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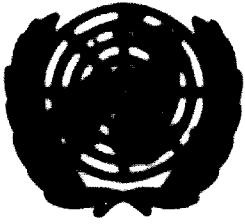
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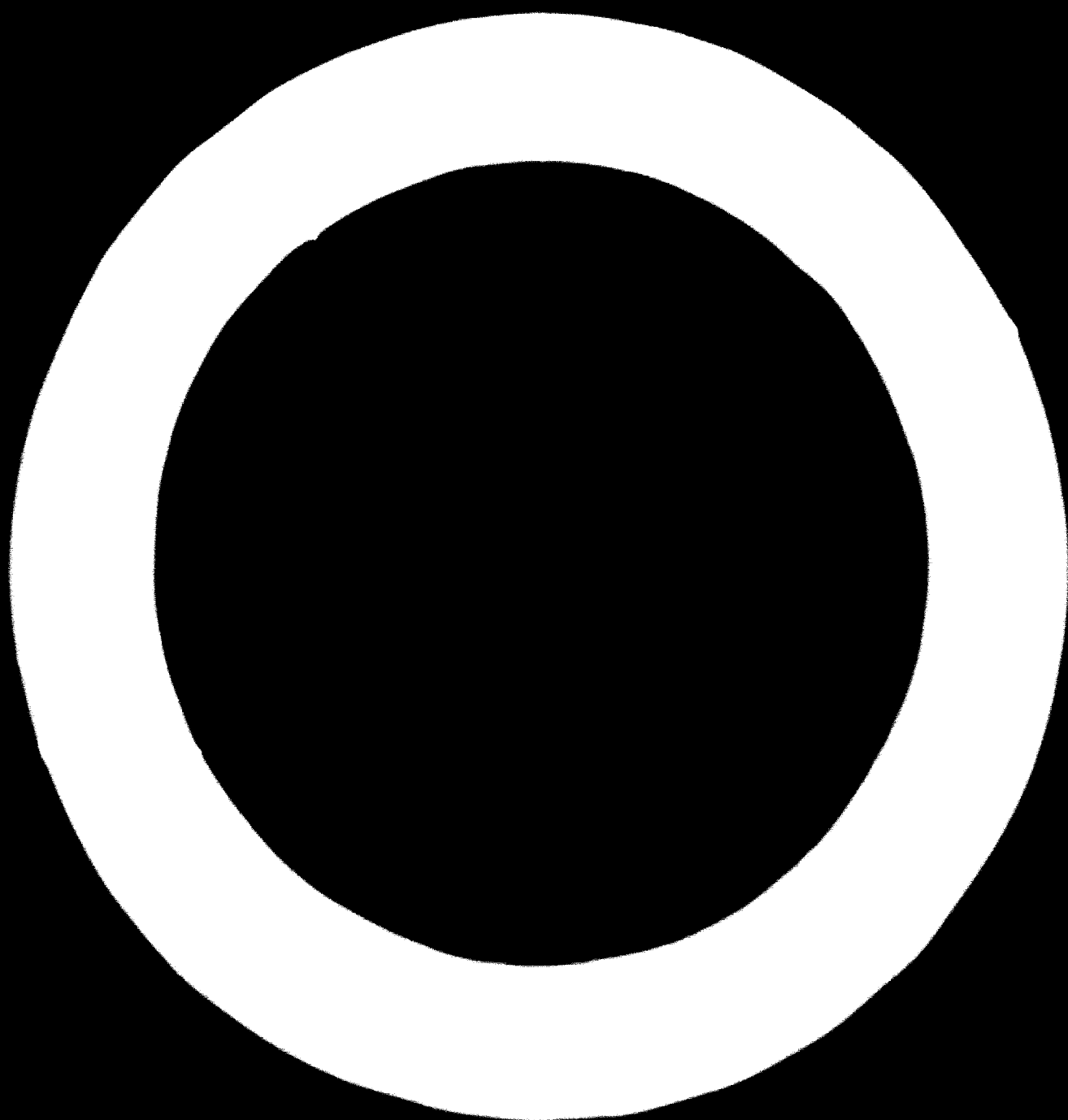
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**The Workshop on Organisational and Technical Measures  
for the Development of Building Materials  
Moscow, 25 September - 19 October 1968**

**BUILDING MATERIALS INDUSTRIES. INCLUDING WOOD PRODUCTS**

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.





1967  
1968  
1969

United Nations Industrial Development Organization

1967-1968

**INTERNATIONAL CONFERENCE ON INDUSTRIAL DEVELOPMENT**  
Addis, 29 November-20 December 1967  
Provisional agenda, Item 1

**GENERAL ASPECTS PERTAINING TO THE DEVELOPMENT OF  
SMALL AND MEDIUM ENTERPRISES, INCLUDING THE PROBLEMS**  
Presented by the secretariat of the Technical Commission for Europe

This paper was prepared on the basis of studies by a group of consultants. A related national study, "Construction in Morocco", prepared by the United Nations Centre for Housing, Building and Planning, is presented to the Symposium as II/CONF.1/25.

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### **Introduction**

1. There is not yet a generally accepted definition of the "building materials and components industries". This is understandable since there are so many industries producing materials and components required in the production, maintenance and modernization of buildings and other construction works. Moreover, some of these industries also manufacture products for purposes other than construction. This is particularly true in regard to some of the most important suppliers of building materials and components, namely, the iron and steel industries and the wood and wood-based industries.<sup>1/</sup>

2. It should also be noted that a considerable share of the material inputs required by the construction industry is still supplied in a semi-processed or simply-shaped state and that, for this reason, some branches of the building materials and components sector are not yet recognized as "industries". There are, unfortunately, only a few branches of the sector that so far have been sufficiently advanced industrially to receive attention in industrial development plans. Examples of such industries are those producing cement, constructional steel, ceramics and some types of concrete product. Strategy in the industrial development of the building materials and components sector cannot, however, be based solely on considerations regarding these "key" building materials and components industries.

3. It is worthwhile to stress that the development of the building materials and components industries is closely connected with - not to say, tied to - the development of the construction industry. The aim of both sectors is to provide society with the infra-structure and other facilities needed for the well-being of the people.

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<sup>1/</sup> Since the development of the industries mentioned, as well as of some other producers of construction input (non-ferrous metals, engineering products, chemicals), is the subject of separate reports prepared for the Symposium, this is not dealt with in detail in this paper.

As a matter of fact, the production of building materials and components on the one hand, and their processing and assembly on the building site, on the other, may be conceived as two stages of a single production process. Hence, the building materials and components sector cannot exist and develop independently of the construction sector, and vice versa. The indivisibility of the two sectors is well illustrated by the fact that one of the basic features of technical development in building production is the steady transfer of operations from building and construction sites to factories, i.e. from the construction industry (as defined in statistical terms) to the building materials and components industries.

4. For the reasons mentioned, it is difficult to discuss the development of the building materials and components sector without making certain basic assumptions regarding the future need or demand for buildings and civil engineering works, as well as the future technical development of the construction industry. A viable international, regional or national building policy must comprise considerations regarding the building and construction process as a whole, i.e. its input aspects as well as its output aspects. Serious mistakes and false conclusions may be arrived at if this fundamental fact is overlooked. Thus, although it would have been desirable to deal with the development of the building and construction process, as a whole, the present paper focuses attention on the building materials and components sector - i.e. the input side of the process. This paper refers to the construction industry only insofar as it is required for discussion or understanding of the conclusions drawn and the recommendations proposed.<sup>2/</sup>

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<sup>2/</sup> The role and desirable development of the construction industry within the framework of economic and industrial development are dealt with separately in a paper prepared for the Symposium by the United Nations Centre for Housing, Building and Planning (document ID/CONF.1/24).



5. At the more primitive stages of economic development, which are characterised by a comparatively limited, simple and highly scattered building demand and by the lack of or insufficient transport facilities, the building materials and components required must necessarily be found locally and delivered to the building site in a crude or simply-processed state. Most of the materials used are cheap, and the labour required is usually provided through self-help or co-operative efforts.

6. The process of industrial, economic and social development, which is characterised by a gradual concentration of the population in urban areas and rising incomes, creates a completely new situation with regard to building production, living conditions and standards in general. The building materials and construction industries are faced, at this stage of economic development, with a demand for sophisticated and elaborate civil engineering works and industrial buildings, combined with demands for more and better housing, schools, office buildings, hospitals etc. These requirements - since they are indispensable and rapidly increasing - are difficult or impossible to meet by using the building methods, materials, labour and managerial skills traditionally employed in construction. A serious mistake is made by neglecting this mounting building crisis or by seeking a temporary, expedient way out of it, through extensive imports of building materials and components and through the insufficiently considered application of building methods and materials used in the more industrially advanced countries. A high price is paid for this short-run approach to economic development. In the case of some African countries, for example, it has been estimated that up to 12 or 13 per cent of their foreign currency is currently being spent on imports of building materials. ✓

7. The lack of determined and continuing efforts towards rationalising the production of building materials and components is causing serious problems and suffering all over the world, a fact which is hard for the people to understand and for Governments to accept. Thus, it is high time for the building

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✓ Ref. No. 1: (Part II, chapter A, paragraph 2). (References and background documentation are listed in annex I of the present paper.

materials and components sector to be given the priority it deserves in economic development planning. Because of the major importance of a rapid, forward-looking, co-ordinated and well-organised industrialisation of the building materials and construction sector; of the complexity of the problems to be solved; of the many vested interests involved; and of the great effect that government policy and international aid may have in this field, Governments and inter-governmental organisations must assume a major responsibility to ensure that all possible measures are taken to improve the present situation.

