet the local demand and therefore import of reinforcement is not necessary. All forms of steel production could also be carried out locally, which is an advantage to the industry.

Use in construction

Whenever required there has been very little or no problem in the use of steel in the building industry. The most common use of steel here is for reinforcement, steel trusses, steel brackets, all forms of sections and plates, etc. Steel is also used as steel girders in bridges and has other applications in other marine structures.

Construction

Methods of construction

Traditional

The most traditional method is the circular dwelling house of wooden poles buried into the ground with thatched grass roof and walls ('bure'). Although these dwellings may not be structurally sound, the thatched grass provides good insulation against the country's tropical climate.

Such houses are still being erected in the more rural areas of the country where no proper designs or drawings have been prepared. These are usually makeshift houses or simple timber frames with corrugated iron roofing and walls.

Modern practices

Fiji being a neighbouring country to New Zealand and Australia, and having close ties with the United Kingdom is greatly influenced by these countries' construction methods. Engineers and technicians are being trained in these countries and the methods learned are taken up on their return home. For example the use of Acrow props and shuttering for scaffolding and formwork is now widely spread.

In Government specifcations, labour and material schedules, labour and bar (programme) charts accompany all necessary drawings to the job site prior to construction. In the private sector, the specifications and drawings are more or less the only documents provided for construction works.

The use of intensive labour in construction is now a rarity with the introduction of more advanced plants and machinery to increase efficiency and reduce the construction time.

Regulations and standards

The conditions of contract documents are prepared with reference to those set out by recognized institutions, especially those of New Zealand, Australia and the United Kingdom.

All local Governments namely City and Town Councils use the same building regulations in certifying all new buildings.

Fiji still does not have its own design codes. Those from New Zealand, Australia and the United Kingdom are commonly used by both the private and public sectors. It is anticipated that Fiji would have its own timber design code for local timbers soon, with the help of the New Zealand and Australia Governments.

Cost comparisons

The public and private sectors

The Government's Ministry of Works looks after the construction of all Government projects, i.e. it designs, constructs and supervises all these projects. For large scale projects beyond the Ministry of Works' manpower, tenders are invited for a contract and foreign consultants are taken on to act on behalf of the Government or the Ministry of Works.

It has been recently claimed that the Ministry of Works is becoming more expensive than the private sector. There is a difference in the cost of labour. The present Government labour rate is $1,61 per hour whereas it is $0,80 (approximately) per hour in the private sector. This is almost evened out in the material cost.

The cost of materials from Government supplies (which supplies materials to Government departments) is only controlled by the Government and is much cheaper than the private sources.

Financing

The Government finances all of its projects unless one is financed by a foreign aid programme. Financing of private buildings is mainly through loans from the bank, insurance companies, home finances and other private sources.

Problems of sectors

An outstanding feature between the public and private sector is the marked difference in the salary scale of the professional staff and the tradesmen.

The professional staff in the private sector (engineers, architects, etc.) are more or less paid one and a half times more than those in the public sector. Due to this, the Government finds it difficult to keep its new graduate engineers and architects once they become qualified on their payroll. The Government is therefore trying to reduce this salary gap between the two sectors for this category of staff.

The labour and skilled tradesmen in the public sector tend to be paid slightly more than those in the private sector. This is mainly due to the commercial status of the private sector.

Another problem faced by the Government is the tendency and pressure from other Government Department clients to go to the private sector with their building projects, because it is claimed that they are less expensive than the Ministry of Works. This is still being fought in Cabinet for approval, since each department controls its own allocated funds for building projects, etc. Another argument is that the Government is being pressurized by the private sector to share its building projects due to the world-wide downturn in the construction industry. If this is approved then the Government will be faced with the problem of having to further make redundant more of its workmen.

Labour force

Quality and availability

The quality of carpenters in the construction industry is at the moment fairly reasonable especially for those who have been through the trade with 10 years plus experience. But management is faced with a problem when age starts to affect the output and efficiency. This is normally the problem in the 50 years plus age group.

Due to the worldwide downturn in the construction industry and due to the reduction in the building rate, there is a large availability of skilled tradesmen (carpenters, plumbers, painters etc.). It is anticipated that when the industry reaches its peak again, the demand will be met by those who are readily available and those coming out from the Government's (and the private sector's) apprenticeship training programme.

Vocational training

For building tradesmen an apprenticeship training programme is provided and it covers all the trades in the building industry, except for painters where experience is normally the main factor. One normally goes in at the age of 17 or 18 years and completes this training on a 6-months practical training annually for five years.

All theoretical training is carried out in the country's only technical institute which is the Fiji Institute of Technology.

High technical training

The ordinary diploma

This is a 'sandwich course' for technicians covering about 2 to 3 years. Successful candidates are expected to work in a design office as draughtsmen and assistants to designers for survey work etc. or in a construction site as assistants to engineers and supervisors.

Graduate courses

This leads to a professional qualification and could only be obtained overseas. The facilities are just not available locally to provide proper training for the obtention of a degree.

These courses are normally sponsored by the Government and foreign aid from overseas especially Papua New Guinea, New Zealand, Australia and the United Kingdom.

Industrial infrastructure

The University of the South Pacific (Suva, Fiji) and the Fiji Institute of Technology are more or less the only two local institutions that could provide training to personnel at all levels.

Courses and lectures are arranged by either the Government's training section, the Fiji National Training Council (a body that looks after training in both the public and private sector) or by established institution (e.g. The Fiji Institution of Engineers). Lecturers could either be from the Government or Private sector or invited guest speakers from other countries.

The Fiji Institution of Engineers and other such bodies and the Fiji Institute of Technology are the only institutions active in the fields of quality control and standards.

It is therefore dependent on each body to set a programme in such fields which are thought to be useful.

The only local institution active in the field of industrial research and management consultancy are those already mentioned but normally chosen personnel are sent overseas either through aid or the Government when such programmes are put up by other countries.

INDIA: THE BUILDING INDUSTRY

Introduction

The construction industry has a very important role to play as it directly affects development of various sectors such as housing, agriculture, irrigation, power, transport, education and health. In particular, there is an urgent need to provide adequate dwellings to millions of people living in both rural and urban areas under sub-standard conditions. It is estimated that housing shortage in the country is over 20 million units - 15 million in rural areas and 5 million in urban areas. The Government has proposed to allocate a sum of Rs.1302 crores (US$1302 million) to construct 5.85 million dwelling units with a total target of 18.7 million dwelling units (13 million for rural and 5.9 million for urban areas) during the Sixth Plan. Hence it is estimated that in order to meet the target of 12.8 million units the private sector will have to meet an expenditure of Rs.11,500 crores (US$11,500 million).

The Government has formulated a policy for providing dwellings to people of various socio-economic backgrounds - middle and low income groups, economically weaker sections, landless labourers and small farmers. The success of implementing this policy depends on the efficient organization of building industry and the effective utilization of high energy materials like cement, steel, bricks and renewable resources such as timber, bamboo, etc.

This paper gives a brief account of the building industry in India with particular reference to building materials, construction practices, and problems, finance and industrial infrastructure.

Building industry

The building industry in India with a few exceptions is not very well organized as is the case in most developed countries. Major construction works like residential and non-residential buildings, highways and bridges, industrial structures, etc., are carried out by a number of large and small builders registered with the Public Works Departments, Railways and Military Engineering Services. These builders execute the work, employ site engineers, supervisors, skilled labourers like masons, carpenters, concretors. Except

for a few specialized structures, construction is carried out manually with a minimal use of machinery or mechanical equipment such as mixers, vibrators and simple hoisting equipment. Very few builders have the facilities for precasting and prefabrication as the majority of construction works are custom built. Type designs and plans for both residential and public buildings are adopted only by Government organizations. Besides private builders, Government building agencies or undertakings such as the National Building Construction Corporation, the State Construction Corporation and the National Project Construction Corporation (NPCC) execute large construction projects both in India and abroad. For instance the NPCC completed Rs. 70-75 crores (US$ 70million) worth of work during 1982-83.

Types of construction

The majority of buildings and structures (residential and non-residential) in urban areas are built using high energy building materials like cement, steel and bricks. Wood and wood based panels presently find extensive use in joinery only. Multi-storeyed buildings, bridges, flyovers, stadia are constructed using reinforced cement concrete and, to a limited extent, prestressed concrete. Industrial structures are built with welded steel frames with cladding of asbestos or galvanized iron sheets. Most of the urban structures are designed by competent architects and structural engineers.

In contrast to urban constructions, rural buildings are mostly built using locally available building materials like mud, sun dried bricks, stone, bamboo, wood poles and timber. Rural houses/buildings have roofs of burnt clay tiles, thatch, reeds and stone slabs, depending on their availability. Reinforced concrete constructions are rare in rural areas, although there is a tendency to use cement and concrete by the affluent rural population. It is interesting to note that rural houses are built by local craftsmen who are semi-skilled and in many cases the houses are of the 'do-it-yourself' type.

Problems faced by the building industry in India can be summed up as (a) unsteady supply and high cost of building materials like cement, steel, bricks, aggregate and timber; (b) inadequate facilities for prefabrication and precasting; (c) absence of standardization; (d) high cost of labour and transport; and (e) scarcity or uneven distribution of skilled labour.

Building materials

Timbers

Forest resources: India has 74.79 million hectares of forest area or 22.75% of its total area. Indian forests consist of a variety of hardwood and softwood species and are the main source of fuel and industrial wood. The recorded production of industrial wood in 1976 was 11.22 million cubic meters, and 13.5 million cubic meters (provisional) during 1979-1980, and it is estimated to amount to 16 million cubic meters in 1982. Forests are also an important source of bamboo which is a major raw material for the pulp and paper industry and for rural housing. The average raw material requirements of industrial wood for the present and future is given in table 1 hereunder.

Table 1: Total industrial raw material requirements (1970,1980,1990 and 2000)

Forest products	Estimated consumption in 1970	Projected demands in 1980	1990	2000
Raw material for sawn wood ('000 cubic meters)	9,561	12,649	17,010	24,600
Wood required for panel boards ('000 cubic meters)	372	943	1,407	2,760
Pulp wood ('000 cubic meters)	746	5,033	12,732	40,000
Round wood ('000 cubic meters) from forest and non-forest resources	5,232	6,927	9,559	13,225
Total industrial wood	15,911	25,552	40,708	80,585
Bamboo ('000 tonnes)				
(a) for pulp and paper	1,191	2,199	1,954	1,800
(b) non-industrial uses	1,582	2,173	2,960	4,000
Total bamboo	2,773	4,372	4,914	5,800

At present, the country depends entirely on indigenous industrial wood supplies for construction and wood based industries. The country imported only 7000m^3 of sawn timber and 17,000m^3 for railway sleepers in 1979. It is estimated that out of 11 million cubic meters of industrial wood about

2.5 million cubic meters of wood was utilized for rural and urban housing and 0.5 million cubic meters for non-residential construction. It is also estimated that about 40% of the available stock of timber goes into the construction industry and the present demand of construction timber is about 6 million cubic meters and the gap is expected to increase further in coming years.

Industrial wood is also used to produce various types of wood based panel materials, namely plywood, particle board and fibreboard. The country consumed 500,000m^3 of round logs to produce 280,000m^3 of plywood in 1981. During this period it also produced 21,400 tons of particle board and 29,300 tons of hardboard.

Construction timbers

Due to the scarcity and steep rise in cost of favoured wood species like teak (Tectona grandis), sal (Shorea robusta) doedar (Cedrus deodara), the construction industry is now using many lesser known timber species. On the basis of extensive research carried out at the Forest Research Institute (FRI) in Dehradun, it has been shown that many relatively unknown timber species can be successfully used in construction after proper seasoning and preservation. At present about 85 timber species have been identified as suitable for construction. They are classified on the basis of durability, treatability, refractiveness and stiffness. The National Building Code (NBC) has classified them into three groups - A, B, and C - on the basis of stiffness. Table 2 hereunder gives a list of important Indian timber species recommended for construction purposes and it is expected that with the increased use of secondary wood species, further supplemented by plywood and other panel materials in construction, the present scarcity of favoured primary species can greatly be overcome.

Table 2: Important species of timber for structural purposes

Group	Species	
	Botanical name	Trade name
A	Acacia catechu Willd	khair
	Albizia odoratissima Benth	kal-siris
	Grewia tiliaefolia Vahl	dhaman
	Shorea robusta Gaertn. f.	sal (UP)

Group	Species	
	Botanical name	Trade name
B	Acacia arabica Willd	babul
	Albizia lebbeck Benth	kokko
	Altingia excelsa Noronha	jutili
	Casuarina equisetifolia Forst	casuarina
	Dichopsis elliptica Benth	pali
	Dipterocarpus spp.	gurjan
	Eugenia spp.	jaman
	Lagerstroemia lanceolata Wall	benteak
	Pterocarpus dalbergioides Roxb	padauk
	Pterocarpus marsupium Roxb	bijasal
	Quercus spp.	Indian oak
	Shorea robusta Gaertn. f.	sal (MP)
	Soymida febrifuga A. Juss	rohini
	Tectona grandis Linn. f.	teak
	Terminalia bellirica Roxb	bahera
	Terminalia tomentosa Wight. et arn	laurel
	Xylia xylocarpa Taub	irul
C	Adina cordifolia Roxb Hk. f	haldu
	Anthocephalus cadamba Mig	kadam
	Artocarpus chaplasha Roxb	chaplash
	Azadirachta indica A. Juss	neem
	Calophyllum spp.	poon
	Cedrela spp.	toon
	Cedrus deodara D. Don	deodar
	Dalbergia sissoo Roxb	sissoo
	Gmelina arborea Linn	gamari
	Lagerstroemia flos reginae Retz	jarul
	Mangifera india Linn	mango
	Mitragyna parvifolia Roxb Korth	kaim
	Pinus excelsa Wall	kail
	Pinus wallichiana A.B. Jacks	chir
	Terminalia myriocarpa Heurck et Muell. Arg.	hollock

Use of timber in housing, non-residential building, bridges/public works

Timber is widely used in three major areas: (a) load bearing constructions in rural areas and low rise construction in towns; (b) temporary constructions such as scaffolding and form work and bridges; and (c) joinery.

In low rise buildings, timber is widely used to support tile and various sheet roofing, ceiling and plank flooring. Solid wood of rectangular sections is widely used as posts, purlins, rafters and trusses for spans of up to six meters. Traditionally, for spans exceeding six meters it was common to use coupled rafters, king and queen post trusses and flitched or keyed

beams. However, at present for spans of over six meters, solid wood is being replaced by steel and RCC. For beams of up to six meters, unjointed solid wood is favoured since effective jointing techniques are almost unknown to the builders.

Research carried out at FRI has widened the scope of using timber having a length of upto 2.5m (short) and not exceeding 5cmx20cm (small dimension) for spans exceeding 12m in the form of nailed timber trusses and nail laminated timber purlins and beams. These have been standardized by the Indian Standards Institute (ISI) and the National Building Organization (NBO). Similarly, the use of hollow rectangular or nail laminated timber columns instead of solid wood columns has been developed.

Research and development work carried out at the Indian Plywood Industries Research Institute (IPIRI) in Bangalore, during the last decade has shown that using water-proof or shuttering grade plywood in combination with solid wood, and using nail gluing techniques, it is possible to construct large span economic structures in the form of glued plywood web beams, rigid plywood frames and trusses, stressed skin panels and other prefabricated building components. Many structures built using these components have performed satisfactorily under tropical climate. Based on the work carried out at IPIRI, ISI has issued standards for structural adhesives for laminating. Similarly, a draft specification for structural plywood is under wide circulation.

CBRI, FRI and IPIRI have also demonstrated the use of treated poles, bamboo boards and mats in rural construction. Due to the present scarcity of high energy building materials, well designed and engineered timber structures should be an attractive proposition especially for low rise and rural buildings.

Timber bridges are rare since they are being replaced by steel and concrete bridges. However, in inaccessible areas and forests, nailed lattice type bridges for spans of upto 14m, designed by FRI, could be used in place of traditional timber bridges.

In shuttering and formwork, shuttering grade plywood is now widely used for a variety of RCC constructions such as multi-storeyed buildings, bridges, shell roofs, water tanks, etc.

Similarly, flush doors, block boards, panel doors (with water proof plywood or particle board) have replaced solid wood doors in urban construction.

The problems faced in the use of timber in construction can be identified as follows:

1. Inadequate supply of processed, i.e. seasoned and preserved secondary wood species;
2. High cost of seasoning and treatment of secondary wood species;
3. High cost and scarcity of favoured species;
4. Inadequate knowledge among engineers and architects on the use of secondary wood species and wood based panels and modern timber engineering techniques;
5. Absence of mass production of prefabricated timber building components, including joinery;
6. Manufacturers and carpenters are not familiar with modern production techniques such as the use of connectors and adhesives;
7. Inadequate infrastructural facilities for effective implementation of know-how developed at R&D organizations.

Concrete

Cement: India ranks tenth in the world the production of cement and has a share of 2.8% in the world production. In 1981, 20.8 million tons were produced, although the production capacity was expected to increase to 27.86 million tons by the end of 1980-81. The drop in production was mainly due to infrastructural shortages.

With the present installed capacity of about 27 million tons it may not be possible to meet the growing domestic demand which is estimated at 30 million tons. To meet the growing demand, the country has virtually banned exports since 1978 and imported 1.39 million tons during 1979 from South Korea, Poland, North Korea, Japan and Indonesia. Furthermore, to increase the supply of cement, mini cement plants are being set-up by utilizing indigenous technology and equipment.

Aggregates: The main type of aggregates used in construction are coarse stone aggregate for concrete work and sand for concrete work and mortar required for masonry plastering. Stone aggregates are made by crushing boulders quarried from stone deposits reserved for quarrying purposes and

sand is collected from river sides and streams. At present crushers are widely used to make coarse aggregates from stone quarried either manually or mechanically. Mechanical quarrying and machine crushing has lead to better productivity and quality. The cost of aggregates is rising steadily mainly due to the rise in transport and labour costs.

Construction practices using concrete

Most building activities in this country are totally dependent on cement. Both low rise and multi-storeyed constructions use RCC extensively. RCC roofs and floors are the usual type of construction for all types of houses, be they in lower or upper bracket.

Bridges, hydraulic structures, industrial structures, schools, hospitals and highways are mostly built using concrete. The country possesses high competence in the design and construction using RCC and prestressed concrete. Obviously all these developments are putting high pressure on the supply of cement and many construction activities, specially housing projects are being affected. Even in rural areas there is a tendency to switch over to concrete construction.

Precasting

The bulk of concrete works or reinforced concrete constructions is now carried out in situ. Few organizations like the Hindustan Housing Factory, the Railways and a couple of construction companies are adopting precasting techniques to produce building components, water tanks, pipes and transmission poles and sleepers. Precasting is not popular mainly because building/house plans are often not standardized and builders find it convenient to carry out construction in situ which does not need material handling and hoisting equipment. However, research organizations like the Structural Engineering Research Centre (SERC) and the Central Building Research Institute (CBRI) have developed precast elements like channel and core units for roofing/flooring, structural members like RCC columns and beams, hollow beams, waffle units, shell roofing units, etc. but these have found only limited applications.

The cost of cement concrete constructions is rising steeply due to the rise in cement prices, coarse and fine aggregates and labour. Cement alone accounts for 18 to 25% of the total cost in urban construction.

Steel

The country produced 10.6 million tons of crude steel in 1981 and ranks seventeenth in the world in steel production. The consumption of saleable mild steel was estimated to be 8.87 million tonnes during 1980-91 and structural steel consists of M. S. profiles, tubes and rounds. They are mainly used in construction of industrial structures, heavy structures, bridges and as reinforcement in cement concrete construction. At present, the supply situation of structural steel appears to be adequate and steady. However, since the installed capacity of steel production cannot be significantly altered, there has been a marked stress on consuming steel in structures. This is possible now with the use of welded steel in construction, the use of open web joists and rigid portal and spaced frames and cold formed light gauge steel sections.