I. RECENT DEVELOPMENTS IN THE CONSUMPTION AND PRODUCTION  
OF BUILDING MATERIALS AND COMPONENTS

A. The importance of the building materials and components sector

8. The diversity and complexity of the building materials and components sector make it difficult to obtain a clear picture of the sector's importance and development on the basis of production figures from the various branches delivering construction inputs. Furthermore, statistical data of this kind are non-existent for major branches of the building materials and components sector. A rough estimate of the over-all importance of this sector may, however, be obtained indirectly from available data on construction activities, provided that certain assumptions are made regarding the share of expenditures on building materials and components in total construction costs.

9. The role and importance of construction activities in national economies have been the subject of considerable attention in a number of reports, some of which have been published by the United Nations.<sup>5/</sup> Although international agreement has been reached on a definition of the construction industry<sup>6/</sup> and although statistical data concerning its importance and development in national economies are annually published by the United Nations<sup>7/</sup>, there are serious weaknesses in the information available, in respect to both reliability and comparability.<sup>8/</sup> First, it is indeed a difficult task to draw a borderline between the construction industry and other industrial sectors (the building components industries, in particular). Second, a considerable amount of building maintenance and modernisation - and sometimes also new construction work - is carried out by a wide range of other industries as ancillary activities, and by individuals, and this activity often is not recorded under

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<sup>5/</sup> ibid. (Part II); Ref. No. 2; and Ref. No. 3 (Part III).

<sup>6/</sup> ibid.

<sup>7/</sup> ibid.

<sup>8/</sup> ibid. (Chapter 2).

the item "construction" in statistical accounts. Third, particularly in the case of the less developed countries, a large amount of construction activity is carried out through self-help or co-operative efforts in the non-monetary sector of the economies; thus, it is not always properly taken into consideration in statistical data on construction activities.<sup>9/</sup> For all these reasons, it is fair to assume that a considerable share of construction activities in countries at all levels of economic development escapes the notice of national statistical offices, and that the figures available in most cases should be regarded as underestimates.

10. In view of the above considerations, it is a striking fact that (according to published statistics), virtually all countries spend between 5 and 15 per cent of their gross national product (GNP) - corresponding to more than half of their investment resources - on the construction of new buildings, civil engineering and public works (see annex II). Closer examination of available statistical information seems to indicate that the share of GNP devoted to investments of all kinds, as well as the share devoted to investments in new construction works, increases considerably with economic development, while the share of total investments used for construction purposes remains almost constant. If the countries for which relevant information is available are divided into three groups according to their per capita gross domestic product (GDP) (group I: less than \$200; group II: \$200 to \$500; and group III: \$500 to \$1000 <sup>10/</sup>, it will be seen that the simple average of total investments increases from around 14 per cent of GNP in the first group of countries to around 18 per cent of GNP in the second group and to nearly 25 per cent of GNP in the third group. The share of total investments devoted to new construction works, on the other hand, remains almost constant at between 54 and 58 per cent. The net result is that the average share of GNP spent on investments in new construction works increases from around 8 per cent for the first group to about 10 per cent for the second group and to more than 13 per cent for the third group (see table 1, columns 1-4 below).

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<sup>9/</sup> See, e.g. Ref. No. 1, (part II, chapter I, paragraph 14).

<sup>10/</sup> The analysis is confined to countries whose GDP does not exceed \$1000 per capita, since the situation in these countries seems to be most relevant to the problems facing developing countries; see Ref. No. 1, (part II, chapter A, paragraph 7).

Table 1

Total investments, investments in new construction works, estimated expenditures on maintenance and modernization of existing construction works and total expenditures on construction activities, in groups of countries at different stages of economic development (1960-1963)

Country group	GDP in 1963; US \$	Total investments; % of GNP	Investments in new construction works; % of total inv.	Investments in new construction works; % of GNP	Estimated expenditures on maintenance and modernization; % of GNP	Total expenditures on construction activities; % of GNP
	(1)	(2)	(3)	(4)	(5)	(6)
<u>Group I</u> Up to US \$200 GDP per capita	127	14.3	55.2	7.9	0.2	8.1
<u>Group II</u> US \$200 - 500 GDP per capita	315	17.9	58.2	9.9	1.4	11.3
<u>Group III</u> US \$500 - 1000 GDP per capita	825	24.7	54.4	13.4	4.0	17.4

Source: Annexes II and III.

11. To the national resources spent on investments in new construction works should be added the expenditure on maintenance and modernisation of the already existing stock of construction works. In the industrialised countries, maintenance and modernisation activities may be - or should be - of a magnitude comparable to those devoted to new construction.<sup>11/</sup> Although it is a well-known

<sup>11/</sup> Ref. No. 6, (chapter VI, section 1).

fact that fulfilment of the needs for building maintenance and modernization - for various reasons and for long periods of time - in many countries has been postponed or neglected, it has nevertheless been estimated that annual expenditures in this field (in industrialized European countries) correspond to between one-third and one-half of current expenditures on new construction works.<sup>12/</sup> Based on this information and a Secretariat estimate of the corresponding probable expenditure on maintenance and modernization activities in developing countries (see annex III), a calculation of total expenditure on construction activities has been made for the three groups of countries referred to above (table 1, columns 4 and 5). The results show that in countries at an early stage of economic development, an average of 8 per cent of total national resources may be estimated to go to construction activities. This average increases to about 11 per cent for the second group of countries and reaches more than 17 per cent for the third group. It is thus obvious that the production, maintenance and modernization of buildings and other construction works constitute one of the most important driving forces in the national economy. It is further clear that resources spent on construction activities carried out in the monetary sector of the economy (to which the figures generally refer) have a tendency to grow - and must grow - far more quickly than the economy as a whole.<sup>13/</sup>

12. The role and importance of the building materials and components sector are determined by the share of the total national expenditure on construction activities spent on the purchase of building materials and components. The size of this share, in turn, depends on the nature of the end-products (and thus on the composition of total construction output in terms of housing of various standards, non-residential buildings, civil engineering works etc.) and on the relationship between the cost of building materials and components (including transport), on the one hand, and the costs of other construction inputs (site, labour, administration, management etc.), on the other. This relationship, in turn, is determined by the nature of the products, the construction techniques used, and the stage of economic development. An accurate picture of the

<sup>12/</sup> Ref. Nos. 6 and 7.

<sup>13/</sup> For further information, see Ref. No. 2 (chapter I).

of the importance of the building materials and components sector cannot, therefore, be obtained for a specific country or region unless detailed studies are made of the composition of the actual construction output, as well as all other relevant factors. In annex III, however, an attempt has been made to show by example, the interrelationship between the various factors determining the role of the building materials and components sector (including transport), at different stages of economic development. Taking into account the composition of new construction in countries at different stages of economic development (based on available statistics) and a Secretariat estimate of the share of the total construction costs spent on the purchase of building materials and components in various types of construction and at various stages of economic development, it is estimated that the average contribution by the building materials and components sector (including the costs of transport to the building sites) may account for between 58 and 63 per cent of total construction costs in new construction in countries at different stages of economic development (see table 2, column 2 below). Based on even rougher Secretariat estimates, the corresponding figures for maintenance and modernization works may be assumed to vary between 40 and 43 per cent (table 2, column 5). If these figures are combined with the data on investments in new construction and estimated expenditures on maintenance and modernization work, an over-all estimate may be made of total expenditures on building materials and components (on site, i.e. including transport) as a percentage of GNP (table 2, column 7). As may be seen, the share of GNP contributed by the building materials and components sector, including transport, increases rapidly with economic development, from around 5 per cent for the first group of countries to about 7 per cent for the second group and to nearly 13 per cent of GNP for the most advanced countries reviewed.

13. In table 3, the conclusions drawn in the previous paragraph have been combined with the data on average per capita GDP so as to provide some idea of the increasing importance of expenditure on building materials and components as countries move up the scale of economic development. The table shows that the annual per capita expenditure on building materials and components,

including their transport to the building sites, may be estimated at about US \$6.00 in countries at an early stage of development (average ~~per capita~~ GDP: US \$127), while in the next group of countries (average ~~per capita~~ GDP: US \$245) the corresponding annual ~~per capita~~ expenditure may be estimated at about \$23. In the third group of countries, with an average GDP of \$625, no less than US \$104 may be estimated as used for the purchase and transport of building materials and components. Expressed in index form, this means that while the relationship between the country groups in terms of GDP ~~per capita~~ is 1.0 to 2.4 to 6.5, the corresponding relationship in terms of expenditure on building materials and components is 1.0 to 3.8 to 17.3 (table 3, columns 4 and 5). Although based on rather uncertain data from a somewhat arbitrarily selected group of countries representing widely different external conditions, it still seems reasonable to conclude that on-site expenditure on building materials and components increases about three times as fast as the GDP ~~per capita~~. Bearing in mind the inaccuracy of the figures of construction activity on the basis of which these conclusions are drawn, it is likely that the estimated increasing importance of expenditures in this field are underestimated rather than the opposite.