Significant savings of steel have also been achieved in steel reinforcements in concrete constructions by using high strength deformed bars (tor steel) in place of plain reinforced bars.

Other building materials

Bricks

Burnt clay bricks are a commonly used material for the construction of superstructure. The quality of bricks varies from place to place depending on the type of clay available and the manufacturing techniques adopted. Besides traditional kilns manufacturing country bricks, semi-mechanized and fully mechanized with sophisticated kilns produce good quality table moulded bricks. CBRI has developed techniques to produce good quality bricks from inferior black and red soils. Bricks are becoming expensive due to the high cost of energy and transportation.

Roofing materials

While RCC roofing is popular in urban construction, clay roofing tiles (Mangalore and Pan types) continue to be an important roofing material in rural areas. In South India high quality Mangalore roofing tiles are being produced and exported. Clay-tiled roofs are supported on timber or pole rafters and wooden battens. Tile roofed houses for economically weaker sections, landless labourers have been built in thousands in southern regions.

Corrugated asbestos cement sheet (AC) and corrugated galvanized iron sheets (CGI) are other important roofing materials widely used in the country. Because of the high cost of cement and the limited asbestos fibre resource, AC sheets are more expensive than tile. Industrial structures like sheds, godowns, warehouses are widely roofed with AC sheets. AC sheet roofs are usually supported on either timber or steel structures.

Locally available materials like thatch (coconut and other palm leaves) bamboo and wood poles are widely used in rural construction. Investigations carried out at FRI, CBRI and IPIRI have shown that the service life of these roofs can greatly be increased by simple preservative treatment.

Of late, a few units are producing corrugated asphalt roofing sheets and these are mainly used in temporary structures. The service life of this material is limited under tropical environment.

Fastening materials

Wire nails, MS bolts and hooks are the most commonly used fasteners for fabricating timber structures and for securing sheet roof to the structures. Connectors are used in developed countries like split ring, plate and bull dog, but these are practically unknown in India. Based on studies carried out at IPIRI, room temperature, structural adhesives (phenol formaldehyde and phenol resorcinol formaldehyde types) are now available in a limited sale for fabricating laminated timber and plywood structural components.

Finishing materials

Paints, varnishes, distempers are some of the important finishing materials used for urban and town buildings. Paints based on synthetic

alkyds, acrylics, vinyls and cement are now produced both by large and small manufacturers. Synthetic varnish based paints and clear varnishes are commonly used for finishing woodwork. Water based acrylic and cement. synthetic oil bound distemper for finishing plastered masonry walls. Paints are expensive as they are mainly composed of petroleum based products. In rural areas traditional finishes, like lime wash, continue to be popular, but they require frequent refinishing. Besides conventional paints and varnishes preservative finishes are also marketed for protection of timber structures/components. These are based on fungicides and insecticides and solvent medium.

Building regulations and standards

Construction activities in the country are regulated through various statutory bodies in cities, towns and villages. Local laws regarding space utilization, building types and materials are the guiding factors for obtaining permission to build. Institutions like the Municipal Corporation, City Development Authorities and the Town Municipalities regulate the construction of buildings in cities and towns. Village Panchayats and Block Development Authorities regulate constructions in rural areas.

The Indian Standards Institute (ISI) is the standard organization in the country which issues standards on materials and construction codes. This is a voluntary statutory organization having close links with the International Standards Organization (ISO). The National Building Code (NBC) formulated by ISI guides engineers, architects and builders in design and construction of various types of buildings.

Cost of construction

The cost of construction varies from state to state, depending on the availability of local materials and labour. However, the cost of urban buildings which are essentially built of concrete, steel, bricks and timber, as analyzed by the National Sample Survey, account for about 65 to 70% of the total cost of construction. Also the building costs in major cities have steeply risen and show an average increase of about 10% per year. Cost of

cement, steel, bricks, timber, sand and aggregates come to about 18%, 10%, 17%, 13% 7% and 8% respectively of the total cost of a building. In case of small houses for economically weaker sections, the cost of roofing comprising of tiles, rafters and reapers will be 50% of the total cost of the building.

Financing

Houses/buildings are generally constructed by individuals through savings and raising loans against security through agencies and institutions. The Life Insurance Corporation (LIC), the Housing and Urban Development Corporation (HUDCO), the Central and State Governments, the state housing boards, the cooperative house building societies and the Housing Development Finance Corporation (HDFC) are some of the institutions which provide housing finance. LIC is playing a major role in house financing and it advanced Rs.114.23 crores ($ 114.23 million) during 1979-80. The bulk of this amount was granted to state Government, housing boards and HUDCO.

Institutions like HUDCO, besides providing finance to state Government, also provide finance to slum clearance boards and small housing. State Governments have special finance schemes for village housing projects. The Janatha Housing scheme for the economically weaker section and financing landless villagers. About 3.6 million families of landless labourers will be given construction assistance during 1980-85. For this, financial assistance of Rs.3000 (US$300) is provided per family, repayable over a period of 20 to 25 years at concessional rates of interest. Housing loans are generally advanced against the security of mortgage of the land and building to be constructed with the loan.

Labour

The building industry still depends to a large extent on labourers who inherited skills without attending vocational schools. With the modernization of building technologies and the increased use of machines, there is a need for trained craftsmen in such trades as welding, plumbing, wiring, along with traditional skills such as carpentry and masonry.

The Industrial Training Institute (ITI) under the Ministry of Labour and Employment provides training in such building skills as masonry, carpentry,

plumbing, wiring and welding in as many as 15 states. The training lasts eighteen months, followed by six months of practical training.

Higher technical education

India ranks third in the world in technical manpower. At present there are about 165 engineering colleges and 336 polytechnics which train engineers specializing in such fields as civil, mechanical and electrical engineering. Besides, there are about 30 colleges of architecture training architects and town planners. Many universities offer post graduate training in such fields as structural engineering, hydraulics, environmental engineering and building technology. There are five Indian institutes of technology (IIT) which are considered to be the country's foremost institutions for training specialists in engineering and technology. Surprisingly there are no organizations which give higher training in the field of wood technology and timber engineering, except for the training facilities available at the Forest Research Institute in Dehra Dun.

Industrial infrastructure

As already mentioned, adequate facilities are available to train engineers, site supervisors, designers and architects. Also, institutions like the Indian Statistical Institute train specialists in quality control and the Indian Standards Institute (ISI) offers training facilities in standardization to qualified persons not only from India but also from other developing countries.

The country has well established research organizations for carrying out research on building materials and techniques. Some of these are under the control of the Council of Scientific and Industrial Research (CSIR) and some are under the full or partial control of Government of India. Organizations engaged in building materials/techniques research are listed hereunder:

- Central Building Research Institute (CBRI);
- Structural Engineering Research Centre (SERC);
- Cement Research Institute (CRI);
- National Environmental Engineering Research Institute (NEERI);

- Regional Research Laboratory, Jorhat;
- Forest Research Institute (FRI), Dehra Dun;
- Indian Plywood Industries Research Institute (IPIRI);
- National Building Organization (NBO).

The Indian Institute of Management (IIM) at Calcutta, Bangalore and Ahmedabad are offering graduate, post graduate and research facilities in the field of professional management and industrial engineering.

Conclusions

From the points brought out, the following conclusions can be drawn:

1. The country has the basic raw material resources to produce essential building materials like cement, steel and bricks. However, the major bottleneck in supplying these materials to the building industry is the shortage of energy required for their processing.
2. In view of large demand for building materials there is an immediate need to conserve high energy materials through efficient design and standardization.
3. There is a need to conserve valuable wood and wood product resources by adopting engineering and application techniques.
4. The building industry has to be organized and should exploit the benefits of prefabrication and precasting techniques widely adopted in developed countries.
5. While the industry has enough engineers, architects and designers, there is a shortage of skilled carftsmen. Facilities to provide adequate training to building craftsmen have to be increased.
6. The building industry should put the results of research and development work into practice.

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INDONESIA: THE PROSPECT FOR THE DEVELOPMENT OF WOOD INDUSTRY

Introduction

Indonesia is an archipelago which consists of 13,650 islands and extends between 6° northern and 11° southern latitude and between 95° and 140° eastern longitude. It extends along the equator between the mainland of Asia and Australia with a total area of more than 1,9 million square kilometers.

Indonesia is a developing country with a total population of about 150 million. The population growth is about 2.4% per year. Indonesia is also facing the problem of unbalanced and uneven distribution of population.

The most densely populated area in Indonesia is the Java islands, where about 66% of Indonesia's population lives on 7% of the country's land area.

Construction industry

Construction industry as such hardly exists in Indonesia, and is merely the sum of professionals, small constructors and manufacturers, which hire workers for each project.

The gradual development of the construction industry, among others is manifested by the size and stability of the construction firms.

In Indonesia, building is characterized by the existence of two sectors: a multitude of very small enterprises of an artisanal nature which operate in the rural and pre-urban areas belonging almost entirely to the non monetary category of the economy, and a small number of large firms using modern techniques and organizational methods, undertaking a major share of the work in the urban centre and all of the large infrastructural projects.

The second sector is sometimes owned and operated by expatriates. Besides the above mentioned traditional and modern sectors, a third sector of an intermediate character is rapidly emerging, which is entirely in the hands of nationals and is represented by small and medium-sized firms capable of carrying out less complicated projects using mostly local skills and materials.

The wood industry

Timber is the most important organic building material in Indonesia. The use of local timber for building and construction is economically attractive in Indonesia, especially in the rural areas, where timber is still available in abundance and where skilled labour is also available.

The total area of forests in Indonesia is about 122 million hectares, distributed over the islands as shown in table 1 hereunder.

Table 1: Total area of forests in Indonesia

Islands	Forest area in thousands hectare	Percentage of land areas
Sumatera	24,420	60
Java and Madura	2,891	22
Kalimantan	41,970	77
Bali and Nusa Tenggara	2,036	28
Sulawesi	9,910	52
Maluku	6,000	80
Irian Jaya	31,500	75
Total	122,227	65

Source: Statistical Pocketbook Indonesia

Of the total forest area only 40.000.000 hectare are designated for production and only approximately 70% or 28,000,000 hectare are currently accessible. Approximately 4,000 timber species are known in Indonesia, but according to the Forest Products Research Institute only about 400 species are suitable for building and construction or for other industrial purposes. Each species is classified according to its durability and strength and also its availability in the provinces and its uses for industry.

The Government has categorized the principal Indonesian construction timbers into seven groups according to the timber export, as per table 2.

Table 2: The timber exports of 1982

Group	Volume (m^3)	Percentage
1. Meranti	4,258,211	54.1
2. Ramin	251,872	3.2
3. Agathis	157,420	2.0
4. Teak	15,742	0.2
5. Pulai	228,259	2.9
6. Kapur/keruing	850,068	10.8
7. Others	2,109,428	26.8
Total	7,871,000	100.0

Source: Statistical Pocketbook Indonesia

Included in the 'others' group is Takir, Rambung, Cendana, Hitam, kuku, Sonekeling, Bakan, and mixed hardwoods.

Lack of housing is one of the crucial problems the Indonesian Government has to face. To cope with this, the Government estimates that about 440 thousand houses must be built yearly.

To alleviate the housing needs, housing industries should be established. In this instance, wood as a construction material has a unique role to play. It exists in abundance, is renewable and besides the wood industry is considered to be a low energy consumer. If the house utilizes about $5m^3$ of wood, about $2.200,000m^3$ would be needed annually for the housing industry, which can of course be supplied easily by the current timber market.

However, some important matters which still need to be solved are transportation and distribution of wood products which are expected to improve gradually in the future.

Other wood industries which are advantageous are industries which produce construction materials for houses of the upper and middle class people and other light frame buildings.

The composition of the Indonesian timber species is suitable for various utilization. Some timbers have certain characteristics which meet specific uses. They are suitable for stress graded timber, fancy veneered plywood, woodwool, chipboard panels, excellent parquet floors and many other decorative purposes.

The meranti and several other light medium hardwoods have characteristic suitable for structural purposes. They are considerably free of defects, straight grained, fairly workable, easy to dry, suitable for glueing purposes, easy to treat, etc. In order to produce high quality timber which will of course meet export requirements as well, the existing sawmills need only minor adjustments and the adoption of timber stress grading.

Construction technology

In Indonesia, relating to abundance of cheap labour, lack of skilled manpower and insufficient locally produced building materials and equipment, currently three types of construction technologies have been used, namely:

- Traditional technology:

  This technology uses domestic equipment simple machines and local materials. It is used for housing construction in the rural areas and has an almost entirely non-monetary character, utilizing indigenous skills and such locally available material such as earth, natural stone, mud, wood, bamboo, etc.

- Conventional technology:

  This technology is used for smaller housing projects both in urban and rural areas.

  This type of building is established on crafts as stone and brick masonry and carpentry work. The knowledge of new materials such as in situ concrete block work, roofing sheets (iron or asbestos) has gradually been added to the old craft.

- Modern technology:

  Tis depends heavily on the use of expensive machinery and sophisticated management skills.

  It requires a high proportion of skilled workers, material and equipment. This technology is used in major housing and infrastructural projects in urban areas.

  It is applied to new materials, advanced reinforced concrete technology, pre-stressed concrete, steel frame structure, mass-production of building components etc.

Timber has always been the most extensively used material in every construction process in Indonesia. It is used for battens, scaffoldings, concrete forms, construction fences, all of which are temporary; or for building parts such as flooring, wall framing and cladding, roof framing and trusses and other permanent construction components.

Suchbuilding constructions as nailed roof trusses and built up beam were recently introduced, but, these new structures were not readily accepted in building practices until recently, when the need for housing was seriously building up, while on the other hand timber has become an important export commodity.

Since then, some new construction techniques have been exercised to find an adaptable method which could meet the unique conditions of Indonesia which are labour intensive, manual and simple. One of them is the possibility of

adopting timber stress grading systems to improve the quality of the product and to benefit by the advantages of structural engineering for safety in design and efficiency of wood utilization.

Training skilled labour

Labour is employed in the manufacture and transport of building materials and components in other operations and also participates in 'gotong-royong' building activities, the informal self- or mutual-help movement practiced by communities.

A high proportion of semi-skilled and unskilled labour is employed in construction.

In the early stages of industrialization, the building industry plays a role of transitional employer for unskilled labour moving from rural areas to major urban centres and from agriculture to manufacturing.

Indonesia faces problems of unemploymnt with an abundance of unskilled manpower. The employment problem can evidently be solved by underlining the general higher unit labour requirements.

The relative share of traditional operative skills such as masons, carpenters, joiners, concrete mixers and plasterers, has changed rapidly and entirely. Following technological changes in housing construction and other building activities, there is also a shortage of skills such as structural ironworkers, construction mechanics and machine operators, which has caused the import of skilled manpower and managerial staff. Training facilities are as yet little developed in Indonesia. Most on the job training is traditional in characater and usually uncontrolled.

Recruitment often takes place at a low educational level. In consequence, few workers have the necessary basic qualifications to move up in the modern or intermediate sectors for promotion to site foremen or to follow upgrading courses to reach a technical level, or in the traditional sector, to become competent craftsmen, so that a substantial increase may be expected in the employment of building workers at all levels.

Universities and research institutes have an important part to play in the training programme, with the help of training courses and seminars, important knowledge on the application of modern industrial engineering techniques relating to work study quality control, etc. may be imported.

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NEPAL: BASIC BUILDING MATERIALS AND THEIR APPLICATION IN THE CONSTRUCTION INDUSTRY

Location, size and extent of Nepal

Nepal is a small Himalayan Kingdom. Situated on the southern flank of the Hymalayan mountains between China and India, Nepal covers an area of 147,181km^2 and extends 885km east/west; and north to south, it varies from 145 to 241km. It lies between longitude 80°4'E and 88°12'E and latitude 26°22'N and 30°27'N. Topographically, Nepal can be divided into three distinct zones: the Terai region, the mid-mountain region and the high mountain region.

The Terai Region

This region lying along the Indian border in the south, is composed of plains, forests and big rivers which make the soils of the region particularly fertile. Timber in this zone is very important and is being commercially exploited.

This region with a maximum altitude of 600m refers to the tropical plains along the southern part of the country. The Terai region, once a harsh zone due to malaria, has since acquired greater economic importance because of its rich forest and agricultural resources. Its comparative advantage in transportation and consequent industrialization has further enhanced the region's growth potential.

The Mid-mountain Region

This zone lies between the plains of the south and the high-mountain in the north and comprises many valleys surrounded by rugged hills. It lies at an altitude between 600-5000m.

This zone, traversing the inner sub-Himalayan belt, has traditionally been the most pyrulated zone of the country. Subsistance agriculture is the basis of the hill economy, accompanied by considerable pressure of population on land resources.

The High-mountain region

This region adjoins the Chinese border and contains the world's highest mountain range. This zone is always snow-clad and has become a unique attraction. The altitude in this region varies from 5000 to 8000m. Because of its harsh environmental condition, the population is scarce and the economic activities are barter trade, animals and some agriculture.

Population and density

According to the 1981 census, Nepal's total population is about 15 million, spread over more than 4000 towns and villages together. The physical as well as ecological features play a distinct role in determining the distribution of the population. The variation of the population density is from 45 persons per km^2 in west Nepal to 150 persons per km^2 in Central Nepal. The Terai region with 17% of the total land area and two thirds of the country's available land supports about 31% of the economically active population. But the mid-mountain region which accounts for 68% of the total land area has a share of about 59% of the total population. The high-mountain region, which covers 15% of the total land and only 11% of the economically active population is a marginal area for human settlement.

Land use

Utilization of land in a country varies according to changes in the social and economic conditions. Based on a World Bank mission estimate (1972) Nepal has the following land use: Forest 34.19% of total area; land under snow 14.97%; grass land 12.66%; cultivated area 16.49% and others (wasteland, built-up areas, etc.) 21.69%.

Climatic conditions

Topographical features exercise a tremendous influence on the economic life of the country. Considering the conditions of the country as a whole,

Nepal is said to have monsoon climate, however, the climatic conditions vary from region to region depending on the configuration and altitude of land surface in the various zones of the country. In summer, the temperature exceeds 30°C in the Terai region, but touches only 10°C on the High mountain region. In the mid-mountain region it varies between 10 and 30°C. In winter the Terai belt is just cool with a temperature around 10°C, but always below zero on the high-mountain region. In the mid-mountain region it is between 0 and 10°C. Most of Nepal's rainfall is during summer. In the Terai region, the annual rainfall during summer varies from 1,500-2000mm, while on the high mountain region it is below 500-1,500mm. On the whole, the influence of the climate on the economic life of Nepal is found to be quite favourable. As the climatic conditions vary from region to region depending on the configuration and altitude of the land surface in various zones of the country, it comprises almost all the climatic zones of the world, such as tropical monsoon climate (below 1,200m); warm temperate monsoon climate (1200-2100m); cool temperature climate (2100-3300m); alpine climate (3300-5000m) or tundra climate (above 5000m). According to this climate, the forest wealth of Nepal has been classified in three different categories: tropical evergreen forests, deciduous monsoon forests, and evergrees coniferous forests.