**B. Recent developments and present situation regarding the production of certain key building materials and components**

14. Building materials and components - particularly those needed or demanded at the earlier stages of economic development - are generally heavy, bulky and cheap; for this reason they cannot be economically transported over long distances. Although difficult to prove in statistical terms, it is thus likely that the predominant share of on-site expenditure on building materials and components is used for the extraction, processing and transport of those that are locally available or domestically produced. As will be pointed out later in this paper, government measures affecting these more "primitive" branches of the building materials sector might have a greater effect on building productivity and capacity than would the setting up of highly sophisticated plants for the production of certain key building materials. The present



Table 1

Estimated share of expenditures on new construction works,  
 on maintenance and modernization of existing construction works and  
 on construction activities spent on the purchase of building  
 materials and components in groups of countries at different stages  
 of economic development (1963-1965)

Country group	New construction			Maintenance and Modernization			Total estimated expenditures on building materials and components \$ of GNP
	Investments, \$ of GNP	Share of investments spent on building materials and components, %	Expenditures on building materials and components, \$ of GNP	Estimated expenditures on maintenance and modernization, \$ of GNP	Estimated share of (4) spent on the purchase of building materials and components	Estimated expenditures on the purchase of building materials and components, \$ of GNP	
	(1)	(2)	(3) (1) x (2)	(4)	(5)	(6) (4) x (5)	(7) (3) + (6)
Group I 500 GNP per capita	7.9	60	4.7	0.2	40	0.1	4.8
Group II 300 GNP per capita	11.5	50	6.6	1.4	45	0.6	7.2
Group III 100 GNP per capita	17.6	65	11.0	4.0	41	1.7	12.7

Source: Tables I and Annex III.

Table 3

Estimated per capita expenditures on building materials  
and components in groups of countries at different  
stages of economic development

Country group	GDP per capita US \$ (1963)	Estimated expenditure on building materials and components % of GNP	Approximate per capita expenditure on building materials and components; US \$	Index growth of	
				GDP per capita	Consumption of building materials and components
	(1)	(2)	(3)	(4)	(5)
<u>Group I</u> Up to US \$200 GDP per capita	127	4.8	6	1.0	1.0
<u>Group II</u> US \$200- 500 GDP per capita	315	7.2	23	2.4	3.8
<u>Group III</u> US \$500- 1000 GDP per capita	825	12.7	104	6.5	17.3
<u>Sources:</u> Tables 1 and 2					

review, however, is restricted to a few key materials which are indispensable in all countries and for which the value/weight ratio is high enough to make world trade worth-while. The situation regarding the provision of these materials is especially important because they account for a sizable share of the import expenditure of developing countries. The progress towards replacement of these imports by domestic production, and its general implications for the economy in general and for the development of the building sector in particular, should be a policy matter of great concern to Governments throughout the world.

Africa<sup>14/</sup>

15. In Africa, the consumption of cement has remained almost constant in the last decade, at a rate of about 40 to 45 kg. per capita. The average rate of increase in consumption between 1952 and 1962 was only 0.8 per cent. Less than half of the countries have cement factories, most of which are located in eastern and northern Africa. Although the total present installed capacity is more than adequate to cover the aggregate consumption of the continent, Africa continues to import substantial quantities of cement from non-African countries. Very few of the installed plants operate at full capacity: it has been estimated that in 1961, production represented only 70 per cent of installed capacity. This problem is caused mainly by the lack of transport facilities and the resulting limitations of trade between the various African countries. However, nearly all of the countries appear to have cement-based industries, producing a range of concrete products which are increasingly used in place of the more traditional and indigenous building materials.

16. A few African countries have integrated iron and steel plants. But as recently as 1965, the annual production outside South Africa was only 120,000 tons, which represented less than 0.1 per cent of the total world output.<sup>15/</sup> About eighteen countries are reported to have plants which produce a range of iron and steel building components based on imported semi-products and local scrap iron. In 1964, about fifteen countries had small re-rolling plants which produce steel bars, rods, wires, nails etc. Nevertheless, the Continent (excluding South Africa) is almost completely dependent on imports for iron and steel products.

<sup>14/</sup> Ref. No. 1 (parts I and II).  
<sup>15/</sup> Ref. No. 10 (table 1).

17. The African Continent has vast resources of wood, especially in the western and central parts, but many countries have not yet decided on national policies concerning the development, economic utilization and preservation of these resources. The urgent need for hard currency has led in some cases, to the depletion of rare species of hardwood. Although there are numerous sawmills, 30 to 40 per cent of total consumption of sawn wood is still covered by imports. Production of plywood and veneers covered total needs. To sum up, while the west, central and east African countries were either self-sufficient in wood products or had a surplus for export, the northern and southern African regions, which were the main consumers, relied on substantial imports.

18. The general pattern of imports of building materials in the various African regions is illustrated in table 4. As shown, iron and steel products account for the largest share of total imports of building materials and components, representing nearly 60 per cent of the import value.

Table 4  
Percentage composition of the total value of  
imports of building materials, by region and commodity

Region	Value of imports 1000 US \$	% Total value of imports	Percentage breakdown by commodity					Total
			Cement %	Sawnwood veneers and plywood %	Iron and steel products %	Ceramics, glass and other non- metallic products %	Paints and varnishes %	
North Africa	227579	42	4	23	58	13	2	100
West Africa	154506	29	23	2	61	8	6	100
Central Africa	30412	6	13	2	61	20	4	100
East Africa	89128	17	7	9	63	15	6	100
South Africa	31650	6	-	35	52	13	-	100
Total and average %	533722	100	10	15	59	12	4	

Source: Table I, Economic Commission for Africa (document HOU/WP/4) Jan. 1964, Building Materials Industry in Africa, Present Structure and Future Growth.

Asia and the Far East<sup>16/</sup>

19. In Asia and the Far East, raw materials for the production of cement are available in most of the countries, and many have become self-sufficient in cement. The Republic of Korea, Malaysia, Thailand and the Republic of Viet-Nam are all building new factories and some are even looking for export outlets. The per capita consumption of cement has risen very rapidly for the region as a whole, from 14 kg. in 1952 to 37 kg. in 1962, corresponding to an annual increase rate of no less than 16 per cent.

20. In the developing countries of Asia and the Far East, integrated iron and steel plants are installed in only a few countries. With the exception of India, however, these plants produce only a small fraction of total needs for construction steel. It can be said, therefore, that in the whole region, developing countries are almost entirely dependent on imports of this key material.

21. Concerning wood resources, it has been calculated that only about 190 million hectares of a total of 430 million hectares of forest area in the region of the Economic Commission for Asia and the Far East (ECAFE) are actually used. Realising the importance of timber and wood products, many countries however, are now planning forest development and the exploitation and setting up of wood-based industries. In India and Pakistan, the production output is still showing slow or moderate progress. Among the smaller ECAFE countries, the Philippines is the largest producer and exporter of logs, lumber and timber. The Republic of China and Japan have plywood production industries (based on imported timber from the Philippines); most of the output is exported to the United States. Malaysia has become more than self-sufficient in timber. Its exports of sawn timber increased by one half in the first half of 1964.

Latin America<sup>17/</sup>

22. In Latin America, the import substitution process regarding cement has been completed in most of the countries. The cement industry generally is characterized by sharp short-term fluctuations, undoubtedly caused by the irregular nature of building activities. Nevertheless, the per capita consumption of cement rose by an average of 3.4 per cent annually, from 68 kg. in 1952 to 91 kg. in 1962.

16/ Ref. No. 1 (parts I and II).

17/ Ibid.

23. Pig-iron and crude steel are produced in comparatively large quantities in Brazil, Mexico, Argentina, Chile, Venezuela and Colombia and, to a lesser extent, in Peru. A small installation is also at work in Uruguay. Generally speaking, the position regarding the steel industry in Latin America is more satisfactory than in the other developing regions.

24. In regard to wood resources, Latin America possesses one quarter of the world's forestry reserves. But, as a result of low concentration of commercial species, lack of transport or complete inaccessibility of many forests, the total exports of commercial timber have so far been low. Improving world market prospects have recently encouraged efforts towards better planning of forest development and increased production for export. Thus, it is estimated that about 50,000 hectares are being planted annually. While the total volume of round wood removed was 215 million m<sup>3</sup> in 1963 and shows only a slightly increasing trend, the production of wood for industrial use is increasing at a rate of about 2.5 per cent annually. Production of sawn wood is increasing even faster, at an annual rate of about 3.5 per cent, and amounted to more than 12 million m<sup>3</sup> in 1963. A considerable expansion in the number of sawmills is expected in the next few years in the region.

#### Central America<sup>18/</sup>

25. In Central American countries (including Panama), cement production was almost quadrupled between 1945 and 1956, by an increase from 90,000 to 342,000 tons annually. New factories have since been established, and cement production has continued to expand very rapidly in recent years. Nevertheless, there is such an increase in consumption that a shortage may be anticipated. The idea of co-ordinating the cement industry in Central America through a form of common market is being seriously considered, but this is hampered, as in Africa, by the lack of adequate transport facilities.

26. Concerning iron and steel, there is only one plant, producing about 9,000 tons annually (1963). It is working on the basis of locally-bought scrap. There is a high demand for steel rods, almost completely met by imports. There is a

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<sup>18/</sup> Ibid. (part I).

small rolling-mill in San Salvador which, however, can meet only a part of the needs for construction of steel in this region.

27. With the exception of El Salvador, all of the countries, including Panama, have extensive forest resources. The main exporting countries are Honduras and Nicaragua. Generally, the region is self-sufficient in wood products, with a considerable surplus for export. Concerning requirements for tiles, porcelain, sanitary ware, paints and varnishes, it is likely that, with the additional factories which are now being considered, a large part of the area's requirements for these items will soon be met.

#### Europe<sup>19/</sup>

28. One of the major problems facing European countries after World War II, was the tremendous demand for and serious shortage of building materials. For this reason, simultaneously with the revitalization of the building materials industry, intensive research was devoted to the development of building techniques and methods aimed at a more efficient use of traditional building materials or their replacement by new materials. The result of all these efforts was a gradual switchover from brick, stone and wood to concrete of all kinds, light metal, plastics etc. Despite a considerable increase in construction output, the demand for traditional materials was thus kept at a steady level, or even decreased, while the consumption of cement in almost all European countries at least doubled within a period of ten years. In western Europe, the consumption of cement per capita increased by about 10 per cent annually, from 167 kg. in 1952 to 335 kg. in 1962, while in the socialist countries of eastern Europe, cement consumption increased even more rapidly, from 107 kg. per capita in 1952 to 247 kg. in 1962, corresponding to an annual increase rate of 13.1 per cent.