Economic situation

As per the 1981 national census, about 94% of the economically active population is employed in agriculture and its allied activities, where the contribution of agriculture to the country's GDP stands at over 66% despite the fact that a mere 17% of the country's total land has been brought under the plough. (Agricultural and forest products also run to about 80% of the country's total export.) Since a predominant number of the population live in rural areas, the prevailing rural conditions and scenes may be broadly taken as an indicator of the national situation. Generally, it may be said that out of the total population engaged in agriculture, more than 68% have survived on an income below the poverty line (Rs.2/day). It can also be generally said that on the basis of the farm size, Terai farmers are a bit better off than their counterparts in the mountain areas. However, even in totality, most of the inhabitants live on a subsistence level, the average per capita income in predominant rural population is below or equal with the absolute poverty line

(Rs.3 or US¢ 30 per day). The annual growth in GNP, about 2% (at 1965 prices) with 2.0% per annum population growth and with shrinking land resources, has barely maintained the living standard of the country. Dry and uneven limited arable land with lack of physical infrastructure and the deteriorating economy on one side as well as the increasing population pressure on the other in mid- and high-mountain regions, has forced nearly one third of the economically active population to migrate and live in plain and fertile belt of Terai and even outside the country. The constant migration flow from Hill to Terai has raised a serious issue for exploring more arable land. A World Bank preliminary report indicates a maximum of 325,000ha out of existing 774,000ha forest to be suitable for agriculture purposes. Even assuming that the average farm size of 0.18ha will hold constant, a predication can be made to accomodate only 1.6 million farm households in this extended area, which is not at all sufficient to solve the total requirements needed.

Development status and the Sixth Plan (1980/81-1984/85)

The initial movement of Nepal in the sphere of planned development, and its first Five Year Plan (1956-61) involving an outlay of US$27.27 million was indeed a maiden venture. Nepal began to pursue economic and social development as its national policy only in the early fifties with practically no development infrastructure. Since then, in the last 20 years, the country has achieved a tremendous record of development in infrastructure like roads, transport, communications, power, irrigation, etc. despite the resources, rapidly growing population and landlocked geographical configuration of the country. One of the dominant features of the previous plan (Fifth Plan) was the conscious effort to conduct development activities on the basis of regional needs and integration. But the current Plan envisages a total plan outlay of Rs.30.94 billion, of which 60% will be in the public sector, 5% in the Panchayat sector and 35% in the private sector.

The Fifth Plan enabled the country to emphasize the raising of employment, mass oriented production, meeting basic health needs, improving infrastructure in a selective basis, etc. In the public sector, the major emphasis on agriculture has further been advanced, allocating it a share of more than 30% of the sector's expenditure. But in the Panchayat sector, the main emphasis was in

providing physical facilities such as schools, health posts, Panchayat offices and water supply (about 40%) and infrastructure (about 30%). Besides agriculture and industry, private housing accounts for the biggest share of expenditure in private sector (27.7%). Shortly it may be said that about 12% of the total plan outlay will go for housing and building construction.

The country's Fifth Plan explicitly recognized the urgent need to adopt national policy to equate demand for construction materials with supply. However, during this period, no major improvement could be achieved to reduce import of foreign construction materials in Nepal. The escalating cost of building materials in the foreign market and the problems in procuring them from the neighbouring countries caused a great supply problem. The main reason is that the Fifth Plan period was marked by a scarcity of construction materials and declining local production. During the current Sixth Plan period, the total budget is roughly three times that of the Fifth Plan. Thus, the Sixth Plan has adopted policies which encourage production and use of local building materials and also the establishment of import-substituting materials industries.

Status, Policy and strategy in industrial development

In Nepal, the industry is at an infant stage of development with fewer than 60,000 persons employed in about 3,500 firms. Production has been handicapped in recent years by erratic power supply, labour unrest and the depressed state of the economy which has limited growth in demand for industrial products. The size of the industrial sector reflects two major constraints: the small size of the domestic market, and the country's landlocked position. The market for consumer goods is depressed by low levels of per capita income and the predominance of a subsistance economy. There are various problems in the industrial sector, like addition of transshipment costs, delay in transit, lack of skilled labour and trained managers, etc. Despite these problems, the industrial output appears to have increased by 6.7% per year during 1975-80, and the industry's contribution to the gross domestic production has remained around 4%. A 1977-78 survey indicated the existence of more than 750 thousand cottage industry units employing over a million persons. In addition, a large proportion of rural and urban households supplement family income with part time handicraft work. According to the estimate, such work may involve over 20% of rural households.

The industrial policy of the Government is to give priority to the development of cottage and small industries specially in mid and high-mountain regions. The Government also tries to increase capacity and productivity in existing industries of public sector. Furthermore, the Government will seek to assist the private sector in identifying selected new product areas where such industries can help to increase the skilled manpower. The industrial sector is now so small that a high growth rate is considered. So the Sixth Plan estimates an annual growth rate of 10% during 1980-85. Similarly, a growth rate of 11-12% per year during 1985-95 is estimated and thereafter, an increase of 9-10% per annum is assumed. Within the framework of industrial development, institutional arrangements, credit extension services, research and marketing programmes will be integrated and launched to develop cottage and small scale industries as well as energy based industries. The Government of Nepal encourages foreign investment, specially in the establishment and expansion of export oriented industries.

Building materials

It is obvious that building materials are the most important factors in the construction industry and their inadequate supply is an obstruction to the speedy national development of the construction sector. The cost distribution of construction is estimated to be 70% for building materials and only about 30% for labour. To meet the ever increasing demand of construction, the country spends much foreign currency in importing building materials. This indicates that the building materials sector is one of the most important sectors in the national socio-economic development. It cannot be efficiently developed unless its development is a part of national plans and is coordinated with building construction and housing programmes. Any construction can only be low cost and cheap, if there is efficient use of locally available building materials and appropriate construction technology. So governments of developing countries, like Nepal, should formulate and enforce the necessary policies on imported building materials and should accept to develop local building materials as a part of national development policy. Nepal is facing big problems in its construction activities due to serious difficulties posed by the production of appropriate building materials. In rural areas, the

majority of the population relies on self-produced traditional building materials for their building construction, but in urban areas it has been unable to meet the total needs of the construction industry. Thus, in some cases, import of building materials and appropriate construction technologies is essential, but it raises the costs of constructions. Thus, any construction is greatly influenced by the availability of local building materials.

Local building materials

In Nepal, construction draws almost entirely on indigenous material. Due to the lack of research organization no systematic survey of building materials resources has so far been made. The traditional building materials commonly used are the following:

- Earth and its allied products: (i) earth; (ii) bricks: (iii) roofing tiles; (iv) flooring tiles.
- Stone and its allied products: (i) block stones for load bearing structures; (ii) stone slab for pavements: (iii) slates for roofing; (iv) crushed stone; (v) lime.
- Timber and other forest products: (i) timber; (ii) bamboo; (iii) thatch; (iv) straw.

Imported building materials

Because the production of local building materials could not meet the need of the construction industry, the country has to depend on the import of building materials which constitutes a major portion of the total import figures. The main items of such import are:

- Non-metallic products: (i) cement; (ii) clay products; (iii) asbestos cement products; (iv) cement products including pipes; (v) flat glass products.
- Wood-based building products: (i) plywood; (ii) teak plywood; (iii) sawdust and other wood particle boards.
- Metallic building materials and components: (i) iron and steel products; (ii) non-ferrous metal products; (iii) finished structural parts of all metals.

- Building fittings and fixtures: (i) heating fixtures: (ii) sanitary wares in all types of materials: (iii) fitting and fixtures in all metals; (iv) electrical fittings and lighting fixtures.

Building materials in construction

Most of the building materials used in rural areas are local. Due to the lack of infrastructure, there is a great problem in the difference in prices in different parts of Nepal. Rural building construction draws almost entirely on indigenous materials. Production of such materials is often on individual basis. There is no organized production method geared towards meeting the wider needs of the consumers, nor is there a policy or incentive for any organized and efficient commercial production. On the other hand, inability to improve the materials qualitatively for changing design or engineering requirements has further discouraged its use. Moreover, due to the high cost of maintenance associated with the use of local building materials, there is a great demand for imported materials like cement and steel, even in such areas which are only accessible on foot. This situation does not encourage the high level of adoption, which in turn has caused poorer availability. As a result, the foreign exchange needs of the country are very high. So, the country needs great attention for improvement in quality, standards and also for promoting large scale production of such local materials.

Urban buildings are usually made of bricks and concrete, and the structures are almost permanent. Thus, urban houses tend to use more manufactured products and imported building materials than the rural areas.

Although urban people have a wide choice of building materials, basic natural materials like bamboo, thatch and stone are still most popular. This is because of the cheaper cost in comparison to other materials, which satisfies the housing needs of the migrant workers in the town of Biratnagar, Hetauda and Birgunj; but in Pokhara the most popular use of thatch roof shows its suitability as a proper roofing material in terms of economy as well as environment.

Forest condition in Nepal

In Nepal, although forests account for 4.2 million hectares i.e. 29% of country's total area, accessible forests are less, extending over only 1.6 million hectares, which are located almost entirely in Terai. Most of the forests are located in river catchments and hence are primarily protective.

Forest production is dominated by fuelwood. Even in the most urbanized region of the country, wood and agricultural residues account for 85% of the domestic fuel consumption, whereas industrial consumption is met to the extent of 75% by imported fossil fuels. So the increased relative cost of fossil fuels over recent years has led to an increased substitution by wood for tobacco-drying and brick-making industries in the Terai area. Domestic fuelwood will be a continuing major requirement for the rural communities of Nepal for many years to come. Reduction in available supplies and increased cost of collection may be expected to lead to reduced per capita consumption, but wood will remain a predominant source of energy for cooking and heating. The total annual consumption of at least five million cubic meters is likely to be sustained for as long as supplies are available. Fuelwood is in serious shortage in the major consuming centres like the Kathmandu Valley and the eastern and central Terai, which have to obtain part of their supplies from distances in excess of 150km. As a result of such needs, forests are being overcut with consequent serious soil erosion in the hill areas, for example, in the Churia range this depletion contributes to heavy flooding, causing rivers to change course from year to year with destructive effects on the agriculture in the Terai zone. Besides the fact that the accessible forests are also being rapidly depleted by legal alienation, encroachment, commercial logging and uncontrolled cutting by the rural population. The accessible forest resources of the Terai zone are expected to last for another 10-15 years only if the current rate of deforestation is not controlled.

Forest resources of Nepal

Since forest resources are very important to the country, commercially exploitable forests are restricted to the Terai and the adjoining regions. In 1974, the extent of the remaining forests in those areas was determined by the Forestry Department from Earth Resources Technology Satellite (ERTS) photographs taken in 1972. Based on this assessment, forests in the above areas still cover some 1.6 million hectares. Not more than 400,000ha, however, have a short term commercial potential in that they are accessible and that their logs are suitable for milling. There are some additional areas totalling 0.2-0.3 million hectares located on reasonably accessible lands which could be developed for industrial uses, but only in the long term and after replanting. The remaining forests, of about one million hectares, in that region are in terrain too rugged to allow safe harvesting, but are extremely important from the viewpoint of watershed protection.

In recent years, a significant decrease in the forest area due to the launching of resettlement schemes, extensive logging and fire has been found. The existing forest resources are thus expected to be exhausted in the next few decades. About 0.3 million hectares of accessible forests are on soils suitable for agriculture, while more, including most of the 0.6-0.7 million hectares with an industrial potential, may be expected to be alienated for non-forestry purpose because of poorly controlled resettlement programmes and fuel wood cutting.

Volumes and types of forests

In the country's commercial forests, the volume of wood of various species and sizes was estimated by the Forest Resources Survey in 1967 at about 97.9 million cubic meters of which about 67 million cubic meters (68%) are of sawlog quality. These volumes represent low stocking densities $9.9m^3$/ha and $68m^3$/ha respectively. In Nepal, more than 60 types of wood are to be found. Among the commercial forests, the most important tree species are sal (*Shorea robusta*), Asna (*Terminalia tomentosa*), Khair (*Acacia catechu*), Semal (*Bombax malabaricum*), Toon (*Cedrela toona*), and Sissoo (*Dalbergia sissoo*). At the lower altitudes

of Nepal. Sal is the predominant species, accounting for about 50-60% of the sawlog size timber volumes and Asna, the second most common, has a share of 14-16%. The rest of the timber stock is dispersed among a host of hardwoods and chir pine, each accounting for less than 2% of the harvestable standing volume. Sal is traditionally preferred to Asna and other possible sawnwood species. In Nepal, 90% of all sawnwood produced is Sal. Both Sal and Asna produce acceptable sawnwood, but Sal is not suitable for plywood or veneer and though Asna is used for sliced veneer to a limited extent, its properties create processing problems. The combined proportion of species suitable for plywood and/or veneer manufacture is very low, an estimated 3.5% of the total stand volume.

Forests have suffered from a lack of proper management. As a result, the annual growth is very low and this does not reflect their future yield potential. Therefore, only hypothetical yield calculations can be made for the country's forest resources, with results varying greatly according to the rate at which the remaining natural forests are assumed to be cut over and/or converted to plantations. Thus, a 30 year liquidation period, sufficient for the establishment of an adequate plantation scheme, would give an annual net sawlog yield of the order of 1.6 million cubic meters - a volume far greater than the past log production in the country.

Forest industries

There exists in Nepal more than 100 sawmills, two small plywood mills, six match factories and several Katha factories. (Katha is extracted from heartwood chips of Acacia catechu, it is chewed along with betel leaves). Sawmilling is at an early stage of development. Almost all mills except one are small and use semi-portable bandmills with a capacity of about 2000m^3/year in two shifts. While some show good sawnwood recovery, the majority are obsolete. The Timber Corporation of Nepal (TCN) a Government corporation at Hetauda, is operating the largest sawmill in the country. This mill is a combination of two circular sawmills and two horizontal bandmills. The average output of that mill is 11,000-13,000m^3/year (two shifts). Due to a poor layout, the current

production is only about half the rated capacity. This is also due to an inadequate supply of logs. In this respect, the mill is benefittingfrom the increasing supply of log resulting from the on-going IDA financed resettlement project.

Trade and consumption of forest products

Between 1960 and 1970 the country's overall trade balance in forest products was quite favourable, but has recently changed because of Government's efforts to curb log exports since 1975. It is also because there has not concurrently been any noticeable increase in sawnwood exports to offset the decreased foreign exchange earnings from log exports. Even if log exports were allowed to continue at the present rate of about 70,000m^3 per year, increasing imports of pulp and pulp products are likely to render the overall trade balance unfavourable to Nepal by the end of the 1970s. Sine 1960, sawlogs have been the main forest product exported to India. Sawnwood exports are negligible since they amount to less than 2000 m^3 per year. The Government has taken some restrictive measure in order to curb log exports which include ad valorem export tax of 35% and a limitation of log sales. But fuelwood has been exported extensively to India and in the 1960s these exports surpassed that of sawlogs and sawnwood combined in value terms. With the increased domestic demand for fuelwood, exports of that product have decreased. Processed Katha from Acacia catechu is a significant export to India.

Nepal is self-sufficient as regards to sawnwood. Consumption is extremely low though not accurately recorded, whereas recorded consumption is of the order of 35-45000m^3/year. Similarly, the consumption of chipboard and fibreboard is very low, but among the other panels plywood is significantly used in the country. Most of the plywood and other panels are imported from India. The main reasons for the low wood products consumption stem from the traditional pattern of wood used in traditional construction and fuelwood of the country and from the fact that most of the rural population are effectively within a subsistence economy. The other main reasons for low consumption are: the shortage of sawnwood resulting from difficulties experienced by the sawmills in

log procurement and the fact that wood based panels are only available to a very limited extent. The consumption of paper and board was of the order of 2000 tons per year in 1972-75. Most of it is imported except for negligible quantities of handmade paper from rice and wheat straw.

Policy and development strategies on forestry

The central Government, the Ministry of Forests which has Department of Forest, Department of Rehabilitation (resettlement), Soil and Water Conservation and Botany owns the forest land of the country. The Forest Department is responsible for all the administration and management of forests under the direction of a Chief Conservator of Forests. The territorial organization comprises nine major sub-divisions, 75 districts and 174 ranges but not all of them are fully staffed. The main responsibilities for timber harvesting and sales, fuelwood harvesting and major sales, and public sector sawnwood production are given respectively to the Forest Products Development Board (FPDB), the Fuelwood Corporation (FCN) and TCN. These are semi-autonomous Government corporations.

In 1976, the Forest Department formulated a national forestry development plan, which stresses the protective role of forestry as well as the socio-economic importance of forest production. For better management purposes, the plan recognizes four major geographic zones: - the Terai-Bhabar, the Inner-Terai, the Midland-Hill area and the Himalayan region, where Terai Bhabar forests are to be managed for timber and fuelwood production and the inner Terai will focus on multiple-use (including wildlife management and tourism development). Similarly, protective reforestation is emphasized in the Middle Hill and conservation in the Himalayan forest area.

The Plan stresses labour intensive methods, the use of indigenous rather than introduced species, the integration of grazing with forestry and the close involvement of the Panchayat in forestry activities. Reforestation targets rise from 4000ha per year to 20,000ha during a five year plan period. The Government's forestry development policies and strategies are commendable for decreasing population pressures in the

Terai region and in the country as a whole, emphasizing the urgency of the need for intensive management of the commercial resources and for the replacement of depleted and non-productive forest remnants by higher yielding plantations. Taking this problem into account, the Forest Products Development Board (FPDB) was established in 1976 and, unlike FCN and TCN, is directly under the aegis of the Forest Department. So far it has been concerned only with the harvesting and sale of logs, but it is intended that it will shortly assume responsibility for felling, extraction and local transport of forest products as well as reforestation. Its functions will therefore include all aspects of forestry, not merely exploitation.

During the past two decades, the forestry sector has been assisted mainly by India (establishment of the Institute of Forestry at Hetauda), the United States of America (assistance to TCN and initiation of a national forest inventory), Australia (afforestation and charcoal production), the United Kingdom (resettlement and forestry research), Denmark, Switzerland and the Federal Republic of Germany. Of particular significance in the present context are some multi-lateral and bilateral projects like the UNDP/FAO Forestry Development Project, the IDA Re-settlement project, the CIDA aerial photography project, and so on.

Use of timber as building material in construction

According to the statistics produced by the FAO, in developing countries more than 80% of the timber cut is burnt as fuel even though timber has been a traditional building material for many centuries. There are more than 4000 species of timber found all over the world, but of these only a few dozen species, known as primary species, are used for construction purposes. So-called secondary timber species could be used after seasoning and chemical treatment. Such use would contribute to the long-term solution of the country's timber shortage. As timber is a renewable resource, it could be used as low cost building material in all types of construction provided proper forest management and appropriate marketing strategies were put to effect. Due to the uncontrolled market, the price of timber used in construction is

increasing day by day. On the other hand, there is an acute shortage of good quality timber. The cost of timber, at present market rate, varies between Rs.28-Rs.65 per cubic foot according to its type, quality and size. The cost of Sal, the most commonly used species in construction, ranges from Rs.55-Rs.66 max., depending on its length. Similarly, the cost of champ ranges from Rs.61-65, the cost of Sissoo from Rs.60-64; and Haldu from Rs.34-37. Likewise other types of timber such as Jaman, Asna and Semal cost Rs.34-37, 30-33 and Rs.28-30 respectively.

Timber is one of Nepal's most important building material for use in the construction industry and it accounts for over 15% of the total building cost. Due to the difficult transport system, indigenous commercial timber cannot be uniformly supplied throughout the country. Timber is used in general as a structural element for columns, beams, roof structures (trusses, rafters, purlins/battens, eave boards, etc.). It is also used for floorings, doors, windows, shutters, stairs, railings, furniture, bridges, formworks, and structural as well as partition wall panels. The use of timber can be seen at ancient places, residential buildings, temples and monuments that illustrate the indigenous use of wood in building construction. But the utilization techniques have not been developed since those ancient times. In rural areas, mostly green timber is used in construction. The method of timber use is still in the traditional pattern, resulting in an unnecessary wasteage of a lot of timber. Modern technical designs are not successfully put to use due to lack of skilled manpower.