29. The consumption of bricks decreased in all countries, particularly in Poland and Yugoslavia where the consumption per room-unit produced in 1963 was only about one half of the consumption ten years earlier. In 1963, European countries could be divided into two "small" groups and one "big" group, according to their brick consumption, namely: (a) Finland, Norway, Sweden, and

19/ Ref. No. 6, (chapter VI, section 2) and Ref. No. 15.

the Federal Republic of Germany, with a brick consumption varying between 700 and 1,200 bricks per completed room-unit; (b) Austria, Czechoslovakia, Denmark, Eastern Germany, France, the Netherlands, Poland, Spain, the United Kingdom and Yugoslavia, with a brick consumption varying between 3,800 (Spain) and 6,700 (Eastern Germany); and (c) Bulgaria and Hungary, each consuming around 11,000 bricks per room-unit. These radical differences in the raw material basis for the building industry may help to explain why the concept of "industrialized building" is still used in some countries for all methods of construction where brick is not the basic structural material, while in other countries, concrete structures cast on site would be classified as traditional construction.

30. The share of total construction expenditures spent on steel remained at a steady level in almost all European countries between 1955 and 1960.<sup>20/</sup> This was probably due to considerable improvements in the quality of the steel used, economies achieved through the use of more perfected methods of calculating concrete structures and a marked preference for reinforced concrete over steel structures for reasons of building costs and tradition.

31. The consumption of wood in construction remained for a long time constant, or decreased. There were several reasons for the decline. Thus, while the cement price remained almost constant over a long period, the price of wood and wood-based products rose considerably. This led to major efforts towards improving shuttering and form-work methods as well as avoiding as far as possible temporary structures (such as scaffolding, ramps and ladders) for which wood had traditionally provided the main raw material. The high price level also contributed considerably to a decrease in the use of wood as raw material for permanent structures (except for special purposes and in the form of high-quality glued prefabricated components) and has been one of the driving forces behind the steadily increasing use of prefabricated structural concrete components and the use of steel shuttering for site-cast concrete structures.

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<sup>20/</sup> Ref. No. 9 (table 48).



## II. BASIC CHARACTERISTICS OF THE BUILDING MATERIALS AND COMPONENTS SECTOR

### A. Characteristics of demand

32. By definition, the products of the building materials and components sector do not constitute end-products in themselves, but are useful only after having been transported to and assembled on the building site, or delivered to other branches of the sector for intermediate processing. In other words, the demand for building materials and components emanates indirectly from construction activities of all kinds. The buyer of the ultimate end-product i.e. the investor in the case of new construction, and the management organization or individual client in the case of maintenance and modernisation activities is interested mainly in the total cost, quality and functional properties of the finished work, and less interested in the building materials and components used to satisfy his wishes.

33. The end-product itself (i.e. the completed construction work) has a number of specific characteristics which further aggravate the difficulties of predicting the demand for building materials and components and of organising their production in a rational way.<sup>21/</sup> Construction works are erected on - or form part of - the ground on which they are sited; this means that they have to be adapted to prevailing ground conditions, as well as to differences in climate or subsidence and earthquake hazards. All building materials and components have to be transported to the building site, which means that transport distance and costs play a predominant role in the choice of raw materials and building techniques, particularly in countries or regions where transport facilities are undeveloped. Furthermore, construction works are expensive and durable and therefore are often bought only once in the lifetime of individual clients and only occasionally by many institutional clients. Attempts to satisfy fully the individual needs, tastes and means of every client easily lead to a demand for an almost unlimited number of "tailor-made" products and, consequently, to great difficulty and uncertainty in forecasting future market prospects for specific building materials and components. The impact on building demand of the vicissitudes of economic development further contributes to discontinuity

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<sup>21/</sup> Ref. No. 3

and uncertainty in regard to the future demand for building materials and components in countries without established long-term development plans which include this sector.

34. New construction, maintenance and modernization of buildings and other construction works - and, thus, a variety of building materials, components and equipment - are required for establishing and developing virtually all sectors of the economy. From the economic and technical points of view, all of these needs are normally classified into three main groups of construction work which - as has been shown in the previous chapter of this paper - may be helpful also in establishing requirements in terms of building materials and components, namely:

- (a) Housing, including all equipment and furniture, permanently installed in connexion with the erection of the buildings;
- (b) Non-residential buildings:
  - (i) public and commercial (schools, churches, hospitals, sports and assembly halls, supermarkets, administration buildings, banks, child-care institutions etc.);
  - (ii) industrial buildings (factories, power stations and gas-works, agricultural buildings etc.);
- (c) Civil engineering and public works:
  - (i) waterways and harbours;
  - (ii) roads, railways, bridges, tunnels and airfields;
  - (iii) irrigation, land reclamation and flood control;
  - (iv) laying of drains, sewers, gas-mains and pipelines;
  - (v) transmission lines and other facilities for the transfer and distribution of electricity;
  - (vi) hydro-electric power stations, mining installations etc.

35. Building materials, components and equipment fulfil a great variety of functions, a fact that is important to take into account when forecasting future demands at various stages of economic development. The main functions may be listed as follows:

- (a) Load-bearing structure: This is the main function of most of the building materials and components used in civil engineering and public works; it is an important function of the products used in non-residential buildings (since machinery and equipment of industrial buildings and similar constructions are not counted construction investment). In residential construction, structural materials and components are less important, particularly in low-rise family house construction. In multi-storey construction, structural materials and components are required, but their share in total building materials and components inputs is comparatively small and decreases gradually with economic development since, with rising living standards, more and more finishing and equipment installations form part of the initial investment.
- (b) Protection against weather hazards (external envelope): Materials for protection against rain and snow, wind, cold and heat constitute the essential demand in all types of residential construction and are also of importance in most types of non-residential building. Roofing, walling and insulation materials are the most important items used for this purpose. The quantitative needs and qualitative properties of these items differ very considerably with the climatic conditions in the various parts of the world.
- (c) Improvement of internal climate: This function is closely connected with the previous one, but the range of possible quality standards is much wider. The demand depends to a large measure on the buying capacity of the population. In countries with the most severe climatic conditions, obviously some kind of heating equipment is absolutely essential and forms an integral and important part of investment in new buildings. In other countries, heating equipment is permanently installed only in buildings in the higher-quality bracket; in still other countries, heating equipment may be regarded as a pure luxury. The situation is similar, but even more pronounced as regards equipment for air-conditioning and ventilation. Generally speaking, it is only in the richest countries that the latter kind of equipment forms a common and important feature of construction input.
- (d) Hygienic requirements: Materials and components for this purpose are, first and foremost, sanitary installations (including drains, sewers and similar community facilities), simple arrangements for ventilation in housing and non-residential buildings, as well as materials for sound insulation.

- (e) Internal sub-division and facilities: The demand for products serving these purposes is almost unlimited and may increase to a very considerable share of total construction inputs at later stages of economic development (lifts, kitchen equipment and machinery, electric and telecommunication equipment, built-in cupboards and other storage spaces, bathroom equipment etc.). Examples of basic items necessary for the functioning of buildings are partitions, doors, staircases and windows. The demand for products of this kind comes essentially from housing construction but also to a considerable extent from the non-residential building sector.
- (f) Aesthetic requirements: The building or construction work, as well as all its various constituent parts, should be designed in such a way as to result in an aesthetically attractive end-product.

### B. Characteristics of supply

36. Taking into account the characteristics of demand as discussed above, it is not surprising that virtually hundreds of industries are required to supply all of the items needed. The split pattern, disorganisation and confusion that often characterizes the building materials and components sector are caused also by the fact that many materials of basically different origins may be used for one and the same purpose, and that some of the most important materials and components serve many functions simultaneously. Timber, wood products and light-weight concrete, for example, have good properties both as structural materials and as insulation against cold. Concrete has excellent load-bearing properties and high thermal capacity, thus providing effective protection against heat; it is also effective as a sound-insulation material and requires a minimum amount of maintenance. The list of examples could be extended almost without limit. The point is that the supply of building materials and components is characterised not only by the diversity of needs and functions, but also by a strong competition and exchangeability between traditional materials serving one and the same purpose or multi-purposes as well as by the constant introduction of new materials and components on the market (e.g. from the plastic industry).

37. For the reasons given, it is difficult to establish any reliable ranking list concerning the importance of different building materials and components which would be generally applicable under the great variety of conditions

prevailing in the various countries and which would provide enough certainty about the future composition of demand. Technical development is very rapid, indeed, in this field. Nevertheless, it would be helpful to know the present composition of total expenditure on building materials and components in various countries in order to give some indication of the importance of the different industries as deliverers of construction inputs and, consequently, of the priorities to be given to the development of the various branches of the building materials and components sector at different stages of economic development.

23. Unfortunately, detailed information of this type is rare or not readily available even in the industrially developed countries. Input-output tables showing the interrelationship between the different industrial sectors have been established in a number of countries, but these do not, in most cases, give enough detailed information regarding the composition of construction inputs. The figures presented in table 5 (below) on the composition of industrial inputs purchased by the construction industry in western Europe in 1953 may, however, help to give a rough idea of the importance of various sectors of the economy as deliverers of construction input. (Although separate data are provided for transport, trade and other services, a considerable share of transport services is probably included in the figures relating to the various delivering industry sectors.) It is likely that the figures in general are applicable - but only to some extent - for a few of the most advanced countries of group III in tables 1, 2 and 3.

table 5

Interrelationship between construction and other sectors in western Europe  
 (excluding Finland and Spain), 1953

Sector selling to the construction industry	Composition of total input of the construction industry	Composition of total purchases made by the construction industry	Composition of total industrial inputs (excl. transport, trade and services)	Proportion of sector's total output purchased by the construction industry
	§	§	§	§
	(1)	(2)	(3)	(4)
Energy	1.4	2.7	3.1	1.8
Metals	4.8	9.2	10.7	11.1
Engineering	5.9	11.3	13.2	4.2
Wood and paper	8.9	17.1	19.9	21.6
Glass	0.9	1.7	2.0	26.4
Cement	3.0	5.8	6.7	77.2
Other industries	19.9	38.2	44.4	12.2
Transport	1.4	2.7		2.2
Trade and services	5.9	11.3	(100.0)	1.9
Total purchases	52.1	(100.0)		
Indirect taxation	2.0			
Value added by construction industry	45.9			
Total input	100.0			

Source: Ref. No. 3 (part III, table 3).

39. Another example, taken from one of the countries listed in group III (Israel), may provide a more accurate picture of the pattern of building materials production in a developing country (table 6 below). Although information on the composition of the construction output corresponding to the inputs listed in table 6 is not available, a comparison between tables 5 and 6 seems to indicate that the construction activities in Israel were more oriented towards structural purposes than the average construction output in Europe in 1953. It is only reasonable to assume that the less developed a country is, the greater the share of its construction activities devoted to structural works, and that the expenditures on finishing and equipment materials increase considerably with economic development.

Table 6

Composition of industrial inputs in the building sector in Israel, 1961

Sector selling to the building industry	Composition of total industrial inputs %
Energy (fuels)	1.2
Basic metals and metal products	26.3
Engineering (machinery, equipment and transport vehicles)	5.6
Wood for framing and joining	20.9
Non-metallic minerals	41.6
Chemicals and paints	4.2
TOTAL	100.0
Source: Ref. No. 1 (annex II, table No. 10.)	

40. It should be noted that the pattern of construction input reported for Israel is the result of deliberate efforts by the Government to increase to a maximum the capacity of the country's building industry, using the minimum amount of foreign currency on imports of building materials and components.<sup>22/</sup> As there was an acute shortage of capital, manpower, experience and building materials, efforts were made at first to economize through the large-scale use of mud structures, building stones and other traditional materials. This was unsuccessful. The conclusion was drawn that, under the conditions prevailing in that country, the only solution would be to develop the concrete and concrete components industries as the main basis for the building industry. This was particularly suitable since the country is rich in rock and sand aggregates. Priority was thus given to the development of the artificial stone aggregates industry and the cement industry, but major attention was paid also to the development of the industries producing bricks, glass, gypsum, clays and ceramics. The main materials which still had to be imported were metals and wood for joinery, scaffolding and form-work. The use of hollow concrete and light-weight concrete blocks for walls and floors resulted in a decrease of the deadweight of structural components and consequently of the requirements for reinforcement steel. The use of twisted steel and special alloy steel had a similar effect. The introduction of reinforced prefabricated concrete floor components and better shuttering methods led to considerable economies in the requirements of wood for form-work and also facilitated the re-use of shuttering boards. On the whole, the number of buildings with site-cast structure decreased, a fact that has considerably contributed to speeding up the building production. It is expected that the growing use of gypsum products will prove to have a positive effect on the quality of buildings and on the possibilities of simplifying the finishing works. The local plastic industry is also expanding considerably. Side by side with the introduction of modern building methods and materials, a great deal of attention and research have also been devoted in Israel to the field of soil mechanics. Thus, a basic change has been initiated in the system

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<sup>22/</sup> Doc. No. 1 (annex II).



of grading and stabilisation of soil in the construction of roads, airports and railways. Research work on the stabilisation of heavy soil by means of lime has given very good results, and considerable amounts of lime are now being used for this purpose. Coarse aggregates and local sea-shore sandstones are currently being used as base materials in place of building and quarry waste, which was not always adequately graded. New methods of providing main upper layers of runways by means of asphalt concrete have also been successfully introduced.

41. Similar examples of the positive effect and the importance of a comprehensive and determined building policy could be cited in the case of many other recently-developed countries, particularly those of eastern Europe. The main conclusion that seems relevant in order to satisfy a country's building needs economically and with sufficient speed is that it is necessary to organise an efficient domestic construction industry based on locally-available raw materials. It should also be noted that it may be more important to give attention to the rationalisation of the production of artificial stone aggregates and the development of factories for prefabricated concrete components than to establish highly-capital-intensive factories for the production of a few key building materials. This is, of course, particularly true in the case of the smallest and the least urbanised of the developing countries, where sufficiently large markets for the production of certain materials and engineering products can only be established by means of regional co-operation.

C. Impact of technical development on the importance of different branches of the building materials and components sector

42. The wide range of possibilities in the organisation of the building materials and components sector, and the changing importance of the whole sector and its various branches as technical and economic development proceeds, may be clarified by subdividing the sector into the following three main branches: <sup>23/</sup>

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<sup>23/</sup> A more detailed classification is provided in annex IV.

- Branch A: Extraction, simple processing and transport of natural building materials and semi-finished building elements;
- Branch B: Production and transport of synthetic building materials and semi-finished elements;
- Branch C: Production and transport of finished functional building components, assemblies and equipment.

43. All three branches may be more or less industrialised, in the sense that more or less advanced techniques, mechanical equipment, organisational and managerial skills may be employed in the production process. Generally speaking, however, branch A lends itself more readily to labour-intensive methods of production while most of the products manufactured by branch B cannot easily be produced economically unless capital intensive and highly complicated industrial methods of production are applied. Thus, in this branch generally, there is a considerable advantage in large-scale and continuous production and consequently, a great need for operational and managerial skill in the operation of plants. There are a few notable exceptions, which will be discussed below. In the earlier stages of economic and technical development, most of the typical products of branch C (sanitary ware and fittings, electrical fittings and heating equipment etc.) have production characteristics similar to those of branch B. However, the wood-based products, such as windows and doors, may be produced by rather simple and labour intensive methods. Furthermore, advanced prefabrication of finished structural components and functional assemblies need not necessarily be capital-intensive to compete with the site methods of production they replace.

44. As pointed out in the introduction, it is difficult to draw a definite dividing line between the building materials sector and the construction industry, particularly housing construction. Technical and economic considerations and local conditions determine the extent to which the building production process is carried out within the building materials and components sector or by the construction industry. Recent developments in industrialised countries have shown

that the entire production process may be integrated under the responsibility of the construction enterprise, which means the incorporation of building materials and components manufacture as ancillary activities of the construction industry. Although, in statistical terms, this would appear as an increase of the importance of the construction industry - on account of the building materials and components sector - these fully integrated building systems are often characterized by a high degree of prefabrication, i.e. a development of finished building components manufacture. In housing construction as a whole, there is a clear trend towards a more extensive use of the products of branch C.

45. In non-residential building, the trend is also towards a more extensive use of the products and services provided by branch C. This is mainly due to the need for speed in construction and to the "once-and-for-all" character of the projects. But the diversity and discontinuity of demand in this field provides a major obstacle to efficient component production. One of the significant features in the development of building technology today is, therefore, the attempt made - nationally and internationally - to standardize building components on the basis of thorough research into the requirements of users, so as to facilitate mass production and trade in interchangeable components with the maximum applicability in various types of building construction. The striving for maximum functional flexibility and the recognition of the fact that structural building components last much longer than the time envisaged for the use of the building, serve as further incentives towards mass production of standardized components in specialized factories.

46. In the earlier stages of technical development, civil engineering and public works were almost entirely based on products of branch A. The raw materials were cheap, and the main operations involved were the excavating and transport of materials from one place to another. These operations were normally carried out by the construction industry, and accordingly - viewed as an independent branch - branch A was not highly developed. Technical advances and the need for more complex and high-quality construction led, at a later stage, to an increase in the demand for products from the building materials and components sector, mainly from

branch B in the form of structural steel components, but also in the form of steel combined with cement and wood (for shuttering and scaffolding) for concrete construction. The result of this change was higher speed in construction, but also a wasteful use of wood and a rapidly increasing demand for skilled site labour. The important results of extensive research into soil mechanics, the rapid development of powerful and high-capacity machinery and equipment for transport of soil and processing of artificial stone aggregates, combined with increasing costs for wood and skilled site labour, have, in recent times, led back gradually to a more extensive use of earth rather than concrete in civil engineering works, wherever possible (e.g. in the construction of dams and irrigation works). Simultaneously, in other types of civil engineering construction, there has been an increase in the use of products from branch C in the form of prefabricated components of steel and concrete (in particular, with pre-stressed or post-stressed reinforcement).

D. Characteristics of the production and use of selected building materials and components

47. In an annex to the main report<sup>24/</sup> on which this paper is based, the results of an analysis of the basic characteristics of some fifty building materials and components are presented in tabular form. Some twenty factors affecting the production and use of the various materials have been isolated for comparison. Furthermore, in a separate table, the importance and main fields of use of the various materials and components are indicated. Although the data on which the tables are based were collated from the building materials industry in Great Britain, emphasis was laid on the characteristics inherent in the production process. This, together with the method of classification, provides data which are generally applicable in developing countries.

48. The main characteristics of the more important building materials and components based on information presented in the full report and in other relevant documents<sup>25/</sup> are discussed below.

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<sup>24/</sup> Ref. No. 1 (annex I).

<sup>25/</sup> See annex IV of the present paper.