Mode of use of timber in rural areas

In rural areas, timber has been utilized either in hand sawn or pole form. Only in urban areas has machine sawing been used, and this only recently. Actually, pole structures have particular advantages in comparison to those using sawn timber. In pole structures, the cost and waste in sawing can be eliminated. In rural areas, poles are used as columns since these can be embedded in the ground thus eliminating the need for the usual foundations. Thinner trees can thus be used economically and sawlogs can be used quite effectively in pole structures. It is scientifically proven that timber used in pole form is stronger than sawn timber since the fibre flow is

not terminated at sawn faces. Poles have larger tension growth stresses around their perimeters than in sawn timber and this assists in increasing the strength of the compression face of a pole in bending.

Other timber materials produced locally are plywood, wood parquet, furniture, etc. The production of such building material is geared only to local consumption and is not for export except furniture.

Plywood industry in Nepal

In Nepal, plywood sheets, because of their low cost and versatility as a building material, are the most widely used material for interior partitions, ceilings, doors, etc. Plywood is manufactured in various grades measuring 3x4, 5, 6, 7 and 8 feet; 4x4, 5,6, 7 and 8 feet; and are produced in 1/8", 3/16", 1/4", 1/2", 3/4" and 1 inch thickness. The cost of plywood, at present market rate varies from Rs.4.80 to Rs.12.50 per square foot depending on its thickness. The plywood produced locally is cheaper than imported plywood from India which is to a certain extent of a better quality than the one produced locally. The total consumption of teak plywood has to be imported from India and costs Rs.9.00 per square foot (3/16 inch).

At present, there are two plywood mills in the country. One has a capacity of some 5000 m^3 log input/year and is privately owned and situated at Biratnagar. The other mill, at Butwal, is partly Government owned and has a capacity of 7000 m^3 log input/year. It comprises a six-foot peeling lathe and a slicer (8 feet). Both of these mills have logistic problems of log supply and operate only occasionally. Thus, neither the plywood mills nor the match factories, nor the sawmills (except TCN mills) have timber concessions of their own and they depend on the Forest Department's annual log supply for raw materials. It is observed, at present, that the country's forest resources do not justify any additional plywood or veneer capacity but in the sawmilling sector there is scope for both expansion and modernization as markets (domestic and external) and raw materials supply would allow limited increase in production.

Nemo parquet industry in the country

At present there is only one wood parquet factory in the country. Nemo Parquet Col. (P) Ltd. was established in 1967 and is located in the Hetauda Industrial District. Its production capacity is 3,000 square feet per day, i.e. approximately 10,80,000 square feet/year. Whereas the factory has made a target of 3,36,000 square foot/year but due to the low market and less demand in the country the factory is manufacturing not more than 2,00,000 square feet, and out of that about 75% is exported to India.

Nemo parquet is used generally for flooring (8 mm thick) and sometimes for wall lining. The two major species used are Laurel (*Terminalia tomintosa*) and Sisso or Shisham (*Dalbergia Sissoo*) because they are very hard and durable. Teak wood has a hardness of 100, Laurel a hardness of 150 and Shisham of 105. The woods are specially steam-seasoned to reduce the moisture content to 8% only and it is made termite proof by adding some chemicals.

The Nemo parquet plant manufactures fingers or strips of 25x150x8mm which can be available in loose form or assembled into laying units of 60x30x8mm with nylon mesh on the underside or paper top. It can be made according to taste in different patterns with these strip units. Of each unit can be bonded directly to plain cement floors or any other hard, level, smooth base with special parquet adhesive.

The cost of parquet, at factory, varies between Rs.10-11/square foot according to the type of pattern. The laying charge is about Rs. 6,- per square foot. The total finishing cost (including material, labour, sales tax etc.) will amount to about Rs. 15-19/square foot.

Utilization of woodwaste in building materials industry

After removing leaves, bark and roots from the harvested trees, the logs are taken to the sawmill. The volume of dressed timber after cutting and sawing of logs represents only about 60%, i.e. 40% of the original weight is waste. There is a great scope for systematic collection and proper use of such timber wastes, which could be used to produce wood based panel products - woodwool board, particle board, etc. Woodwool board consists of strands of wood bound together with portland cement. The production is not costly since it only needs a simple woodwool machine. The mixing and pressing sequence is very easy. Thus woodwool board can be manufactured easily by using wastes of cheaper timber species of densities from 300 to 1300 kg/m^3. Similarly wood particle board and medium density fibreboard could be made from timber wastes, but they require adhesives which represent more than 50% of the cost of the board itself. In Nepal, none of these wood based panels are manufactured yet. An integrated policy to conserve timber by rationalizing its use and for the utilization of waste timber for producing wood based panels is essential.

In most developing countries, timber is found to be very costly and first class timber is used mostly in high cost buildings. An effort should be made to use secondary species as much as possible and to avoid wasteful as well as indiscriminate use of expensive first class timbers. The extra seasoning and preservation costs involved in the use of secondary species cause problems. It should be proven that such treatment will increase the durability of the building at least twice, otherwise the consumers will not be convinced.

Importance of cement in construction

Cement is one of the most important building materials in this era. The massive and big structures are impossible to build without cement. For the development of permanent structures, it is needed as a basic building material, but due to the higher cost of cement and its unavailability, the traditional building materials are dominating construction practices in rural areas. This is also the case for housing in the lower income bracket in urban areas. At present market prices the cost of cement varies from Rs. 90 to 110 depending on

its quality. The locally manufactured jute bag cement of 50 kgs costs Rs.90 whereas the imported paper or polythene bag of 50kgs, imported from China, Korea, Indonesia and other countries costs up to Rs.110.

Consumption and need of cement.

Nepal started to use cement in 1960, with an increasing rate of a little over 11% during a ten year period. The country's indigeneous production can hardly meet 15-20% of the country's demand. There is a single cement plant with 160 tons per day installed capacity . Thus, about 80-85% of the demand has to be met by imports from India as well as overseas countries like the People's Republic of China, Thailand, Indonesia, the Philippines, Korea, Japan. A forecast for cement consumption using standard techniques has been made by various agencies and sources. The actual consumption is not so far from these forecasted figures. At present the country has to rely on importing cement until such a time when two projects, i.e. Hetauda Cement Ltd. (750 tons per day) and Udaipur Cement project (3000 tons per day), start their production. The first cement plant,namely Himal Cement Co. Pvt. Ltd., with a rated capacity of 60 tons per day, was established in 1967 but only started production in 1974. The plant produces at 60% of its total capacity. The major cause of breakdown and idle hours of the plant are the factors affecting the whole country such as insufficient power supply, timely supply of the coke breeze (fuel) and its quality, problems arising from spare parts, etc. This factory plans to expand its production to about 400 tons per day in two phases.

Cement industries

Himal Cement Co. Pvt. Ltd.

At present Himal Cement Col Pvt. Ltd. is only catering for the market of the Kathmandu valley where cement requirements are estimated at about 120,000-140,000 tons. The plant is satisfying 30-40% of the Kathmandu Valley market requirements. It is estimated that 50% of the total consumption of cement is in the Kathmandu Valley. The other 50% in cement requirements is

met by imports, it is estimated that about 70,000 to 80,000 tons are imported. The total cement demand of the Kathmandu Valley by the year 1984 will be around 150,000-180,000 tons. Hence it is not likely that the demand of the Kathmandu Valley can be met by this plant even after its proposed expansion.

Hetauda Cement Industries Ltd.

Hetauda Cement Industries Ltd. was commissioned during 1974/75 under a financial loan from the Asian Development Bank. It is located in the Terai Region of Nepal at Hetauda, which is the junction of the several highways crossing the country. Therefore, the proposed cement plant at Hetauda can easily cater for the market of the Terai region and other parts of the country except Kathmandu and other remote areas. The demand forecast for the year 1985 being around 350,000 tons, the combined capacity of Hetauda Cement Plant (240,000 tons per day) and capacity of Himal Cement Co. Pvt. Ltd. after expansion (120,000 tons per day) can meet the demand.

Udaipur Cement project

Similarly His Majesty's Government of Nepal and the Government of India decided to undertake a joint venture for the establishment of a large cement plant based on the high grade limestone deposit located at Sindhuli and clay deposit in Bettar in the Udaipur district, which is export oriented primarily to India and to Bangladesh. It will not have any sales difficulties since the Northern part of India and Bangladesh have a demand of one million tons of cement annually.

As is seen, cement has a greater importance in Nepal because it is the basic material for concrete which may represent, in consideration of economic and/sound factors, the only viable alternative to timber. As the more durable timber species have been depleted, concrete block for housing and other building construction has become the most suitable material compared to timber due to its durability. The use of non-durable timber species and the lack of of preservation has created a big problem to the people for the construction of timber houses. Cement is a most important building material because it is

extensively used in almost all kinds of construction. Its subsequent use in concrete products is sometimes wasteful. so concrete proportioning and quality control should be given high attention. In view of the shortage of good quality of timber it is becoming increasingly necessary to develop the cement and concrete industry. Some private enterprises have established concrete as well as aggregate products companies which produce a variety of precast elements including hellow block, concrete pipes, structural elements, RCC railings, etc. in a variety of sizes.

Concrete in structures

Concrete products are also foremost among building materials which are adaptable and versatile. Any concrete structure with proper design and specification lasts longer than and is generally economic and competitive compared to most other locally available building materials. other building material. The properties of concrete depend upon the basic ingredients of fine and coarse aggregate, cement and water. Aggregate production is fairly primitive. Coarse aggregate is hand crushed. This results in gap graded and misshapen particles which are not suitable for economic concrete and its products. Sand is generally dug at accessible locations in rivers and streams. It is never washed or screened before selling. On the construction site it is only screened for masonry purposes. THe concrete mixes are generally designed with proportions on the 1:4:8, 1:2:4 1:1 1/2:3, 1:1:2 etc. (cement/sand/aggregate) basis, by volume with water being added. Compaction is not taken into consideration at the construction site, which tends to result in poor quality concrete and less durability. There is thus a great need for the development of concrete technology in the country.

Concrete blocks as building material elements for construction

Concrete blocks are accepted as one of the modern building materials throughout the Kingdom because it has come out as a new exciting exposed building material, beautiful in textures patterns, as well as in colours. The

Use of concrete blocks provides a pleasing simplicity, impressive dignity, sinking beauty, warmth, etc. It is generally water proof, does not warp, sag, deteriorate, peel, blister, or fade, even in extreme weather. It cannot be destroyed by termites, rodents or insects. It also has favourable insulation and accountable properties. With concrete blocks, all kinds of constructions can be achieved, i.e. load bearing walls, partition walls, cavity walls, screen walls, basement walls, columns and reinforced concrete masonry constructions, retaining walls, pools, etc. It saves construction time and minimizes maintenance as well as repairing works.

Types and sizes of concrete blocks

Concrete blocks, found on the Nepalese market are hollow building units made of portland cement and suitable aggregates such as sand, gravel, crushed stone, etc. The shell thickness is 3 inches or over. Such units are made in a great variety of shapes with thickness varying from 4 inches to 8 inches whereas height is usually about 8 inches and length about 16 inches. The blocks are made in moulds and the concrete is consolidated by tamping or vibrating. Sometimes dry mixture is also used so that moulds are removed immediately. The blocks are properly cured in humid temperature for some days and are stacked in a storing area. Some ranges of concrete products available on the market are:

- Plain concrete blocks: 8 x 8 x 16", 6 x 8 x 16", 4 x 8 x 16", 8 x 8 x 8", 6 x 8 x 8", 4 x 8 x 8":
- Decorative blocks: 8 x 8 x 16", 6 x 8 x 16", 4 x 8 x 16", 8 x 8 x 8", 6 x 8 x 8", 4 x 8 x 8":
- Lintel elements: 8 x 8 x 16":
- Screen units: 8 x 8 x 2", 12 x 12 x 4"

Using the above blocks, buildings can go up to a height of 5 storeys as the breaking loads achieved by these blocks have proved. The blocks (40 to 50 mm webs for continuous bearing walls) are manufactured with the following proportions:

Cement of standard portland type: 175-200 kgs

Standard sand without dust, loam, clay 0-3m: 0.400 m^3

Crushed stone aggregates without dust 3-5mm: 0.400 m^3

Crushed stone aggregates without dust 6-10mm: 0.400 m^3

Water free from impurities: 70 to 80 litres.

The joint mortars for the cavity blocks should be so proportioned to offer a mechanical strength no greater than that of the blocks to be connected. As such, good quality mortar would consist of cement, lime and sand in the volumetric proportion of 1:2:9. The prevailing ratio of 1:6 cement sand mortar is also satisfactory.

In this connection, the Department of Housing, Building and Physical Planning under the Ministry of Works and Transport, His Majesty's Government of Nepal has recently tried to produce concrete stone blocks in an experimental way. The block size is 11 1/2 x 5 1/2 x 5 1/2 inches. This is made by the help of wooden/metal mould box. Larger stones are laid in the bottom of the mould which is filled with lean concrete (1:5:10 ratio) mix. After this, smaller stones are put in and the mould filled up to the top with lean concrete of the same ratio. About four hours after this process it is demoulded and cured by sprinking water for 28 days. The acquired compressive strength of the concrete stone block is about 32 kgs/cm^2. The cost per block is Rs.2.50 where Rs.1.75 goes to material only and Rs.0.75 for labour cost. Similarly the Research Section of this department is doing research on concrete door and window frames for the replacement of wooden frames which commonly warp due to non-seasoning of timber. The cost of RCC doors and windows is about 2/3 of that of timber.

Reinforcing steel the in building industry

Steel is also one of the most important building materials, and, as with cement, there is a shortage. The imports, production as well as transportation and distribution suffer from serious problems. Actually there is a great need to developeng appropriate technology for using substitute materials in lieu of steel, which should be used only for the most essential parts, where such substitution is not possible at all or economically viable. New techniques and appropriate technologies have to be developed to minimize the use of steel.

The existing steel mills in the country produce the following:

- Bar mill products - mild round bars, deform bar and high tension torsteel;
- Iron and steel casting - cast iron pipes and fittings;
- Secondary wire products - wire, nails, and chain links fencing.

The local demand of reinforcement mild steel, deform bar and torsteel is not covered by local production and imports. From the last decade the demand for mild as well as deform bars has exceeded the local supply from the existing mills leading to shortages partly due to the uncertain market where certain distributors and consumers buy more materials than they can actually consume. As an interim measure the Government has imported a lot of steel from overseas countries, like Japan, Korea, etc. Instead of that the Government should give the priority and incentives to the existing mills for them to increase production.

The Himal Iron and Steel Pvt. Ltd. has been operating a foundry since 1961-62 with a yearly production capacity of 20,000 tons. Its main production is mild steel, deform bar, tor steel with diameter of 8, 10, 12, 16, 20, 22, 25, 28 mm, binding wire, fencing wire, nails and some other castings. Raw materials in MS billets forms are imported from India and overseas. A new rolling mill and electric arc furnace have just been installed so that the production of reinforcing steel is expected to rise.

Construction in general

Today national progress is possible only with industrial development. The quality and quantity of industrial development achieved is influenced by the quality and quantity of technology support received by the industries. Construction is not only a integral part of human civilization but also an important constituent in national development. In Nepal, analysis of expenditure under the successive national plans clearly brings out that the expenditure on construction has not had a great part of the total investment.

As has been accepted, construction forms the backbone of the socio-economic development of a country. However, care has to be taken to

develop the indigenous construction sector simultaneously, allowing free and full play to indigenous techniques. Of course, the socio-economic realities prevailing in the country are going to have a considerable impact on that sector. In Nepal, the high population growth, disproportionate population distribution, unemployment problem, low level of income, lack of capital investment in construction industries and traditional customs are the main features that have to be taken into consideration. For the achievement of economic and social objectives, a large scale construction programme has to be gotten under way. The population increase, proliferation of industries and the efforts at raising the living standards boost the capacity and efficiency of the construction industry which is one of the biggest employment generating sectors in the economy.

Problems in construction

In rural areas most people have to build their houses themselves, since to date there is no agency at sub-national level involved in the preparation of regional development plans. There is no institution to provide housing loans, construction aid, or technical guidance. In the absence of such institutions for construction, one has to have cash and labour at hand to build a house. Thus, people construct buildings in different phases due to lack of skilled labour and shortage of capital. Most of the construction and repairing works will be done by the family members themselves, thus the quality of the buildings is low. The same factor is responsible for the slow rate of increase in building construction compared to the increase in population.

In rural area where more than 90% of the population is living on a subsistence agro-economy basis, the low level of living does not permit modern methods of improvements to construction. Therefore, an indigenous method is needed to organize the collaboration of cheap village manpower resources and to aid with cash. It should be tried to establish some building materials and micro construction industry which could increase the rate of growth of building construction activities with standard quality.

It is apparent that the dimension of the construction problem in urban areas is quite different from that in rural areas. Whereas in urban regions the problem becomes visually conspicious because of the conglomeration of the population, in rural areas, it is more hidden. Moreover, due to concentration of resources in selected urban areas, the rural housing construction problem is magnified, since the rural environment does not hold basic ingredients for launching successful building improvement programmes. A building agency with a purpose to help, maintain and increase housing stock in urban areas could be established and in this connection various financial institutions have shown their interest in housing construction programmes by at least providing loans to government employees at a low rate of interest.

Traditional construction system in Nepal

Terai region

In Terai, houses are temporary looking because of the building materials used primitively in the structures. Most buildings in this area are single-storeyed light structures, but because of high water table and lack of damp-proof material, moisture often penetrates. Due to the moist and humid climate the houses have practically no openings except for the front and back doors. The houses in this region are rectangular and usually grouped together in a clustered form. The walls are made of bamboo mats tied to wooden columns (i.e. logs) placed at regular intervals along the periphery and the walls are plastered with cow dung and mud. These wooden columns work as the main load bearing medium for roof structure. The roofs are mostly thatched and a few tiled. Roof structures are generally made of pole rafters spanning between the central ridge and log columns. Thatched roofs are tied to round wooden purlins by bamboo stripes. Most of the materials used to build such houses come from the local forests. Generally forest products like logs/poles, twigs, bamboos are directly used. Similarly one storey timber houses are very famous in this region. These houses are generally raised about 3 feet above the ground on poles, where round columns (logs) support the floor and the roof. Sawn planks are used

for flooring and walls. Tiles are laid in mud placed over planks or tree bark with one tile over the next to it. Sometimes these tiles are laid over split bamboo battens over wooden rafters, the last row of tiles near the eaves and the ridge are laid in mud mortar. In this region foundation walls as well as roof construction have to be repaired by a high percentage of households.

Hill region

Buildings are usually loosely scattered along hill slopes, on hill tops in flat valleys or along ledges, as the terrain allows. Most traditional houses in this region are one and a half to two and a half storeys high having the walls made of random stone in mud mortar roofed with local slate or in some cases thatch. Depending on availability, dressed sandstone or river boulders are also often used in mud mortar for wall construction. In this area besides thatch and slates, wooden single roofs with stone counterweights are also often encountered. The application technology of thatch is similar to that in the Terai zone, but slates are either laid over mud placed on timber boarding or wooden strips or carefully nailed to timber battens. Masonite floors are mostly supported on wooden beams spanning between external wall and mid wall. Thin narrow wooden planks not more than 2 inch in width are placed across the beams to form the base for a mud floor which is usually 6-8 inches thick. In some buildings a flat roof of thick mud over beams and planks is also built. In this zone, the main problem seems to be concentrated on structure. More than one third of the houses need major repairs in walls, beams, floors as well as other building components. To solve such problems strong measures should be taken to control and guide the building activity and to stimulate proper constructions.

High-mountain region

In the Himalayan region with its extreme climate and hostile topography, houses are mostly clustered together in a terraced form due to lack of agricultural land. In this zone as in the hill area, stone, earth and soft pine wood are the major building materials. The houses are single storeyed or two-storeyed depending on the slope and location of the building site. One of

the big problems in this region is the binding material without which massive structures are impossible. Walls made of stone in mud mortar are not apt to have enough openings, and so rooms are usually dark. In case of two-storey houses built with stones only up to the floor and with wood beyond that, the roof is covered by locally made wooden shingle elements.

Need of building codes and standards

The physical environment in and around the buildings is not of a reasonable standard. Due to the lack of proper building codes and standards, buildings are not structurally safe, functionally efficient nor durable. Economy in cost of construction is a major consideration. The existing building codes and regulations, if functioning, may have to be amended frequently to accomodate lower standard specifications in the interest of cost reduction and more durability. In no case, however, should safety of a structure and structural soundness be compromised. Structurally safe and functionally sound buildings could be achieved at lower cost by adopting suitable construction techniques and appropriate materials as well as the application of suitable building codes and regulations. The Government should take measures to protect the indigenous construction sector including the utilization of the country's resources for the production of building materials and reasonable support should also be given to the development of building codes and standards for appropriate buildings materials and techniques.

Conclusions and recommendations

A detailed survey on the availability, location, quality and quantity of forests and agricultural wastes should be carried out by any developing country. Such information would help in deciding on the locations and future expansion of forests, and the possibilities of timber export to neighbouring countries. International organizations such as UNDP, FAO, UNIDO, UNCHS, UNESCO will have roles to play by providing technical and financial assistance for such purposes.

Governments of developing countries should know that agro-industrial and forest wastes offer potential sources for low energy consuming building materials which are greatly needed for low-cost construction.

Large scale tree plantations should be organized to increase and renew natural resources which provide good quality timber and timber products for building materials especially in rural areas.

Adequate training for craftsmen, engineers, architects, entrepreneurs will be essential in use and production of new wood based materials and will have to be arranged as part of a national policy. Incentives and research facilities will have to be given for popularization.

On the national level, the Government and other related organizations are in a position to enforce codes of practice and standards for timber and timber products so that misuse of timber could be minimized as well as substituted or complementary products with less energy component could be intensively used. Such programmes should be undertaken in a long term plan based on local conditions, requirements of the construction type etc. supported by intensive research and development.

Incentives should be provided for production and use of cost saving materials from wood wastes by way of tax reduction, financial assistance at low rate of interest, etc.

It is clear that the price of portland cement increases when it is taken far from the city. Developing countries try to establish small and medium scale industry (mini cement plants) in order to avoid transportation costs and make such material as available as possible to the urban poor and rural people.

Higher priorities for manufacture of concrete products are required to be given in national plans which should be one step ahead of the national plans for development and construction.

Research for improving quality of timber, steel, cement as well as concrete should be intensified.

One of the problems of the improvement and development of building materials, adoption of appropriate construction technology, and popularization of new building components in the developing countries is the lack of skilled workmen and upper as well as middle level technicians. In order to overcome such problems governments of respective countries should encourage technical institutions to include training programmes for civil engineers, architects, middle level technicians and labourers.

Technical information on the improvement and development of building materials and appropriate application of them should be given the necessary support in developing countries. Dissemination of such technical information could be transferred to the users by posters, wall-charts, radio, local newspapers, exhibitions, data sheets, pamphlets, seminars and demonstration programmes.

It is necessary to ban the misuse of building materials like timber, cement, steel, etc. by adopting new codes and standards for them.

Government should take measures to promote the construction sector including building materials industry. Reasonable support should be given to the development of standards and specifications for appropriate building materials and proper construction.

Construction techniques and building materials production should be labour intensive so as to provide employment to the large labour forces available in most developing countries.

Government should assist the manufacturing and construction agencies in developing local capabilities towards better efficiency and improved productivity in building materials industries.

Building materials and construction industry should be included in the core sector of the national development plans as well as of the five year plan.

Developing countries should start identifying areas of cooperation, coordinating research and development exchanging technical personnel and communicating results. Application of appropriate technology an their transfer among developing countries is very essential.

PHILIPPINES: A PROFILE OF THE BUILDING INDUSTRY

Introduction

The present state of the building industry in the Philippines is marked by the Government's active involvement in mass housing through the National Shelter Programme. This programme was initiated and is implemented by the Ministry of Human Settlements and its subsidiary agencies 1/.

The Ministry's involvement results from the fact that the private sector encountered problems in providing adequate services for housing requirements in the country.

In the past year, the Ministry noted a housing backlog of 1.2 million units. Notwithstanding the current efforts made by the Government and private developers, the housing shortage will increase at the rate of 200,000 units per year 2/.

In a country with a steady population growth, this backlog could increase further if no concrete steps are taken to solve the multiple problems in mass construction of houses. It is noted that the construction industry plays an important role, and the Government therefore supports it. The Government intensified efforts in land acquisition and development, financing and the actual mobilization of institutions in order to coordinate its approach to shelter development with the private sector.

This paper attempts to show the current situation of the construction industry, particularly as regards to shelter development, the resources utilized by the industry and the problems it faces.

1/ The Ministry of Human Settlements has seven attached agencies: Human Settlements Development Corporation, Human Settlements Regulatory Commission, National Housing Corporation, National Housing Authority, Home Development Mutual Fund and the National Home Mortgage Finance Corporation. Just recently, the Land Investment Trust was created under the MHS umbrella.

2/ Isidro Roman, "Housing Backlog totals 1.2 million units," Bulletin Today (December 2, 1982).

The importance of the building construction industry sector

This sector comprises general contractors (for residential and non-residential projects) and special trade constractors for structural, electrical, plumbing, painting works, masonry, carpentry and wood flooring installation, metal, stone, glass, tile, terrazo and concrete. This sector is characterized by many small firms and a few fairly large ones which dominate the market, especially on non-residential projects. In housing construction, it is the small contractors who are able to work on residential projects.

The big demand for housing in the Philippines has to be matched by adequate services from this sector, for here lies its importance. In order to provide such services, the industry has to have the necessary financing and manpower resources. However, due to the adverse economic condition being felt in the Philippines, as elsewhere, due to world-wide recession, the construction industry - both big and small firms - as well as other industries, has been affected and the government had to step in to alleviate this problem situation.

To ease the problem, the institutional-cooperative approach was adopted. It is actually a system of "cooperative ventureship between the Government and the individual home-buyer, between the Government and private industries related to shelter development, between the Government and the financial institutions and private investors, and between the Government and the land owners." This is aimed to develop, according to President Ferdinand Marcos in his speech during the celebration of Shelter Consciousness Week (February 14-18, 1983), a house that is within the financial reach of wage-earners and provide cheap but decent houses for Filipinos 1/.

In this context, the financial programme called PAG-IBIG which pools the resources of the home-buyer, bank industry and Government is making this a reality.

1/ "FM Declares Shelter Consciousness Week", MHS Management Bulletin, vol.1, No. 2 (January/February 1983).

A survey of private building construction

Based on the proposed private construction as reported by the Philippine National Census and Statistics Office, for the period 1981, private building for construction should approximate 38,805 units with a total floor area of 5.4 million square meters and construction value estimated at 6.3 billion pesos. (US$ 810 million at pesos 7.8 = US$ 1 in 1981).

Residential building construction comprised 61.6% of the total with 23,922 units covering 2.4 million square meters with the value of 2.4 billion pesos. For non-residential, 5,622 units or 14.5% was proposed. This however registered the highest construction cost amou ing to 9.2 billion pesos or 23.9% and the highest area of 2.7 million square meters. Work on additions, alteration and repairs registered 9,261 units or 23.9% and a floor area of 307,000 square meters worth 507 million pesos.

Comparatively, the number and value, including the average cost of construction for residential buildings for 1981, increased by 8.9%, 6.7% and 10% respectively. The floor area was, however, short by 3% as compared to the 1980 figures.

Increases were also registered in non-residential projects. The number rose by 3.1% and the value by 18%. The average cost per square meter increased by 22.4% but the area covered dropped by 3.6%. The same survey noted an upward trend in construction costs.

Some problems of the industry

Among the problems perceived by the leaders in the industry, the following have a greater impact:

(a) Poor financing due to the tight money situation, interest rates are high;

(b) Poor design and profit orientation result in over-pricing 1/;

(c) Difficulty in the procurement of construction materials and their increasing cost.

1/ Edward Escalante, "What is Real Success", Bulletin Today (February 16, 1983), p. 25.

However, there is a strong optimism that these problems will be resolved in due time as a result of the initiative being taken by the government sector in response to these problems.

Certain sectors in the industry, likewise predict a perking up of the market, that a "building boom" is forthcoming.1/ In real estate, impressive gains are expected, that is "given the high levels of liquidity reported by banks and the lowering of credit interest rates from 12% in 1981 to 10% last year (1982). It is also observed that the prime lenders are becoming aggressive in investing their loan portfolios.

Accordingly, the lowering of the inflation rate to a single digit, which is expected to remain this year, will tend to promote domestic savings and investments.

The above projections made by a Filipino realtor, were based on the observation that the utilization of local construction materials and financing by private and government-owned institutions, through a secondary mortgage market operated by the National Home Mortgage Finance Corporation (NHMFC) have stabilized real estate prices within the reach of the middle class 2/.

Similarly, the wood industry sees brighter prospects this year. Having experienced a poor market situation in the last three years, it looks for 'better days ahead' as it counts on the Government's housing programme, which intends to build, starting this year, some 100,000 housing units annually for the next ten years to attain the target of 1 million units.

Based on this demand, it is estimated that an average house of an area of 50 square meters will need about 7 cubic meters of wood; a total of 1,700,000 cubic meters of wood products will have to be supplied annually for the Government's housing programme alone. Accordingly, this volume comprises 61% of the lumber produced in 1982 which is 1.15 million cubic meters.

The same optimistic note prevails in other construction related industries.

1/ Jose Antonio, 'Predict building boom this year,' Bulletin Today (January 12, 1983), p. 16.

2/ Ibid.

The National Shelter Programme (NSP)

The active involvement of the Government in shelter development has been hailed by the private sector as a timely move in the right direction towards spurring into action the building construction industry which has of late been lethargic.

The National Shelter Programme, in its Operation Plan for 1982 sought to stimulate participation through various incentives and facilitate the implementation of a support system by professional consultations, technical extension work, the transfer of appropriate technologies for home improvement, low-cost housing and self-help construction. Added to these are the other programme objectives of instituting an integrated system for the production of low-cost building materials: developing a system of marketing for the building materials industry; introducing fabricated housing components of acceptable designs, and relating with efforts involving research and development on building materials and construction technologies 1/.

Late last year, the Programme developed a new housing model, the Flexihome design, which was conceived by the First Lady and Minister of Human Settlements, Imelda Romualdez Marcos. This model features flexibility in terms of marketing construction and aesthetic considerations.

Flexihomes come in three area dimensions, namely 50.4 square meters; 60.4 square meters, and 77.7 square meters. It has a variety of designs and accents to choose from, it is marketable in its component form and is affordable by practically all market levels. Construction of these models allows efficiency and economy because components are standardized and prefabricated 2/.

1/ Operations Plan, 1982' National Shelter Programme, Ministry of Human Settlements (January 1982).

2/ Butch Racquel, 'An Innovative Approach to Mass Housing in the Flexihomes.' MHS Management Bulletin, vol.1, No. 2 (January/February, 1983).

Building materials

Wood

Wood is the traditional material used in housing in the Philippines. This is only natural since the Philippines has vast forest resources and various species of wood are suitable for construction purposes.

Land area

In terms of land area, the Philippines has some 16.7 million hectares of forest land. Of this total, 19 % are unclassified while the rest are forest reserves (3.2 million ha), timberland (5.5 million ha) and National Parks and Reservations (2 million ha).

Timber resources

The existing timber resources approximate 1.55 billion cubic meters mostly made up of dipterocarp species comprising 1.4 billion cubic meters.

Utilization

Wood is utilized in various forms among which are: lumber, pulp and paper as well as other wood-based panels.

Production

In 1981, an aggregate volume of 1.22 million cubic meters of lumber was produced. This is 20 % less than the 1.53 million cubic meters produced in 1980.

In 1982, 1.15 cubic meters of lumber production were registered; this again is lower than the production of the previous year. However, the prospects of a bigger turnout for 1983 are good since a substantial demand will be made by the housing projects.

Some indigeneous timbers of importance to the construction industry

The following is a list of the major species considered for use in construction:

Common name	Scientific Name
Molave	Vitex parviflora
Ipil	Intsia, selected species
Yakal	Hopea basilanica and other species
Guijo	Shorea guiso
Apiteng	Dipterocarpus grandiflorus and selected species
Narra	Pterocarpus spp.
Nariq	Yatica manggachapoi
Mahogany	Swetenia macrophylla
Palosapis	Anisoptera spp.
Tinang	Shorea teysmanniana
Bagtikan	Parashorea malaanonan
Almaciga	Agathis alba
Almon	Shorea eximia
Tangile	Shorea polysperma
Manggasinoro	Shorea philippinensis
Red lauan	Shorea negrosensis
While lauan	Pentacme contorta
Mayapis	Shorea palosapis
Malabayabas	Tristania spp.
Dungon	Tarrietia sylvatica
Mangachapin	Hopea acuminata
Tindalo	Pahudia rhomboida 1/

Some of the above species are rare and are seldom utilized for construction purposes. The most commonly used species for construction are Yakal, Apitong, Tangile, Molave, Red and White Lauan. Narra is prime wood and is used in the manufacture of furniture, panel board and other wood products.

Philippine imports of selection wood

In 1991, the Philippines imported sawlogs, veneer logs (conifers) and lumber from the United States, Australia and Japan for a total of 16,126 cubic meters valued at 1.2 million dollars.

1/ Refer to the National Building Code of the Philippines; Luis Reyes, Philippine Woods, Manila: Bureau of Printing, 1938) and Tamesis and Aguilar, Important Commercial Timbers of the Philippines (Manila: Bureau of Printing, 1953)

Construction requirements and regulations

The construction of buildings is governed by the National Building Code of the Philippines. This code defines the provisions of its scope and application, general building requirements and site requirements.

As to the type of construction, the code specifies five major types, which are:

Type I — Buildings of wood construction with structural elements selected from any wood building materials permitted by the code.

Type II — Buildings of wood construction with protective fire-resistant materials and one-hour fire resistant throughout, with exception permanent non-bearing partitions may use fire-retardant treated wood within the framing assembly.

Type III — Building of masonry and wood construction with structural elements selected from any wood material permitted by the Code, provided that the building shall be one-hour fire resistant throughout. The exterior walls shall be incombustible fire-resistant construction.

Type IV — These are buildings of steel, iron, concrete or masonry construction. Walls, ceilings, and permanent partitions are of incombustible fire resistant construction.

Type V — These are buildings that are fire resistant and the structural elements are of steel, iron, concrete or masonry construction. Walls, ceilings and permanent partitions are of incombustible fire resistant construction.

The code further defines in the various chapters the requirements for:

- Fire zones,
- Fire resistant construction,
- Building use or occupancy,
- Light and ventilation,
- Sanitation,
- Building projection over public streets,
- Protection of pedestrians during construction/demolition,
- General design and construction,
- Electrical and mechanical regulations,

- Storage and handling of photographic and x-ray films together with its fire extinguishing system,
- Pre-fabricated construction,
- Plastics,
- Sheet metal,
- Paint spray booths,
- Glass and glazing.

Programme implementation

Through the Shelter Programme, the housing problem in the country is being resolved through four components of shelter development, namely: regulation, production, finance, and marketing. These are administered by the seven Shelter Agencies under the Ministry of Human Settlements

The major projects already implemented include the following:

Bliss Programme

This is the regional component of the Programme and it involves the construction of housing units in 1500 cities and towns throughout. It is designed to improve the living conditions and the quality of life in rural communities. Each project consists of 50 to 100 units. Some 448 projects have been completed and occupied by some 20,000 residents.

Urban Bliss

This concerns the development of urban communities which cater to low-income families. The communities are a cluster of medium-rise apartment buildings with provisions for livelihood activities. Nine completed sites are now occupied by around 1,226 family beneficiaries which are organized into associations. Added to this is a total of 1,328 units which are nearing completion.

PAG-IBIG Programme

This is a nation-wide savings movement for private and government employees which emphasizes house acquisition at liberal terms. The fund for the purpose is generated through the contribution of a percentage of the employees' salaries to be equally matched by their employers.

Together with the Flexihome programme mentioned above, and other related programmes of agencies like the Government Service and Insurance System, the Social Security System and the National Housing Authority, which seek to implement shelter development, there is a feeling of optimism that the perennial housing problem in the Philippines will soon be overcome and this on account of the dedication of the national leadership to meet the shelter challenge.

SRI LANKA: THE CONSTRUCTION INDUSTRY

The importance of the construction industry

The construction industry of Sri Lanka encompasses the main aspects of civil engineering i.e. buildings of all types, infra-structure development and irrigation including hydro-power projects. The importance of the construction industry for a developing country such as Sri Lanka cannot be over-emphasized particularly at a time when the Government has launched massive development schemes in a number of spheres. Development is an essential ingredient to the progress of a nation, and the construction industry has to play a leading and important role if developent projects are to be accomplished effectively, efficiently and economically. This involves the use of the most appropriate technology and construction methods, available construction skills and utilization of local resources as much as possible. Furthermore, the use of effective contract systems and efficient contract management are also necessary.

While being a part and parcel of development, the construction industry also generates many other industries such as the manufacture and supply of building materials and equipment. Besides generating employment in its own sphere, the construction industry also helps generate employment in other connected industries as well, and in this respect is greatly beneficial to any country.

Construction agencies

Agencies responsible for construction in Sri Lanka can be categorized as follows:

(i) Public Sector agencies such as Government Departments and Corporations;

(ii) Private sector firms and small time private contractors;

(iii) Foreign contracting firms.

Unfortunately few statistics are available on the share of construction work handled by each category.

Although during the period 1970-77 the policy of the Government of Sri Lanka was to entrust almost the entire quantum of construction to public sector agencies, since 1977, the Government has opened the doors of the construction industry to the private sector as well. This policy together with the massive increase of construction activity in the country during the ensuing years gave rise to the emergence of a large number of private sector firms in the construction industry. However, the capacity of the public sector agencies and the private sector firms being limited, a large number of foreign contracting firms have been employed, particularly on irrigation and hydro-power projects and on some infrastructure and large building projects too.

While the construction of public buildings such as housing schemes, school buildings, office buildings, hospitals, etc. is shared by the public and private sector, the construction of private sector buildings such as hotels, factories, offices, shopping complexes, etc. is in the hands of private sector firms. Private dwellings continue to be constructed by small time private contractors.

In the sphere of buildings the two major construction agencies are the Department of Buildings and the State Engineering Corporation of Sri Lanka, both institutions being part of the Ministry of Local Government, Housing and Construction. The Department of Buildings in most instances in turn hands over the projects to a private contractor on a tender basis, a few projects being handled with direct labour. The State Engineering Corporation with a work force of around 8000 employees handles most of the projects on direct labour while a few projects are given on a labour contract basis to private contractors. While the annual turn-over of the Department of Buildings is around Rs. 500 million (approximately US$ 22 million), the annual turn-over of the State Engineering Corporation is around Rs. 350 million (approximately US$ 15 million).

Problems facing the industry

The main problem faced by the construction industry in Sri Lanka today is its instability. With global recession and sharply rising costs

of building, the Government has been forced to prune down its investments in this sector. Most of the on-going projects are funded by external financing and procurement of foreign aid for further development works is getting more and more difficult. Under such circumstances long-term or short-term forecasts for the future of the industry are not possible, and the future of the industry in this respect is quite at stake. As a result, the survival of the local construction agencies, let alone expansion, has become difficult.