### Cement

49. It is hardly necessary to stress the overriding importance and universal applicability of cement in construction throughout the world. No viable construction industry in any country is likely to develop without the extensive use of cement. It should be noted, however, that cement is only an ingredient - though an indispensable one - in concrete and concrete products and that world production of cement is high enough to cover present demands. As noted in the previous chapter, there is in some regions a considerable over-capacity, or large fluctuations in production, implying the wasteful use of invested funds and uneconomic production. It should also be noted that, citing the example of western Europe in 1953, cement accounted for only 3 per cent of total construction costs, corresponding to less than 7 per cent of industrial inputs purchased by the construction industry. Although it is true that cement may be produced by rather primitive methods and for small markets, the considerable economies of large-scale production<sup>26/</sup> and the high, even quality required in modern construction generally call for the establishment of big and highly-automated production units. For all of these reasons, great caution should be exercised in deciding on the establishment and location of new cement plants.

### Aggregates

50. In contrast to the great attention already given in most countries and regions to the provision of cement, it appears from the information available that fewer efforts have been made in rationalizing the provision of the aggregates necessary for production of concrete products. As the example of Israel has shown<sup>27/</sup> both speed and economy in construction can be greatly increased by investing comparatively small funds in rationalizing and increasing the capacity of aggregate production and by improving the quality and grading of aggregates. Aggregates are cheap and heavy, and it is only natural that attempts are made to find necessary raw materials as close as possible to the ultimate building site. But the enormous requirements of aggregates and the improved transport

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<sup>26/</sup> Ref. No. 8.

<sup>27/</sup> Ref. No. 1 (annex II).

facilities that will be required for economic development seem to justify fully the priority to be given to locating resources of suitable raw materials and setting up rational plants for large-scale production of aggregates.

#### Concrete

51. In most countries and in the majority of cases, concrete is likely to provide the basic material for structural purposes, particularly for multi-storey building construction and for some types of civil engineering and public works, and also (in the form of hollow concrete blocks, tile and slates) for low-rise housing construction. Concrete may be mixed by hand or by more or less complicated machinery on the building site; it can also be produced in fully automated large-scale production plants and be delivered to building sites or component factories in ready-mixed liquid form. The more primitive methods of production may be justified in rural districts and in cases where high quality is not required. It should be pointed out, however, that any large-scale application of primitive concrete-production methods is bound to lead to wasteful and ineffective use of materials, particularly cement, and that such methods cannot be used when a high, even quality is required. It was only recently that these considerations were fully recognized even in the most industrialized countries and that high-output factories for ready-mixed concrete were set up in urban centres. In view of the conditions prevailing in developing countries - enormous needs combined with efforts towards limiting cement consumption - it would seem advisable and economically justified to take steps towards advanced technology in this field as early as possible. The setting-up of large concrete-production units, equipped to produce the exact amount and quality of concrete required for each specific purpose, should provide a major key to rationalizing and speeding up the building production process in these countries.

#### Concrete products

52. The concrete-products industry is another example of an industry which had been neglected or undeveloped until recently in the industrialized countries. In most countries, it was only in the past decade that the shortage of skilled

site-labour and the apparent waste of shuttering materials on sites elicited attention to, and interest in, the production of prefabricated concrete components. It is true, of course, that simple products such as concrete blocks, tiles, slates, pipes etc., had been produced for a long time, but most concrete structures were until recently cast on site. Bearing in mind again the particular conditions prevailing in developing countries - lack of skilled site-labour, abundance of unemployed or under-employed unskilled labour, scarcity or lack of the key materials required - it seems appropriate to consider whether it would be advisable, as far as possible, to avoid site-casting of concrete and to organize the production, on site or in labour-intensive factories, of prefabricated standardized concrete components. The experience gained in Yugoslavia and Israel seems to indicate that such a policy is feasible and speedily gives rewarding results. In Yugoslavia, it has even proved possible to employ a very advanced and material-saving technology, based on the post-stressing of structural components and using unskilled labour and rather primitive methods of production. Generally, the possibilities of saving expensive key materials in developing countries by applying advanced technology should be stressed. The extensive use of pre-stressed and post-stressed prefabricated components in building and civil engineering works may well prove to be a suitable short-cut to the solution of building problems in developing countries, provided that the required qualities of basic materials can be ensured.

#### Clay products

53. The production of burnt-clay products in the form of bricks, blocks, tiles, slates, pipes, ducts etc., has been for centuries, and still remains in some countries, the backbone of the building materials industry. Bricks and brick blocks still provide, in many countries, the predominant walling material in building construction. There are many reasons for this situation: bricks are easy to produce and can be manufactured by a wide range of methods of varying degrees of efficiency; bricks have good load-bearing properties and acceptable insulating capacity, at least in countries with milder climates; bricks are

durable and call for virtually no maintenance. However, brick-laying is a time-consuming job, calling for highly skilled site-labour, especially in high-rise construction or other cases where high quality is desired or required. It further calls for various temporary arrangements on the building site, in the form of scaffolding, and is difficult to carry out under unsuitable weather conditions. These drawbacks, particularly the lack of competent masons and bricklayers, were some of the driving forces behind the gradual switchover to concrete structures (most accentuated in northern and eastern Europe). The introduction of hollow-bricks and blocks, the rationalization of brick production and brick-laying and, in the last few years, the introduction of large prefabricated panels based on clay products, have helped to maintain the position of bricks and other clay products as a main material in building production.


54. In developing countries, clay products also play an important role in building production. There is no reason why the production and use of bricks and other clay products should be deterred from the established pattern. On the contrary, these products fill a major need, especially in housing construction; through minor incentives in terms of advice and small investments in simple machinery, the output may be raised considerably and the quality improved. It is less certain whether attempts should be made to reorganise the clay product industry in the direction of mass production, as has been done in some industrialized countries. Such a change in the production pattern would not seem to correspond to the pattern of consumption. On the basis of the experience in industrialized countries, it is doubtful whether, in the long run, bricks would be able to compete successfully with concrete as a structural material in urban construction. The large-scale use of bricks would also call for large-scale training of skilled site-labour, and the employment of such labour at a later stage of development may prove to be an obstacle to further technical development of the building industry, which probably will be required if, in the long run, capacity is to keep pace with demand.



### Timber and sawn wood

55. Timber and sawn wood provide the classic building material in countries with forest resources. The material has an adequate load-bearing capacity for buildings such as about four storeys. It has good insulation properties, it is easy to handle, shape and transport. Its main drawbacks lie in its liability to rot and to insect attack, its insufficient durability for permanent structures, its need for maintenance and its characteristic fire hazard. The last-mentioned factor, in particular, has resulted in the prohibition of wood as a permanent building material in most urban centres of industrialized countries and in the all of the territory of some countries. Therefore, the building up of an infrastructure and a permanent building-stock cannot be based on wood as a structural material. For a long time, the main use of wood in construction has been as an ancillary material for temporary structure, scaffolding and form-work, required especially for on-site erection of concrete structures. The use of wood in its natural form for such purposes, however, should not be encouraged, since it is expensive and wastes valuable materials which could be used as raw material for much more advanced products. Even in countries with vast forest reserves, therefore, it would seem better to encourage the setting-up of wood-based industries for production of plywood, hardboard, doors, joinery, furniture etc., which could be exported and thus provide a major source of hard currency.

### Steel and iron products

56. Steel and iron products are key materials in construction. First, they are indispensable as structural materials, used either in their "natural" form (steel bars, girders, beams, tubes, piles etc.) or in the form of reinforcement of concrete structures. Steel is also required for railway tracks, and pipelines and as jointing and fitting materials (wires, nails, bolts etc.). Furthermore, steel is the basic raw material for production of a number of building components, such as partitioning and roofing components, banisters, guard rails, rainwater pipes, staircases, lifts, sanitary fittings, mains and drains, heating installations, boilers and radiators, ventilation shafts etc. 

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27/ 12.12.2

57. As shown earlier in table 5, metals (predominantly steel and iron products) accounted for nearly 11 per cent of total industrial inputs in construction in western Europe in 1953, while the corresponding figure (though perhaps not quite comparable) for Israel's building industry in 1961 was 26 per cent. There are probably three main reasons for the wide difference. First, in a developing country, construction activities are more oriented towards structural purposes than in countries where the basic infrastructure has already been built up. The second reason is that a developing country cannot afford complicated equipment and high-quality finish. Third, there is a completely reverse relationship between the cost of simple raw materials and the cost of advanced industrial products in the two types of economy. While in developing countries the cost of raw materials is low, manufactured products - whether produced domestically or imported - are often twice as expensive as in industrialized countries. In the latter countries, on the other hand, raw materials must often be imported or are comparatively expensive to extract, or must be transported over long distances.

58. The major importance of steel in construction in developing countries and the fact that current needs are now largely covered by imports makes it advisable to pay special attention to this material. As pointed out in the study on the iron and steel industries (ID/CONF. 1/34) for the Symposium, the most important steel and iron products in almost all developing countries are heavy and light sections and sheets, which together usually account for between 40 and 70 per cent of total consumption. While, in industrialized countries, a considerable part of the sections consist of high-quality products used in machinery manufacture, "in developing countries, the bulk of sections is accounted for by concrete reinforcement bars and structural shapes of ordinary quality; the sheets used in industrialized countries are, to a large extent, of deep-drawing quality required by the motor-vehicle industry and production of consumers' durables, whereas in developing countries most of sheet imports consist of galvanized sheets, used for roofing".<sup>29/</sup> The result of these major

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<sup>29/</sup> Ref. No. 10 (paragraph 28)

differences in the consumption pattern of steel products between countries at different stages of economic development is that while, in industrialized countries, only about 20 per cent of total consumption is used for construction purposes, the corresponding figure for developing countries may well rise to 80 per cent or even more.<sup>30/</sup> This is natural since, by definition, other main consumers of steel products (manufacturers of household equipment, transport equipment and vehicles, engineering products etc.) usually do not exist in developing countries.

59. The problems of establishing new steel plants in the present world market situation and taking other difficulties into account are described in other reports.<sup>31/</sup> Seen from the point of view of steel as a construction material and having in mind the considerable amount of foreign currency now spent on imports of constructional steel, it may be worth-while to quote the main conclusion reached in a recent report. The discussion "brought out clearly that for developing countries, erection of national steel production must always be preceded by planning or parallel establishments of consuming industries and the initiation of large-scale construction projects".<sup>32/</sup> It would seem that this conclusion is particularly relevant to the building materials and components industries, since the steel qualities required in construction are those which are most easily produced in developing countries and since, at the earlier stages of economic development, construction activities account for the predominant share of total demand for steel products.

#### Other building materials and components

60. Apart from the more traditional and, at present, most frequently used materials discussed above, attention should be paid by the Governments of developing countries and by international organisations to some recently-introduced materials which may play an important role in future construction activities. Reference should be made, in particular, to aluminium, asbestos cement and plastic products which are light, durable and easy to transport and

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<sup>30/</sup> Ibid., (paragraph 25 and table 3).

<sup>31/</sup> Ref. No. 10

<sup>32/</sup> Ibid., (paragraph 63).

which could find major uses, particularly for roofing and piping purposes<sup>11/</sup>. Light-weight concrete is another rather recently-developed material which has proved to be particularly suitable for certain purposes. It has excellent qualities of durability and heat insulation, and it is easy to handle, shape and transport. Asphalts and bituminous products, paints and varnishes, as well as a range of other building materials, may also be considered for production in developing countries if the available raw materials and other production factors are such as to ensure that the price of the products will be competitive in the world market.

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<sup>11/</sup> See, *inter alia*, *ibid.*, p. 12

### III. DEVELOPMENT PROSPECTS AND TRENDS

61. The figures presented in chapter I of this report clearly point to the vital importance of rapid development of the building materials and components sector, including transport facilities, in order to ensure economic advancement. No significant growth of the economy is likely to take place unless a considerable share of national resources is devoted to investments and the major share of these investments is allocated for construction purposes. The importance of giving priority to investments of this kind is shown by the fact that, as compared with investments in highly complex machinery and equipment - which would normally be imported - construction investments draw predominantly on locally available resources of materials and manpower and thus call for comparatively small outlays of hard currency.

62. It is essential to realize, however, that even if imported materials account for a small share of total construction costs, in absolute values the foreign currency spent for this purpose may easily increase to an unacceptable level if no planned action is taken to replace imports and to develop an efficiently working domestic building materials industry, wherever - and as soon as - the market justifies such action. In the long run, and in most countries, it will prove to be a dangerous policy to rely heavily on imported materials for the provision of all the construction works required for economic development and, in particular, for the satisfaction of the basic need of housing the people. This is evident from the fact that all industrialized countries are virtually self-sufficient as regards their needs in building materials and components.

#### Targets of the building materials and components sector

63. It has been pointed out that:

"There are several ways in which the targets and objectives of the building materials and components industries in the development of the national economy may be assured. Through national accounts and censuses of industrial production statistics and through other gross construction figures, an assessment can be made of the output and employment content which domestic building materials production might achieve in a developing economy; through analysis of statistics on imports and domestic deliveries,

an assessment can be made of current market possibilities for individual materials and components; through analysis of known construction programmes, principally public, in current and perspective development plans, a further assessment can be made of current and likely market conditions for specific materials and components; and through studies of long-term international trends in consumption of key materials, a long-term perspective for consumption of these building materials and components, can be established." <sup>14/</sup>

64. Some of the methods proposed are of a passive, theoretical and branch-oriented nature, and they seem more suitable for use by the various industrial branches concerned than by Governments and international organizations. Many different materials and components in various combinations may be used for one and the same construction purpose. Moreover, new materials and construction methods are constantly entering the market. It would be a mistake to give preference to one or the other material, unless this is found desirable from the point of view of the national economy as a whole, or for other important policy reasons. It is realized, of course, that there are certain key materials, especially from the steel, non-metallic minerals, and wood sectors, which are indispensable to any national construction programme. However, the actual quantities required and the mutual importance of these materials may vary considerably for one and the same construction programme, according to the conditions prevailing in each specific country or region. <sup>15/</sup> False conclusions, therefore may easily be drawn and serious mis-investments made or encouraged by the unconsidered adoption of experience gained in other countries or regions.

The need for long-term programming of construction activities <sup>16/</sup>

65. A certain amount of assurance as to the scope, composition and continuity of future construction activities provides the essential basis for efficient production of building materials and components and for correct investment decisions in this sector. The great variety of construction work needed, the heavy investments involved in - - and the once-and-for-all character of - - each project (particularly in the early stages of economic development, when

<sup>14/</sup> Ref. No. 1 (part II, chapter B, paragraph 1)

<sup>15/</sup> Ref. Nos. 10 and 11.

<sup>16/</sup> Ref. No. 1 (part II and Ref. No. 2 (Chapter III).

construction investments are concentrated on civil engineering and public works) undoubtedly make the establishment of long-term programmes of construction activities an intricate and difficult task.

66. Despite the difficulties, the aim must be to prepare long-term construction programmes with increasing precision and certainty. This aim is furthered by certain characteristics of construction investment. The first characteristic is that a large share of construction investment, particularly in low-income countries, is carried out by public bodies, either as total investor or in partnership with private investors. This offers a unique opportunity to develop long-term programmes - even if provisional - in sufficient detail to provide a basis for estimating building material needs. The establishment of long-term construction programmes is also facilitated by the fact that construction needs over a long period can be foreseen from surveys of existing deficiencies in infra-structure, housing, schools etc.

67. So far, the absence of assured long-term construction programmes appears to have been a major impediment to the planned development of the building materials industry in developing countries. Although national long-term plans of economic and social development - for countries as a whole as well as for individual regions and industrial sectors - have been recognized in most developing countries as being necessary for creation of new branches of industry, due attention has not yet been paid to the building materials and components sector. The importance of establishing long-term, objective projections in this field is, however, increasingly recognized and accepted. Thus, in many developing countries of the EC/FE region, the absence of long-term planning has been noted as retarding the establishment of building materials industries as well as the introduction and development of new materials and construction techniques. In a recent study of building material needs in East Africa, attention has also been drawn to the lack of long-term programmes for development of the local production of building materials and components. In Latin America, variations

in the volume of residential building and consequently the total construction have been very great and they constitute a serious obstacle to development of the construction industry and all the related economic activities.

Techniques of forecasting the demand for building materials and components

68. Building materials, components and equipment are required not only for the erection of new construction works, but also for maintenance and modernisation activities. The forecasting of future demands for building materials, components and equipment must therefore be made on the basis of anticipated expenditures for all these purposes. Such estimates are necessary, even though they are bound to be approximate.

69. In some respects, projections of investment expenditure can be made with less difficulty than in the case of consumer expenditure (which is related to the elasticity of income to demand and other factors quite difficult to forecast). However, reliable investment projections are still not easy to make. The reasons is that they are normally dependent, on the one hand, on estimates of savings or external borrowing and, on the other hand, they depend on reliable capital output ratios, or even reliable estimates of the cost of individual projects - information which is often lacking in developing countries. Investment programmes in these countries are particularly sensitive to balance-of-payment problems, since heavy imports of capital equipment are often implied. Unfortunately, a reduction of demand in the economy designed to reduce imports is usually effected most readily by restricting capital expenditure, particularly in the public sector. The extent to which the construction industry relies on domestic rather than on imported materials can, in fact, become a major factor in reducing the instability of investment programmes caused by balance-of-payment problems.<sup>37/</sup>

70. The considerations above refer mainly to new construction works carried out in the monetary sector of the economy, and by comparatively advanced methods of construction. A considerable quantity of building materials and components

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<sup>37/</sup> Ref. No. 1 (part II).



- - a quantity still harder to predict - - is used in more primitive forms of construction which is completely beyond government control except in the case of the strictly planned economies. Most rural housing construction and a considerable share of urban housing construction in developing countries, as well as most week-end houses and other construction works of a less permanent character in the industrialized countries, fall into this category. Generally, the financing of such construction work is largely provided by individuals, from funds that otherwise would be used on pure "consumption items", and the labour is provided through self-help or co-operative efforts. In principle, therefore, these "spontaneous" construction activities should be encouraged, since they help to increase the country's capital assets and to improve social conditions, without draining the investment funds needed for "more productive" purposes. However, as long as the required key building materials are imported, these uncontrolled construction activities may have an undesirable effect on the balance-of-payment situation; they may also create other problems which might be difficult to remedy in the future. These activities, therefore, should always be the subject of a rather strict watch by Governments and local authorities to see that they are in accord with the desired environmental development and also comply with physical planning and sanitary standards. When domestic production of the required key materials starts, i.e. normally at a later stage of development or in the larger urban centres, spontaneous construction activities should certainly be encouraged since they help to create the requisite market for large-scale production of building materials and components.

71. Maintenance and modernisation also create an important demand for building materials and components, especially at later stages of economic development and in connexion with mass-produced items for finishing and equipment purposes. The possible future market opportunities for modernisation purposes may be illustrated by the following quotation from a study on housing conditions in Europe.