Rising costs of construction have also been a major drawback to the industry. Construction costs which from 1969 to 1977 showed a gradual increase (average cost index of 100 for 1969 going up to 186 in 1977) has shown a very sharp increase from there onwards, up to 1982 (average cost index 598) for all construction work. The greater demand for construction materials resulting from the surge of construction activity, global inflation and rising local costs have given rise to the sharp increase in costs.

The shortage of skilled labour and trained personnel for supervision of construction works is another problem faced by the industry. This has been caused by the out-flow of these categories mainly to the West Asian countries for more lucrative jobs and the lack of adequate training facilities to produce skilled workers to meet the increased demand.

Building materials and their uses

The major building materials used in Sri Lanka are timber, cement, steel, bricks, tiles and asbestos. These constitute a large portion of the costs in construction of conventional buildings. Other materials used are galvanized iron sheeting, aggregates, rubble, sand, lime, paints, hardware, sanitary equipment, PVC items, electrical accessories, glass, aluminium, etc. Cadjan and earth are also used in traditional rural housing.

Structural materials

Timber, concrete and steel are the alternative structural materials used for roofs while clay bricks, concrete, cement/sand blocks are used

for walls and supporting framework for floor slabs. Concrete, and to a lesser extent, timber and steel are used for structural floors. The structural framework for ceilings almost always consists of timber. Concrete, rubble and bricks are used for foundations.

Non-structural materials

Tiles and asbestos are abundantly used in conventional buildings as roof covering materials. Calicut tiles and half round tiles are used more for single and two storey dwellings, while asbestos is used for dwellings as well as for other types of buildings. The asbestos roof is overlaid with half round tiles in some buildings to reduce the heat. Galvanized iron sheeting is also used at times as a roofing material mostly for temporary or semi-permanent buildings. Cadjan is used as a cheap alternative in traditional rural housing.

Finishing materials

Cement/lime/sand mortar is used for plastering brickwalls and concrete work, while cement/sand mortar is used for rendering floors. More expensive floor finishes sometimes used are terrazo flooring, terra-cotta clay tile flooring and vinyl flooring. Plastered walls are finally lime washed or painted with cement based paints or emulsion paints. Timber wall panelling is an alternative finishing material but is quite expensive.

Timber, concrete and steel - their availability, use and associated problems

Timber

Sri Lanka, having a tropical climate, has a considerable potential for timber, and timber is one of its most valuable natural resources. Sri Lanka presently possesses around 350,000 acres (141,640 ha) of timber plantations, both in the dry and the wet zone and approximately half of

this is teak plantations. However, in the absence of a regular planned reforestation/afforestation programme in the past, forced deforestation required for the country's major river diversion scheme and the greatly increased demand for timber has necessitated the optimum use of the available popular species of timber as well as the use of indigenous timbers in the construction industry.

In this respect, apart from the study of properties and durability, and use of the lesser known species of timber which are not available in very large quantities, it may be well worthwhile to promote if suitable the use of treated rubberwood for structural and non-structural purposes. Preliminary tests carried out have shown that rubberwood prossesses adequate strength properties and if its durability can be suitably extended by treatment at reasonable cost, this may turn out to be a break-through in the construction industry, as rubberwood is abundantly available in rubberwood-plantations and is presently used mainly as firewood and at times as formwork for concrete constructions.

The estimated annual requirement of timber in terms of log volume according to the State Timber Corporation is around 800,000 m^3. The State Timber Corporation has been able to provide only approximately 25% of this total market requirement while the balance is provided by the private sector on permits issued by the Government and the major quantity by illicit timber dealers. More than half the sale of timber through the Corporation has been in the form of logs. In order to meet the increased consumer demand since 1979 timber has even been imported to Sri Lanka. Timber was imported mainly through the State Timber Corporation who have recorded sales of around 3500m^3/year, while some timber has been imported by the private sector as well.

Timber has been used in Sri Lanka for centuries. There is ample testimony of this in ancient temples, churches, etc. It had been common practice those days to use very large timber sections not only for structural members in roofs, etc. but also for doors and windows. Timber had also been used to a very great extent for furniture. In the past, good quality timber had been lavishly used because it was abundantly available and inexpensive .

Timber in Sri Lanka today is an expensive commodity with a heavy demand. Since 1969, the price of timber has gone up by 700%. The

present price of sawn timber varies between Rs. 7,400.- 10,940.-/m^3 (US$ 321 - 475). However, timber is still being used for many purposes in the construction industry. Timber is still by far the most popular structural material for roofs and ceilings in housing. It is used for roofs and ceilings in other types of buildings too, though not to the same extent as in housing. Timber is at times used for upper floors of buildings, and temporarily as props and formwork in concrete construction work. A timber species ('Hora') is sometimes used as piles in foundation work. It is also used abundantly for doors and windows of all types of buildings as well as for furniture. Further uses are for panelling, ceiling boards, partitions in the form of chipboard or plywood, railway sleepers, electric poles and timber boats. Timber is very rarely used for bridges in Sri Lanka.

The problems faced by the construction industry in using timber are many. Adequate information is not available on the mechanical properties and durability of most of the indigenous species. Today, selection of timber is based more on traditions and beliefs than on scientific information and therefore is not very satisfactory. The classification of timber as done presently by the State Timber Corporation is rather vague and keeps on changing with the increased demand. Stress grading of sawn timber is not carried out at all, and grading of logs has been just started at the Timber Corporation. As a result, high safety factors have to be used in design and the use of indigenous timbers is greatly limited.

Scientific seasoning and preservative treatment are rarely done. As a result of this, and the fact that the demand for sawnwood is very high, the timber available on the market is very often green timber. Although not suitable for use, builders are often compelled to do so.

The high cost caused by the heavy demand and the scarcity of good quality timber are further drawbacks that users have to face.

Concrete

Concrete is a much more modern material which is sometimes used as a substitute for timber. The construction industry in Sri Lanka uses reinforced concrete to a large extent and pre-stressed concrete to a

lesser extent. Due to the large increase in construction activity over the last four to five years, it has been necessary to import cement to meet the increased demand.

Sri Lanka's cement production in 1982 has been around 700,000 metric tons. This is expected to increase to about 1,393,000 metric tons by the end of 1983. A quantity of about 700,000 metric tons of cement was imported in 1982.

The aggregates used in concrete consist of sand as fine aggregate and granite and limestone as coarse aggregate, all of which are available locally. However, with the increase in demand, these materials too have shot up in price with increases of 500 to 600% on the 1969 prices. Cement too has increased by around 800% since 1969. The average cost of grade 20 concrete is around Rs. 1,545 (US$67) per cubic meter.

Concrete is heavily used in the construction industry for multi-storey buildings, hydro-power projects, water retaining structures, irrigation works, bridges, and, to a lesser degree, in single storey buildings. Precasting of reinforced concrete members of prestressed concrete members is also practiced, with most concrete work done in situ. Pre-tensioned concrete purlins are used in large housing schemes, factory buildings, etc. as a substitute for timber and is found to be comparable in cost.

The problems faced in using concrete in the construction industry are the high cost and the fact that Sri Lanka is still not geared to produce high strength concrete due to inadequate quality control, non-uniform aggregate grading and inadequate testing facilities.

Steel

Steel is another heavily used construction material being used structurally and as reinforced for concrete.

Steel is produced locally at the Ceylon Steel Corporation from imported ingots. The private sector is also free to import steel and as such a large stock of imported steel also comes to the country. The annual consumption of locally produced steel is around 30,000 metric tons. At present, about the same quantity is also imported annually. High tensile steel for prestressed concrete is imported.

Steel is often used as a structural material for medium to large span roof trusses, purlins, etc. and to a lesser extent for other structural members such as columns, floor beams, piles, etc. in the building industry.

Reinforced steel costs around Rs. 950 (US$41.3) per 50 kgs tied in position, while structural steel costs around Rs. 1150 (US$50) per 50 kgs fabricated and installed in position.

Steel does not pose any specific problem in the construction industry, other than maintenance in the long term and corrosion, encountered if structural steel is used close to the sea shore.

Construction

Modern technology, which includes the use of modern construction equipment and modern construction materials such as cement, steel, asbestos, etc. has been used in Sri Lanka for quite some time, whereas materials such as aluminium, high quality light weight roofing, etc. have been introduced over the last few years. However, traditional construction practices using mud and cadjan still exist in the rural areas.

There are no uniform specifications and standards for construction work. In general each organization draws up its own specifications and standards based on the British Standard Specifications. For specialized jobs where no specifications are available, the British Standard specification may be directly used for design and construction. Sri Lanka standards have however been drawn up for various building materials from time to time in order to improve their quality, but these are not mandatory. Materials conforming to these standards may carry a stamp to indicate this.

With the very high cost of construction, and in a situation where the rate of inflation in the construction industry is much higher than the general rate of inflation, financing of construction work is no doubt difficult.

With high rates of interest on bank loans even the contruction of a private house is beyond the average wage earned. Completion of Government projects too often get delayed due to lack of funds to meet escalated costs.

Labour

Labour is freely available in Sri Lanka, but skilled labour is scarce due to the large exodus, particularly to the West 'sian countries for more lucrative employment. As a result, semi-skilled workers are often called upon to carry out skilled work, and thus workmanship and quality of work has been found to suffer.

The facilities for vocational training were lacking in Sri Lanka until the establishment, very recently, of the Construction Industry Training Project under the Ministry of Local Government, Housing and Construction. This project has been undertaken with financial assistance from the World Bank/IDA and its objective is to increase the supply of trained manpower and to improve the level of technical management expertise.

Facilities for higher technical education have been available in Sri Lanka for quite some time through a number of junior technical institutes and the output of these can be said to be adequate.

Industrial infrastructure

The Centre for Housing, Planning and Building in Sri Lanka, set up under the Ministry of Local Government, Housing and Construction with assistance from the Government of the Netherlands, provides useful training for technical personnel in the construction industry. It trains in the fields of housing and planning and construction management by conducting short-term courses for site engineers, middle level technical officers and new recruits to the technical grades.

Quality control and standards are fields which are unfortunately quite neglected in Sri Lanka. The only institution which is in some way involved in these fields is the Bureau of Ceylon Standards. Although they have from time to time prepared standards for some building materials, the machinery to implement these has still not been established.

The institutions involved in the field of industrial research are the Building Research Institute of the State Engineering Corporation, the Ceylon Institute of Scientific and Industrial Research and the National Engineering Research and Development Centre. The funds, staff and facilities available for these institutions being limited, their contribution to the construction industry is small. A proposal has been drawn up to set up a National Building Research Organization under the Ministry of Local Government, Housing and Construction with assistance from the United Nations Development Programme, and if this is implemented, it would be a great boost and the fulfilment of a much needed requirements for the building and construction industry in Sri Lanka.

ST. LUCIA: A SURVEY OF LOCAL BUILDING CONSTRUCTION

The average temperature in St. Lucia is 80 ^{o}F. St. Lucia spreads over an area of 238 square miles. Its capital is Castries. Its population totals 45,000 and the total population of St. Lucia is 130,000.

Introduction

The construction industry in St. Lucia peaked in the early 1970s with a massive injection of foreign capital in resort construction. It sustained the level mainly through Government projects for schools and housing and significant infrastructural development of roads, harbour and airport extension. It suffered a major set-back as a result of the energy crisis, inflation, and the recent turmoil in local politics and Government.

Today

The political turmoil ended last year when a new leader was reinstated. Today, the construction industry seems to be on the road to recovery with several foreign-aided or financed housing projects and resorts on the verge of construction and a few industrial and commercial buildings under construction.

Building categories and materials employed in construction

The main public buildings in Castries - Treasury, Registry, Law Courts, Ministry of Finance - are housed in buildings constructed after the 1948 fire and are built of masonry. A few Government offices are also housed in old army barracks with walls of stone 14" to 24" thick with heavy wood roof trusses. Modern office construction, both in public and private sectors, consists of reinforced concrete columns and beams with floor systems of reinforced concrete or wood joints. Industrial buildings are built of steel frame and metal cladding or reinforced concrete structural systems and concrete block in-fill. Houses are built of concrete blocks, rubble/stone or timber. In all of these building types, corrugated galvanized roofing is commonly used.

Problems facing the industry

Some of the problems facing the industry are:

- the high construction costs caused by persistent inflation.
- long distance of material suppliers from St. Lucia. It takes from six weeks to six months from order to receipt of material. Cost of shipping is implied.
- lack of skilled labour and personnel.

Building materials

Timber Resources

The island has an expanse of woodland and forest representing some 46,000 acres or approximately 31%of the total land used (59% mixed - agriculture, pasture, human settlement). One third of the forest resources, approximately 16,400 acres is fully protected forest reserve.

Indigenous timber (see appendix)

Several species of indigenous timbers are available (limited supply) for use in house construction and for furniture (mainly). A few include: teak, red cedar, white cedar, blue mahoe, mahogany, Carribean pine, breadfruit, satinwood, merise, gommier, bois canon, laurier mabre, balata chien.

Characteristics of a few popular timbers

Teak is used in furniture construction and flooring. It is a dense and darkish wood.

Mahogany is a hardwood which is ideal for wall panelling, flooring, furniture and doors.

White cedar is suitable for siding and shingles; its colour is light and is a very durable material.

Balata chien is a very durable timber which is suitale for exterior use such as piles, floor superstructure, pilotis, etc.

Peasants have been using indigenous timber for years. Traditionally the trees are felled and sawn into boards and then finished after having been transported to the construction site. With the advent of the banana industry, this occupation dwindled and concrete block houses were considered as the sign of upward mobility. Today, the Forestry Division of the Government of St. Lucia is the chief promoter of timber on the island.

Timber obtained from forests

	April 81-March 82	April 82-March 83
Private lands	43,157 cu.ft	38,775 cu.ft.
Crown lands	10,985 cu.ft	17,899 cu.ft

Foreign supply

Major suppliers of pitch pine are USA and Canada. Greenheart and mahogany come from Guyana. Other supply countries are Brazil, Honduras and the United Kingdom.

Use

Greenheart is widely used for door and window frames, exterior siding, deck members-balustrade ceilings. Pitch pine is used for flooring, ceiling, door and window frames. [illegible]y is used for furniture, wall panelling and doors.

Problems

One drawback of timber construction is its susceptibility to attacks by termites. Wood therefore has to be treated, which means an additional cost.

- Conservation of the forest is essential for the continuity of water supply and preservation of soil quality.
- The protection of environmental resources in view of their unique ecological, historical and economic significance.
- Limited natural resources: the nature of the tropical forest does not provide the concentration of a species in a given area.

- Flat land is used up by the larger estates for major export crops of bananas and coconuts. Other forest areas are also being cleared for agriculture and timbers are cut for the production of charcoal.
- Due to improper methods employed in timber connections, imported greenheart did not withstand the hurricane of 1980 - a reflection on technical incompetence.

Concrete

Cement is not produced locally but imported from Barbados. Other sources are the United States of America, Colombia, Guadeloupe and Puerto Rico. A local cement factory has been envisaged and foreign donors are presently being sought for its implementation.

Aggregates

Stone is quarried locally and is in abundant supply. Sand is mined from river beds and beaches. The latter source, until recently, was more prevalent. Recent legislation has made it illegal to remove sand from beaches. Pumice is a new material which is presently being researched for use in concrete blocks.

Precasting is not generally used in large projects. It is used mainly for caissons (piles), culverts and slabs but was once used on a housing project of approximately 20 houses (La Resource, Vieux Fort). The Hess Co., an American company which funds and constructs some schools on the island under an agreement with the government, utilizes precast concrete panels. The average builder, however, cannot afford the heavy equipment (which is not available) that is necessary for precast construction.

Concrete used in construction

Concrete is used extensively in all sorts of construction - for foundations, exterior walls, partitions, fireproofing of steel sections, decorative finish and waterproofing timber (expanded metal and plaster finish to timber in bathrooms).

Costs

Concrete has been proven to be a cost effective material and has a low maintenance coefficient.

Problems

- The sand is mined locally from beaches resulting in serious beach erosion.
- Sand is not washed to remove the salts - thus cracks and irregularities occur in construction.
- Cement is sometimes scarce, causing delay in construction.

Steel

Steel is imported from Holland, the United Kingdom, Canada and the United States of America. Steel rods and wire mesh are used to reinforce concrete beams, columns and floor slabs for both public and private sector buildings. Rolled sections are used in areas where large uninterrupted spaces are needed.

A fabrication plant has recently been established on the island and has reached some measure of success.

Costs

Steel is economical both in initial cost and in erection time. As long as it is protected from the elements, it is extremely cost effective.

Problems

- Steel corrodes after attack by sea salt carried by the wind, especially on the windward side of the building.
- Savings gained during erection is outweighed by methods of steel protection and maintenance.
- Lack of equipment limits its use (heavy sections) in construction over three storeys.

Others - Roofing, fastening and finishing materials

Corrugated galvanized iron is the prevalent roofing material by virtue of its low cost and easy application. Wood shingles have been the traditional indigenous material but are not readily available. Other roofing materials are asphalt shingles, felt and built-up roofing. Tile roofing has been used but the material has to be imported and is expensive.

Materials used for fastening are corrugated galvanized nails, steel bolts and nuts, steel nails, hurricane clips and clamps, steel anchor bolts.

Finishing materials are mainly paint, plaster, wood panelling and siding and various concrete/aggregate textures.

Construction

Traditional

Timber houses on wood stumps or stone piers has been traditionally built by peasants. This is a low-cost method.

Modern practices

Reinforced concrete beams and columns, with concrete block infill or decorative grille blocks, floor slabs of reinforced concrete and wood rafters for roof.

Regulations and standards

The basic 1948 code, revised and amended in 1971 is presently being revised. This code is not comprehensive enough and needs to be more specific in technical areas. It relates more to planning requirements.

Financing

- Through the Urban Development Corporation and House Building Programme for middle income earners.

- The Housing Development Bank for the middle/lower income group.
- The St. Lucia Mortgage and Finance Company and Commercial Banks and Insurances for the middle/upper income groups.

Problems

Most finance companies only assist up to 80% of estimated cost of building and land which must be owned.

Labour

High percentage of unemployment represents or reflects a large number of unskilled labour. Approximately 20% unemployment exists among the youth. Apprenticeship programme and other training must be instituted.

Industrial infrastructure

A technical college exists and is co-educational. Training is provided at the tertiary level in construction techniques, technology and drafting, among others. Island-wide multi-purpose workshops are presently at the planning stage by the Ministry of Education. A few secondary schools provide training in carpentry, drafting and woodwork.

A couple of firms are involved in project management and quantity surveying.

Conclusions and recommendations

The survival of the construction industry depends on five factors:

(a) The provision of more readily available indigenous materials at reasonable cost and on par with imported materials.

(b) Imports of materials at reasonable cost to builders. Efforts should be made to limit imports.

(c) Supply of competent professionals as well as skilled labour in the building sector.

(d) Cooperation between the public and private sector.

(e) Introduction of appropriate indigenous technology and research and technology transfer from other countries.

Sources

- Government of St. Lucia - Ministry of Finance, Planning and Statistics.
- 1970 Census, St. Lucia
- St. Lucia Forestry Division

Credits

Miss Jennifer Auguste, Architectural Assistant, for some research.

INDIGENOUS TIMBER

Scale of Royalty Rates of Timber According to Girth or Cubic Foot (a Breast Height over Bark (cubic foot) over Bark Mid Girth)

$ 7 for each complete foot of girth or 85c per cubic foot	Red Cedar - Acajou; Teak; Mahogany.
$ 6 for each complete foot of girth or 75 c per cubic foot	Caribbean Pine; Blue Mahoe; Acomut; Bois d'orange; Coubaril; Laurier Canelle; Satin Wood; Bois Pain Marron; Gommier; Laurier mabre; Merise; Bois d'amande.
$ 5 for each complete foot of girth or 65 c per cubic foot	Balata Chien; Bois Blanc; Bois Lezard; Bois Reviere; Bois Tan; Breadfruit; Contrevent or Bois de Rose; Dalmare; Dedefouden; Feuille Doree; Laurier other than Mabre and Canelle; Penny Piece; Poire or White Cedar; Pommier; Zolivier.
$ 4 for each complete foot of girth or 55 c per cubic foot	Barbaquois; Bois Aguti; Bois Creole; Bois de Fer Bois de Masse; Bois Guille; Case Rate or Cacarat Casse; Corosol Marron; Chypre; Goyavier; La Glu; L'encens; L'épineaux; Pois doix; Savonette; Ti Citron and all species not mentioned in this schedule.
$ 3 for each complete foot of girth or 45 c per cubic foot	Aralis; Bois Canon; Bois Cendre; Bois Cate Bois Flot; Bois l'orme; Chataignier; Figuier Gommier Maudit; Mahot Cochon; Mapou; Mombin; Paletuvier; palms (all kinds); Silk Cotton.

THAILAND: THE CONSTRUCTION INDUSTRY

The booming era for the construction industry has gone, and construction firms are now facing grave difficulties due to the sharp decline in construction activities on the local market. Local construction firms are in fierce competition for contracts. There has been a marked drop in public sector construction. The Government began to slow down its construction activities in 1977. Public sector construction amounts to roughly 40-60% of the total.

The problems of the local construction industry are attributed to the general economic slowdown, to the high interest rates, to the restrictions placed by the commercial banks on credits to the construction industry, and to the fact that the Government has done away with escalation or 'K' payment regulations. These 'K' payment regulations gave refunds to contractors when building costs rose steeply due to inflation and the raising of taxes on sales of services from two to three percent.

The National Housing Authority (NHA) continues to be the largest home builder. On 13 December 1972, the Government issued Decree No. 316, setting up the NHA. The Decree dealt mainly with the problems of Government housing for the lower and medium income bracket. More than 2000 persons are employed by the Authority for various projects such as:

- The construction of about 4000 housing units of site and service project at Tung Song Hong.
- The construction of satellite towns at Lad Krabang and Bang Plee - Bang Bor. A total of about 7,900 houses are being built.
- The construction of more than 3000 units of flats at various projects such as Nava Nakorn, Bon Kai, Din Daeng, etc.
- The improvement of the slum areas, aiming at creating better living conditions for people who live in various congested and heavily polluted areas of the capital. The NHA hopes to improve about 11,200 houses.
- The NHA has also been given the task of building houses for various groups of Government employees.

The construction of houses by private developers ranges from high and medium income houses and apartments to shophouses as well as a small portion of low-cost housing. The sizes of the private firms are varied as are the numbers of people employed by them. Private builders are supplying only about 5000 to 6000 houses a year in the Bangkok area.

Thailand has a basically sound building materials industry capable of producing all the essential materials, required by the country, and often with a surplus of production which is then exported. From 1975 onwards, a building boom ensued and because some manufacturers were slow in responding to the increase in demand, shortages of some types of materials were registered.

Some building materials industries can be briefly described as follows.

Concrete

Concrete Products and Aggregate Co. Ltd., established in 1952, makes a variety of pre-cast elements including hollow block, prestressed posts, poles and piles, structural elements as well as plain and reinforced concrete pipes. The company also provides ready-mix concrete and crushed rock. Raw materials are readily available. Reinforced steel is the only item imported. Quick-hardening cement is supplied by the Siam Cement Co.; current production is 40,000m^3 of piles, beams and telephone poles, 13,000m^3 of precast footing, slabs and concrete pipe; 4 million hoolow blocks, 500,000m^3 of ready mix concrete and 450,000 metric tons of crushed rock.

Thai Concrete Products Co. (1967) also produces hollow blocks, pipes and piles in a variety of sizes. The daily capacity is 10,000 blocks, 400 pipes and 200 piles. Several smaller companies also manufacture concrete products.

The Siam Cement Co. Ltd. was founded in 1913. The company produces ordinary cement ('Elephant' brand), silie cement ('Tiger' brand), quick setting cement ('Erawan' brand) and white cement. Small quantities of coloured finishing cement are also produced. Raw materials (marl, slate, laterite, gypsum) are all available in Thailand.

The Jalaprathan Cement Co., was set up in 1953 by the Irrigation Department for the construction of the Bhumibol Dam.

The third factory in the cement industry is the Siam City Cement Co. Its total production is about a million tons per year. Cement was in short supply during the Viet Nam war build-up, but now there is an excess of production. Cement is exported to Laos and Viet Nam. Some special grades of cement, particularly high-early-strength cement is imported from Japan.

Steel

Large deposits of iron ore are located in Thailand. Most of the mining production is exported to Japan. Iron ore ranks second in export earnings, after tin. New finds and increased local demand for ore by newly established steel mills are expected to raise production.

The Siam Iron and Steel Company has been operating a foundry since 1950. Its production is pig iron reinforcing steel bars (plain and deformed) and some casting. Raw material is scrap iron 20,000 metric tons of pig form are produced per year; 7,500 metric tons of reinforcing steel, and 4,500 metric tons of castings.

The Thai Steel Co. Ltd. also produces reinforcing steel, production is 6,000 metric tons per year.

The Bangkok Iron and Steel Co. produces 30,000 metric tons of reinforcing steel from scrap iron.

G. S. Steel Co. Ltd., a Thai/Japanese firm, built a plant in 1967. It produces 90,000 metric tons of reinforcing steel per year. Output is expected to increase to 130,000 metric tons.

Thailand is rapidly becoming self-sufficient in reinforced steel. In 1965, nearly all steel products were imported. At present, Thailand produces enough to meet domestic demands.

Timbers

Thailand has extensive forest resources of high commercial value. Teak and Yang have long been used in house construction, but their increasing value as export commodities has led to the use of other hard and softwoods in local construction. The following table illustrates some species preferred for housing.

Local name	Application
Kabak	Concrete form works
Daeng	Flooring, siding, boards
Phluang	Flooring, siding, shingles, temporary structures
Rang	Posts, beams, structural elements
Sak	Furniture, flooring, doors, windows
Saya	Panelling, partitions, flooring, doors, windows
Takhian	Panelling, partitions
Teng	Posts, beams, structural elements
Yang	Flooring, siding, temporary structures.

Demand for wood in construction and other wood-using industries is exceeding production. The annual consumption rate is about 2,375,100m^3 (source: Royal Forest Department) but the production of timber is only about 1,798,500m^3. The national reserve forest area is about 196,470.Km^2. The imbalance of production has led the country to import timber, mostly from Malaysia, Indonesia and Burma. The total imports of timber amounts to about 584,400m^3. There are over 500 small sawmills in Thailand. Only the three mills of the Forestry Industries Organization have a large output. There are approximately 300 woodworking and furniture factories, eleven paper mills, thirteen match factories and seven parquet flooring factories.

Others

The Siam Fibre-Cement Co. Ltd., founded in 1938, produces tile roofing, corrugated sheets, flat sheets and pressure pipes. Raw asbestos is imported from South Africa, 15% are produced locally; portland cement, locally produced comprises the remaining 85%. Asbestos cement is rapidly becoming a preferred building material in Thailand replacing corrugated iron roofing.

Ceramic tile production is small. The output depends on orders. The major demand is for religious and administrative buildings.

Porcelain Sanitary Ware is produced locally by American Standard, Shank and Wataware.

Most of the paints, varnishes, lacquers, thinners and solvents are now locally produced. Raw materials are imported. The Metropolitan Paint Factory, just outside Bangkok is the largest domestic producer.

The cost of some building materials are shown hereunder in Baht.

Description	Cost (Baht)
- Concrete, cement content 325 kg/m^3 (elephant brand)	1,170/m^3
- Lean concrete, cement content 200 kg/m (elephant brand)	975/m^3
- Round bars, SR 24, Average for all sizes	9,485/ton
- Deformed bars, SD-30 average for all sizes	9,608/ton
- Roman tile 50 x 120 cm (uncoloured)	33/sheet
- Small corrugated sheet 54x120 cm (uncoloured)	30/sheet
- Hardwood (Teng, Daeng)	280-320/ft^3
- Soft wood (Kabak, Yang)	150-160/ft^3

Source: Siam Cement Co. Ltd.

Construction is basically of wood, concrete, or a combination of both. Generally, the traditional, labour intensive method was employed. Only recently have some attempts been made to introduce industrialized methods, with some success. However, due to the lack of continuity in the construction industry, development of the industrialization is still limited.

Most of the houses are built of reinforced concrete frame and floor slabs with light brick, concrete block, hollow clay tile or wood in-fill for walls and partitions. Their heavy structures require footings founded on extremely deep and expensive piers because of the plastic 'Bangkok Clay'.

A number of experiments are underway among builders in prefabrication techniques. At this point, it appears that hand-crafted construction is still cheaper. One area that could be greatly improved, with a probability of saving in construction costs, is the modular standardization of building components which must be made individually. This interferes with the possible factory production of doors, windows, etc. and results in material waste in cutting. All heavy equipment used in construction must be imported. Actually, construction in Thailand uses very little heavy equipment. A bulldozer might be used in landfill, but quite often fill brought in by trucks is spread by hand. No cranes are used, except for small pulley lifts. Concrete may be mixed in a small gasoline powered mixer. Mortar is usually mixed by hand.

Building codes enforceable in all municipalities of the Kingdom have been established by a Royal decree in 1936. For the capital city, the enforcement of the codes is the responsibility of the Metropolitan Municipality, however, in an attempt to decentralize its function, permits for small residential dwellings (up to three storeys high) are now issued by the engineers of District Administration Office (Ampur). There have been many amendments to date; yet fragmented attempts at adapting the codes' inadequate comprehensiveness have not produced any tangible results thus far. For example, while the building codes did mention the need to utilize fire resistant materials in some instances, no details were specified as to the required performance; hence it is open to wide ranging assumptions. This is a generality of the present codes and many clauses are so vague that it calls for the designers and builders to act responsibly and with discretion, which

one cannot always rely on. Furthermore, the lack of conscientious and knowledgeable enforcement officers such as building inspectors made it very easy for unscrupulous operators to avoid building according to the specified plans.

The most desired type of house construction is the single detached unit. Due to inflated land costs, these units are relatively expensive. Construction costs could be fairly reasonable if wood framing were used and imported materials avoided.

The following is a summary list of the cost of construction. These vary according to types, materials, workmanship, etc.

Houses	Approximate Cost/m^2 (Baht)
Five-storey - walk up flat (NHA)	1,990
Two-storey - raw house (NHA)	1,850
Two storey - single detached house (NHA)	1,900
Two-storey - single detached house (private construction	2,500 - 7,000
Shop - houses (general)	2,000

Source: Cost and estimate section, NHA

Housing finance in Thailand was established 30 or more years ago, but during this time its development was slow and not as successful as might be expected. The reason for this is mainly due to the amount of work which was carried out in the form of solving immediate problems without long term planning of future developments. Moreover, progress was still retarded by the fact that the Government did not seem to give any real attention to bring about the construction project.

Since there are a number of people who own land which they might have acquired by way of hire purchase or inheritance but who have insufficient means to secure houses, many companies therefore offer to construct houses on condition that the land on which the house will be constructed is to be mortgaged to the company or commercial bank, while the landowners pay for their houses periodically.

Traditional Thai culture does not accept various credit systems such as loans from commercial banks for house construction or payment housing units on hire purchase terms, etc. This is why most people tend to build houses with their own savings or seek capital investment on their own. Most houses thus built tend to be rather below standard and do not always meet architectural requirements.

Hereunder is a summary list of approximate wages in the construction industry. These vary according to the location and need.

Labour	Rates in Baht/day
Mason	90 - 180
Carpenter	80 - 150
Electrician	100 - 200
Plumber	100 - 200
Painter	70 - 200
Concrete worker	50 - 70

The following is a list of vocational training and higher technical education in Thailand.

Type of education	Persons/year
Vocational training	5,500
Higher technical education	1,200

There are about 2,550 registered architects classified broadly into categories in terms of grade; i.e. associate, junior and senior architect. Most architects are employed by the industry or Government agencies and have only part time private practice. There are about 30 full time architect firms in Bangkok. These are controlled by the Registered Professional Architect Committee and represented by the Association of Siamese Architects.

Labour

There are three groups of labour in Thailand.

1) Professional common labour group: It is cheap and readily available.
2) Occasional common labour group: It is also cheap but not readily available, depending on the time or season. Most of this group come from upcountry to do construction work as a second profession.
3) Skilled labour: It is expensive, highly demanded and not readily available.

A large proportion of the common labour group is female. Female labour costs about 40-60 Baht/day, while male labour costs 50-70 Baht/day. Women do all sorts of work on the construction site, with the exception of lifting very heavy loads. Common labour is generally temporarily picked-up or laid off according to work load. Speed and efficiency are not great. Common labour, under supervision will do carpentry, formwork, steel work, concrete mixing and pouring, masonry work, plastering, roofing, tile laying, land fill and painting. Supervision, however, must be close to ensure proper work.

Skilled labour such as carpenters, masons, electricians, plumbers, generally supervise a group of common labourers doing the work in their trade. As they are in high demand, they are generally permanent employees of the builders or sub-contractors. Skilled workers earn 100-200 Baht/day.

Supervision usually consists of one or two foremen, perhaps a part-time architect or engineer and the builder himself.

Engineers have organized the 'Engineering Institute of Thailand'. There are about 60 engineering consulting firms and over 23,500 registered civil, electrical, mechanical and soil engineers.

There are about 76 vocational schools and 37 technical colleges which are spread all over the country such as:

- Uthen Thawai School Building Construction;
- Bangkok Institute of Technical College;
- Monthaburi Institute of Technical College;
- Kon Khaen Institute of Technical College;
- Korach Institute of Technical College;
- Southern Institute of Technical college;
- Tark Institute of Technical College;
- Pranakornnua Institute of Technial college.

The graduates from these colleges are trained as technicians and foremen.

There are some institutions which are active in the field of quality control and standards such as the Applied Scientific Research Corporation of Thailand, the Thai Industrial Standards, the Engineering Institute of Thailand, etc.

KINGDOM OF TONGA: BUILDINGS AND CONSTRUCTION INDUSTRY

Introduction

The Kingdom of Tonga covers a vast ocean area of 259,000 square kilometers, see fig. 1 hereunder.

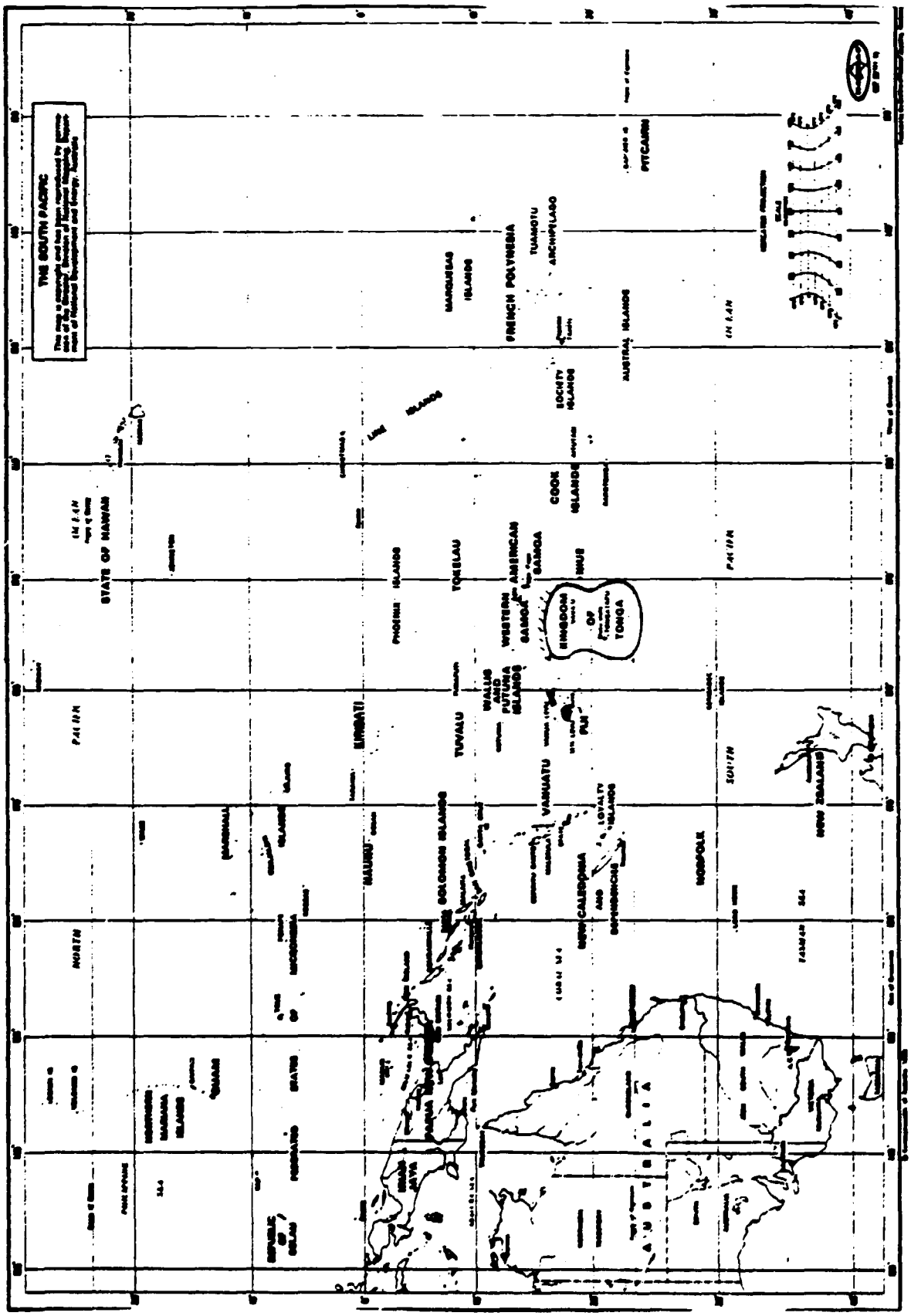

Fig. 1 Location of the Tonga Group

The total land area of the Kingdom is 750 km^2 comprising 169 islands of which only 36 are inhabited. In all, these islands are distributed generally over three larger island groups, the Tongatapu Group in the South, the Ha'apai Group in the centre and Vava'u in the North, see fig. 2 hereunder. Tongatapu is the largest island covering 256 km^2 and Nuku'alofa, the capital of Tonga is located on this island.

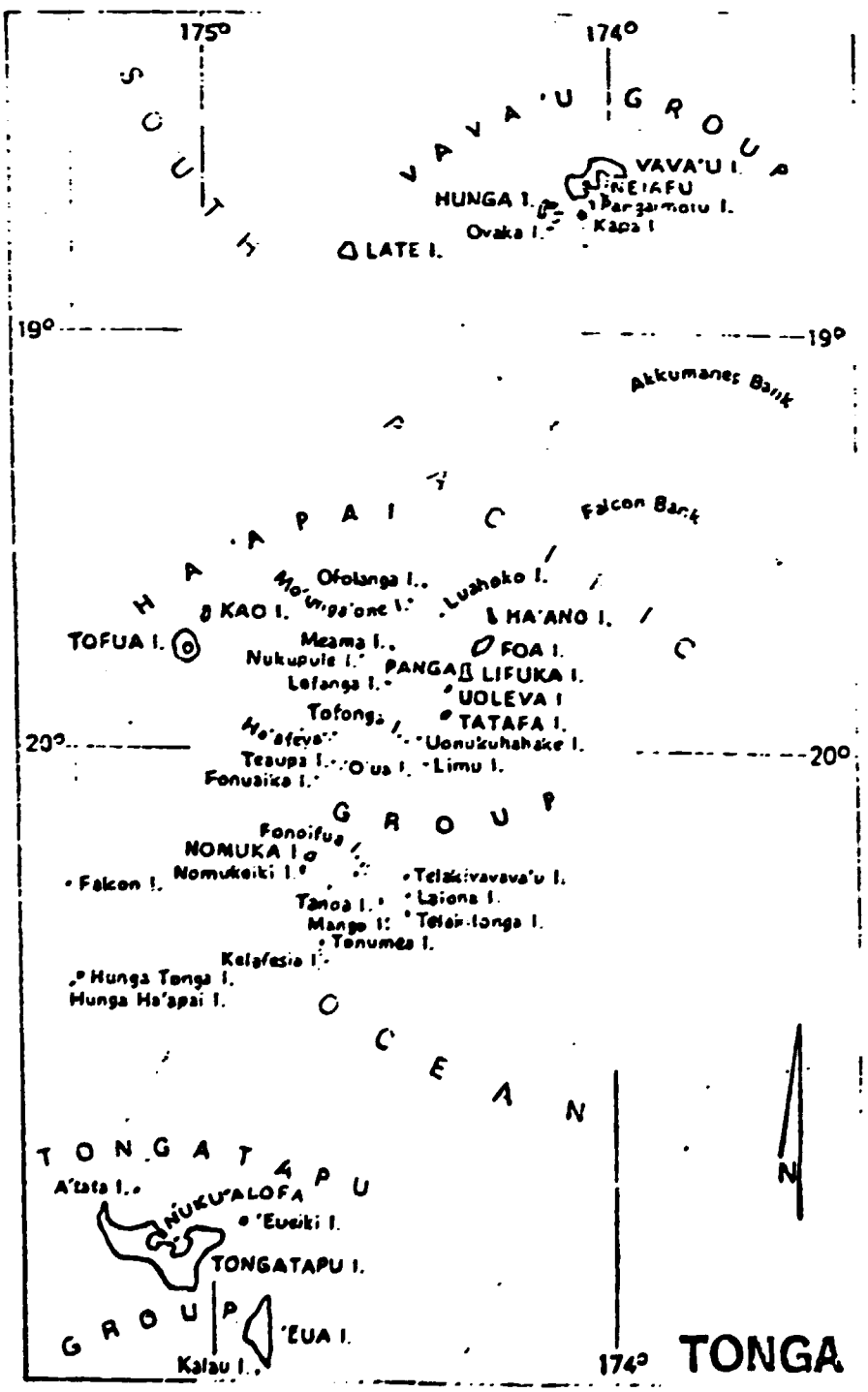

Fig. 2 Islands of the Tonga Group

There are two chains of islands: those to the west are volcanic and those to the east are coral islands.

The people of Tonga are Polynesian. According to the latest census in 1976, the total population was determined to be 90,085, with a population density of 138 persons per km^2. In 1980, the population was estimated to be 94,760. However, due to emigration to Australia, New Zealand and, increasingly, the United States of America, the annual increase in population was reduced to 2% in the pre-1976 census years.

Internal migration from the other islands to the main island of Tongatapu resulted in an eight-fold increase of the population on Tongatapu between 1891 and 1976. While the population of Tongatapu has been growing fast, the population of its capital town Nuku'alofa has been growing twice as fast. The magnitude of such inflow has put severe strains on land and housing.

Building demand

Present Situation

The building and construction industry in Tonga is growing and evolving, constantly seeking new and better materials for building and more efficient uses for old ones. The amount of construction materials used is constantly growing and a basic knowledge of the important ones is essential to designers and planners, estimators or those actually involved in the construction of a building.

Building and construction activities are carried out by Government departments, church organizations, contractors and private builders. In terms of volume, the main agency engaged in construction is the Ministry of Works. This Ministry has two divisions:

- The Building Division: for design and construction of Government housing and buildings;
- The Road Construction Division: for the construction, maintenance and extension of roads, airfields and wharves.

Five major private contractors exist and there are no international contractors represented on the islands currently.

Building materials

As per the 1976 census, the materials used in house construction are shown in table 1 hereunder. Table 2 shows some aspects of the regional differences in house standards.

Table 1 Materials used in house construction (1976 census)

Style	Number
European style - wood	6,316
- concrete block	2,129
Iron - roof, wooden walls, Tongan style	1,367
Thatched, Tongan style	2,708
Other mixed materials	1,493
Total	13,908

Table 2: Regional differences in materials used in house construction (1976)

Region	Iron Roof(%)	Wooden walls (%)
Nuku'alofa	90.4	72.6
Rural Tongatapu (excl. Nuku'alofa)	71.9	51.0
Vava'u	73.8	66.9
Ha'apai	63.8	52.6
'Eua	87.8	61.6
Niuas	29.7	16.9

Timbers

Timber is one of the only two building materials (the other is aggregate) available locally and is presently obtained from 'Eua and the senile coconut stems on Tongatapu. According to the 1976 survey of forest resources on 'Eua, it was estimated that there was 32,893 cubic meters of timber on 'Eua on an area of 644 hectares. The most common species were Tamanu (*Callophylum sp.*), Toi (*Alphitonia sp.*) and Tavahi (*Ivhs. sp.*). A sawmill on 'Eua is currently producing about 300,000 super feet per annum. Eighty hectares per annum of *Pinus caribaea* and *Eucalyptus species* are currently being replanted.

This survey indicates that there were 12,500 hectares of senile coconut palms in Tonga with an average of 150 stems/hectare. In 1976, a sawmill to process coconut timber was established. It currently processes about 300,000 super feet of timber per annum. Both the native hardwoods and the coconut timber are preservative treated.

The Foreign Trade Report of 1981 shows figures of the timber imported in Tonga. The timber species are Pinus radiata from New Zealand, Douglas fir from Oregon and others from Australia, Fiji and Western Samoa. In 1981, a volume of 6.887 cubic metres of dressed timber was imported. The import percentages from New Zealand and USA are greater. Timber is mainly used in housing. However, in the years 1975-1977, the trend has been to substitute the use of timber. This was due to the substantial increase in the price of timber while the cost of cement remained relatively stable. Therefore, Tongan builders were forced to substitute concrete blocks for timber framing and cladding.

Currently, the average cost per square metre of timber in building and construction is T$440/$m^2$.

Concrete

Cement is not produced locally, and all cement concrete construction depends on import production. The main supply sources are Australia and New Zealand. In 1982, about 9,600 tons of cement was imported. This includes cement from China (Taiwan). This cement is cheap but the shipment problem still has to be solved.

Coarse aggregate for concrete is obtained by blasting or ripping coralline limestone which is then crushed to the appropriate size. A large number of coralstone quarries are operated on the island by the Ministry of Works. Some sand is taken from the beaches, but as this source is practically depleted, quarry or crusher dust being the by-product of crushed coral, is being used as fine aggregate for concrete. Concrete block is the most commonly produced item. In 1979, an excess of half a million units were produced. Concrete products are made by the Ministry of Works, the Tonga Construction Company, Jones Industries Ltd., and the Construction Division of Warner Pacific. Pre-casting is not very common in Tonga.

Currently, the average cost per square meter of R.C. concrete, including masonry blocks buildings is T$430/$m^2$.

A very strict quality control of concrete is required because of the poor quality of the aggregates in Tonga.

Steel

Structural and reinforced steel are imported, mainly from New Zealand.

In construction, they are used in wharves as sheet piling and reinforced concrete structure. Several commercial buildings use steel frames but in general steel framed buildings are not very common. Construction costs are understood to be cheap. Unfortunately, there is a lack of skilled labour in this field.

Currently the average cost for a steel framed building is T$290/$m^2$.

Roofing, fastening and finishing materials

All these items are imported. The main supplying countries are New Zealand, Australia and Fiji.

Galvanized iron is rolled into roofing sheets by both the Tonga Construction Company and Jones Industries Ltd. This latter company also produces nails, fencing and barbed wire and imports white paint in bulk and tints it in Tonga.

Construction

Housing and buildings

The Tongan traditional house uses bush timber or split coconut stems for the framing, and woven coconut leaves or woven pandanus leaves for the thatch roofing.

The transition from traditional building materials to conventional materials began by replacing the thatch roof with corrugated iron. Sawn timber, wall cladding and louvre windows then followed, but many houses are still being built using conventional materials in the traditional style (i.e. with rounded ends).

Tonga is within a hurricane and earthquake zone, but there are no building regulations or standards. Designers in Tonga would consult overseas standards, for example the New Zealand Code of Practice (for earthquake designs) or the Australian standards (for wind resistant structures).

The main financing source for house construction is the Bank of Tonga. Many Tongan families overseas also become sources of finance to their relatives in Tonga.

The current housing cost for a modest three bedroom western style house ranges from $10,000 to $20,000. However, most conventional style houses are beyond the financial capacity of the average income earner. An unskilled labourer earns an average of $60 per month.

The volume of building and construction expenditure amounts to almost T$8 million in 1979/1980, as follows:

- Government sector	T$ 3,596,000
- Quasi-government	421,000
- Private	3,768,000
Total for Tonga	T$ 7,785,000

Construction expenditures in aggregate terms of real growth rose 84.9% over the Third Development Plan Period (1975-1980). The Fourth Five Year Development Plan(1980-1985) estimates the total value of construction to be carried out in the five year period to be T$60 million (final draft).

Labour

According to the 1976 census, about 24% of the total population (90,000) is in the labour force. The majority of these people would be employed by the Ministry of Works and the Tonga Construction Company. Current estimates of building programmes for the Fourth Five Year Development Plan (1980-1985) indicate that the demands for construction works will increase .

In 1978, an apprenticeship scheme was established in the Ministry of Works. This scheme includes carpentry, joinery and mechanics. The carpentry and joinery programme lasts four years and the apprentices receive their training on the job, but recently classroom instruction was introduced. The Tonga Defence Forces operate a trade school and two Government high schools in Tongatapu, and these have industrial art classes.

Students for higher technical training are sent to New Zealand, Australia, Fiji, Papua New Guinea, the Solomon Islands or India. The University of the South Pacific Tonga Centre runs an extension course in carpentry.

Conclusions

In recent years considerable investigations on the resources in Tonga have been carried out by overseas specialists sponsored by organizations such as the United Nations and the European Economic Community. These studies include manpower surveys, reviews of housing options and resources of materials for construction in general.

In the light of these studies several conclusions can be drawn:

(a) For the next two to five years, a steady growth in the Tongan construction industry is envisaged.

(b) There will be a great demand for skilled tradesmen.

(c) The utilization of timber, especially locally available (e.g. coconut timber), is to be encouraged in building pratices. Current masonry construction shows evidence of not being adequate for an earthquake prone area. Timber construction is by far the more suitable to Tonga's climate rather than concrete block housing.

(d) There is a need for building regulations specifications (standards) to control the material specification and improve construction methods.

However, there are other regulations or building codes available (e.g. NZA, SAA, ACI) but they need to be adapted to Tongan conditions.

Housing in the rural Tongatapu and Central island group is the poorest in the sense that less durable materials are used in construction.

These are the areas that are greatly affected by the hurricanes.

The current method of loan from the Bank of Tonga has enabled some of these people to afford a house at a low cost.

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ZIMBABWE: CURRENT STATUS OF BUILDING AND CONSTRUCTION INDUSTRY

Introduction

Zimbabwe is the southernmost country of inter-tropical Africa with an area of 390,000 square kilometers and a population exceeding 7 million. The Gross Domestic Product (GDP) is expected to exceed Z$3000 million in 1983 and the building and construction industry normally absorbs 10% of the GDP (Z$300 million).

By the year 2000 the construction industry is likely to reach an output of Z$710 million at current prices. Some 60,000 people are presently employed in the construction industry but there have been indications that productivity has been declining since 1970.

Output is currently split (72%) in the public sector output and (28%) for the private sector. The establishment of building brigades is likely to further moderate this division of output.

The following categories of building and construction are common, residential, commercial, institutional and Government building, road, highway and airport construction, dams and irrigation, energy and power construction, railway telephone and telegraph facilities, oil and gas installations and other minor constructions.

Building Materials

Timber

Zimbabwe has no indigeneous conifers and it is a remarkable achievement that the country now possesses commercial plantations valued at more than Z$60 million at cost comprising approximately 100,000 hectares of

Pinus patula, *Pinus taeda*, *Pinus elliottii*	65%
Eucalyptus grandis	16%
Wattle	16%
Other	5%

The plantations are situated mainly in the fertile Eastern Highlands north and south of Mutare. Nearly 40% of the plantations will reach maturity within the next five years.

The consumption of round wood by the primary processing industries is some 600,000m^3 with 67% processed in Manicaland and 18% in Matabeleland and the remainder in Mashonaland and the Midlands.

The intake of indigenous hardwood timber is approximately 80,000m^3 and is mainly teak, mukwa, iroko, makore, sapele and gum. Restriction of foreign currency has greatly reduced the importation of American oak, jellutong, meranti and teak in recent years.

Volumes of sawn timber produced are approximately:

160,000 m^3	of structural sleepers and other uses
15,000 m^3	of treated wooden poles
6,000 m^3	of veneer
5,000 m^3	of plywood
12,000 m^3	of blockboard, etc.
15,000 m^3	of particle board and chipboard
25,000 tons	of wood pulp

The expected return in round softwood varies between 14-20m^3 per hectare per year.

The output of structural grade pine is thought to be:

Grade 4	20,000 m^3
Grade 6	15,000 m^3 (speculative)
Grade 8	10,000 m^3 machine graded
Grade 10	5,000 m^3
	50,000 m^3 per year.

The demand for roof trusses battens, purlins and bracing is estimated at 12-15,000m^3 per year, and with the lack of application the structural market is presently oversupplied.

Stocklam (fingerjointed glued laminated boards) is produced in 38 and 50mm structural sizes to 76, 114, 152, and 228 dimensions. Current production is 18-20,000m per year.

Provided careful attention is paid to design details, moisture content, dimensional stability, preservative treatment and finish there does not appear to be any major problem concerning the performance and durability of structural timber.

Few structural engin have more than a superficial understanding of the use of structural timber. Successful design is constrained by standard cross section dimensions and fixed intervals of length in which solid timber is supplied. Methods of jointing individual members are as vital to efficient design in timber as in any other structural material.

Since timber is a variable, hygroscopic, anisotropic and visco-elastic natural material, the penalities to be paid for badly designed joints are also heavier.

The data available on structural timber in Zimbabwe is chronically weak particularly in areas of technical liaison between designer fabricator/builder and Government.

The technical factors inhibiting the optimum use of structural timber could broadly be enumerated as:

i previous over-reliance on external CSIR[1/] resources;

ii the lack of expensive specialized timber testing equipment and resources to quantify mechanical strength properties, grade distribution and structural performance of building components;

iii the absence of some form of industrial research institute or forum to focus professional interest on technical developments in structural timber; to rationalize supply and demand; to coordinate the establishment and verification of quality control within the industry/building sector;

iv the limited resources available for technical education, industrial seminars and liaison with state-of-the-art applications overseas;

v the uniqueness or peculiarities of timber available in Zimbabwe.

In Zimbabwe, concern is continually being expressed over the quality of the following materials and products:

Manufactured quality	Effective Utilization	Long term Performance
Bricks	Waterproofing (asphalt)	Weathertightness
Door furniture	IBR steel roofing	Roofing (AC)
Roofing sheets (AC)	Cement (PBFC)	Adhesives (Epoxy)
Electric light fittings	Cement (PC15)	Sanitary ware (plastics)

1/ Council for Scientific and Industrial Research (South Africa)

Construction

The construction industry is characterized mainly by the fact that approximately 75% of construction activity relates specifically to the building process. There is a fairly constant correlation between investment in building and construction, gross fixed capital formation and gross domestic product although the demand for buildings is directly related to economic growth, population growth, urbanization and developments in science and technology.

Cyclic instability within the construction industry is concerned with the irregular upswings and downswings in the level of activity. This complex phenomenon is the result of a multitude of economic processes in the business trend. From the measurements of deviation from the growth path of various output sectors making up the construction industry, it is concluded that building for the private sector assisted in many respects by civil engineering work for the public sector contribute most to instability or cyclical movement in the last decade.

In spite of major studies of management in the building industry and developments in organizational theory, the performance of long established procedures, general organization and contracting techniques, are less than satisfactory.

Concrete and steel in construction industry

The following production statistics are available at current prices.

Sand, stone gravel, etc. Z$16 million per annum;
Cement and lime Z$23 million per annum;
Concrete and asbestos products Z$11 million per annum;
Bricks and clay products Z$12 million per annum;
Bituminous products Z$7 million per annum;
Glass Z$3 million per annum;
Paint and varnishes Z$5 million per annum;
Plastics, tiles, sheets, papers Z$5 million per annum;
Iron and steel, Z$6 million per annum;
Metal manufacturers Z$49 million per annum;
Electrical equipment Z$30 million per annum.

The utilization of concrete and steel in the construction industry in Zimbabwe follows that in most other developed countries. Apart from problems of replacement of outdated capital equipment the industry is well served by industrial research and service agencies such as Portland Cement and Structural Steel Institute.

The following problem areas are pertinent. While design errors are found to account for more than 50% of cases of failure, faulty execution of work accounts for 35% and the prime reason for failure during construction stage appears to be lack of supervision, allocation of responsibility, with technical communications a contributing factor.

The building industry must inevitably become much more sophisticated and increasingly professional in meeting the building requirements of society. It must achieve this goal, in the realisation that the informed and knowledgeable client will be monitoring progress and will show little hesitation in resorting to legal redress at the first sign of incompetence.

An appropriate technology is required for local building, design methods and finishes, in Zimbabwe. The importance of what to build is understandable, but it is clear that expensive lessons on how to build are not being assimilated nor learned throughout the industry and professions, not only in this country, but in many countries overseas.

The knowledge system for the building process is very weak in many respects. There are serious limitations in understanding the building as a whole as well as the conditions affecting the performance of its various parts, and how these in turn are influenced by the various design calculations. The knowledge system serving the designer is not only a major one, but also one which has been most in need of improvement.

Labour

Zimbabwe has an abundant supply and projects are generally labour intensive rather than capital intensive.

The commercial labour force is distributed as follows:

Agriculture and forestry	350,000
Mining and Quarrying	60,000
Manufacturing	132,000
Construction	60,000

Vocational training prospects in Zimbabwe are improving rapidly and National Technical Certificates available at the Polytechnic Colleges in Harare and Bulawayo. Other technical institutions are being developed in the Midlands and in Manicaland. Students can sit City and Guilds examinations (UK) during their apprenticeship or eventually proceed to the National Technical Diploma in engineering subjects which can be accepted as entrance qualifications to the faculty of Engineering at the University of Zimbabwe.

Industrial Infrastructure

Few African countries have assumed independence with the same potential for development as Zimbabwe with a reasonably sophisticated economy and infrastructure supported with natural resources and a tradition of professional and technical skills.

Development programmes have placed great strain on existing training institutions where existing facilities and teaching equipment are unable to cope with the aspirations and the growing number of school leavers. While requirements are known, lack of expert personnel and foreign currency allocations greatly hinder this vital training sector of the economy.

Quality control and standards are maintained by an active Central African Standards Association with headquarters in Harare and representatives throughout the country.

There are few industrial research agencies other than Forest Research Centre (Forestry Commission), Agricultural Research and Specialist Services, Medical Research Council and Mining Research Institute. Traditionally, Zimbabwe has placed reliance on the Council for Scientific and Industrial Research (SCIR) in South Africa for most research projects and is currently considering the development of a similar facility in this country.