"Cautious estimates of the cost of supplying all dwellings with piped water, toilet, bath and electricity, amount to a sum of the same magnitude as the present investments in new housing for between five and twenty-five years. In other words, if all resources now spent on new construction were re-allocated to the improvement and modernization of the present housing stock, it would require between five and twenty-five years to catch up the back-log in qualitative housing standards. The present rate of modernization is not precisely known in most European countries, since this kind of building activity is to a large extent carried out by individuals on their own account. But, the "consumption" of plumbing and other equipment, which sometimes is twice as high as the demand emerging from new construction, and other indirect evidence seem to indicate that where means permit, the rate of modernization is considerable." <sup>38/</sup>

The cost of maintaining and repairing the building stock increases rapidly with economic development. For the least durable building material items (such as paints, oils, varnishes, linoleum, wallpaper etc.), the share of total consumption used for this purpose may well rise to 70 to 90 per cent.

72. Following establishment of an estimate of future expenditures on new construction, maintenance and modernization activities, an attempt should be made to convert these expenditures into physical units. A complicating factor, in this connexion, is that construction works are expensive and extremely durable and, once erected, they cannot easily be moved. The economic planning of construction investments, therefore, is closely connected to and dependent on simultaneous efforts in the physical planning field. This simple fact has not always been fully realized. Physical planning often lags behind and causes bad investments and last-minute reallocation of investment resources; this, in turn, may completely upset any long-term programming for provision of building materials and components. Comprehensive, forward-looking and carefully elaborated regional and local plans would provide the ideal basis for economic planning. In turn, the speed at which these plans are implemented would be determined by the progress of the economy and by decisions, to be taken at a later stage, on priorities and allocation of resources.

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<sup>38/</sup> Ref. No. 6 (chapter VI).

73. Despite the difficulties of forecasting the future needs and demand for various building materials and components, it would seem that the proposed method, based on long-term programming of construction activities, provides Governments with one of the most valuable means of actively promoting the rapid and well-organized development desired in the building materials and components sector. But much more research and investigation are required to provide the necessary basic information. It is high time that Governments acquire the basic data on the envisaged composition of their construction programmes and on the materials consumed in typical kinds of construction.<sup>39/</sup> Great care must be taken, however, to ensure the availability of accurate data, reflecting the great variety in design solutions, exterior conditions and available raw materials. The standardization and simplification of design solutions provide effective means of achieving the desired quality of design and of facilitating estimates of future requirements in building materials, components and equipment.<sup>40/</sup>

74. A vital consideration in establishing construction programmes and drawing conclusions regarding the markets they represent for building materials is the locational factor. An analysis of materials consumption on the basis of information regarding total expenditure on construction activities and on the basis of trade statistics is not sufficient to enable the location of a country's market to be assessed. The importance of transport considerations requires that decisions on the establishment of manufacturing facilities be based on the size of the market that can be economically served, as well as on the economic availability of raw materials. In large countries, therefore, national construction programmes must be split into local and regional programmes. Similarly - and this will be discussed later in this paper - many countries are too small to provide the size of market required for certain building materials and components. In these cases, possibilities should be explored for combining or co-ordinating several national programmes.

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<sup>39/</sup> An example of the research and calculations required is provided in Ref. No. 16.

<sup>40/</sup> Ref. No. 1 (part II).

General consumption trends in key materials <sup>41/</sup>

75. As pointed out previously, it is advisable that national forecasts and plans for provision of building materials, components and equipment be made on the over-all national or regional level and that any preference for one or another material should be avoided. Nevertheless, some perspective can be given to national projections by considering long-term trends in the world consumption and regional consumption of a few key materials. This method is not conclusive but, if taken with other estimates of demand, it might help to provide some guidance for planning and investment decisions in establishing targets for building materials production.

76. Information on long-term trends in cement consumption is particularly important; investment in cement plants is expensive and should be made in the light of foreseeable future demands rather than of present demands alone. As stated in chapter I of this study, the consumption of cement per capita increased considerably during the past decade, particularly in Europe and Asia. There is no sign or likelihood that this increase will diminish in the future, since construction output will increase and concrete (particularly in the form of prefabricated components) will no doubt remain a predominant material for structural purposes. In Africa, the trend in cement consumption is less clear, and future prospects are less definite. Since 1960, there has been a decreasing trend in per capita consumption which, however, is partly due to a high population growth. Nevertheless, the United Nations Economic Commission for Africa has estimated that the demand for cement would increase from 11 million tons in 1962 to 17-22 million tons in 1970. Concerning the various regions, it was expected that cement demand would increase steadily in East and Central Africa but, as result of under-utilisation of the capacity already installed, it was necessary to exercise caution before installing more new plants. In West Africa, it was estimated that cement demand would increase from 2 million tons in 1964 to 3.2 million tons in 1970. The very rapid increase in demand for cement at a

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<sup>41/</sup> Ref. No. 1 (part II).

somewhat later stage of economic development is shown by figures obtained from two countries: in Yugoslavia, consumption rose from about 700,000 tons in 1946 to 3,040,000 tons in 1964; in Israel, it is estimated that production will increase by 84 per cent between 1967 and 1970.

77. Regarding timber products, it has been estimated that annual consumption of sawn wood in Africa will increase by 1.5 to 3.0 per cent, and of veneer and plywood by 5 to 6.5 per cent, in the period 1960 to 1970. Consequently, total consumption of sawn wood is expected to increase by 40 per cent, and veneers and plywood by 100 per cent for Africa (excluding South Africa), with Libya and North Africa accounting for the major share. It has also been calculated that, unless the industry is expanded, shortage in the supply of sawn wood would increase by 1.0 to 1.5 million m<sup>3</sup> and in veneers and plywood by 120,000 to 180,000 m<sup>3</sup>; if the limited inter-territorial trade and the dependence on imports are taken into account, the real shortage would be greater. The Food and Agriculture Organisation (FAO) has estimated that demand for sawn wood in Central Africa will double between 1960 and 1975 and that the demand for timber-based panels (plywood, fibre-boards etc.) will triple between 1960 and 1965. Although precise estimates of this kind are not available for the other regions, it is likely that the increase in demand for timber products will be of a similar magnitude in other developing countries.

78. Reliable estimates of the future demand for steel and iron products are more difficult to make, since they are highly sensitive to market conditions and substitution policies. As shown in chapter I, constructional steel and iron products constitute a predominant share of the developing countries' total imports of key materials, and it is likely that every effort will be made by Governments to promote construction techniques using the minimum amount of steel. The main competitive material for structural purposes is concrete which, at least in its more advanced form, contains a considerable amount of steel reinforcement. Furthermore, the demand for steel sheets for roofing purposes, which at present

is very high in developing countries, may be expected to remain high, although there are important substitution possibilities (asbestos cement sheet, in particular). For these reasons, it is likely that the demand for steel and iron products will continue on a comparatively high level. The situation may completely change if and when integrated iron and steel plants are set up in developing countries. With the basic material produced on the spot, the ancillary units for production of construction of steel products should be encouraged to develop quickly and, consequently, the importance of steel in construction would again increase.<sup>42/</sup>

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<sup>42/</sup> See Chapter II, paragraph 56.

#### IV. PROBLEMS AND POLICIES

##### The importance of non-industrial locally produced building materials<sup>43/</sup>

79. The technological level at which building materials production should be developed involves several investment choices and decisions which are not always easy to make and which, in practice, can only be made in the light of actual circumstances. Nevertheless, a limitation on the industrial production of building materials and components exists in many developing countries in that these products may prove to be more expensive, whether home-produced or imported, than local non-industrially produced traditional material. Economic and social policies should therefore favour the use of cheap non-industrial building materials to increase or supplement construction resources where appropriate, mainly in residential construction programmes. The economic limitation on the use of industrial building materials and components is illustrated by a comparison made some years ago of the cost per square foot of different materials in Asia, giving the following results:

- (a) bricks and concrete blocks - - US \$3.00 to \$5.00;
- (b) timber - - US \$3.00 to \$1.50;
- (c) timber-bamboo - - US \$3.50;
- (d) mud - - US \$0.80;
- (e) bamboo - - US \$0.50.

The conclusion was drawn that, while every effort should continue to be made to encourage increased industrial production of basic materials such as cement, steel and milled timber, even greater importance must be attached to improvement of local materials and techniques that are now in general use. Examples from other developing regions confirm this conclusion.

80. Improvement in the quality of local materials is often possible through a marginal evolution involving improved production techniques. Thus, in India, in local production of bricks, tiles, stones, chips etc., machines are progressively replacing manual labour. In India and Indonesia, the quality of lime is

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<sup>43/</sup> Ref. No. 1 (part II, chapter A).

being improved by more effective lime kilns and mechanisation of production. In Burma, the impregnation of bamboos, involving treatment costing 30 per cent of their value, has made it possible to increase the lifetime of the material from five to fifteen years.

#### Promotion of small-scale industry<sup>44/</sup>

61. Building policy, as distinct from over-all industrialisation policy, should thus encourage and assist in improvement of production and the use of traditional materials because they are cheap. Encouragement of traditional materials, however, must not be confused with an industrialisation policy aimed at actively encouraging the establishment of small manufacturing units for producing industrial building materials for markets which can afford these materials but which are likely to be too small to justify large-scale capital-intensive units. Thus, small sawmills and joinery workshops, small modern brickworks or concrete-block undertakings, may exist while round wood and sun-dried bricks are also being used. In the longer run, or concurrently in larger urban centres, where markets permit, larger wood-product factories, brick-works and concrete-product factories that employ the most advanced technology may be justified.

#### Industrial mass production of building materials and components<sup>45/</sup>

62. There are sectors of construction in all countries - and these sectors are growing - which call for the use of high-quality materials. These materials can be produced, economically, only under the most advanced technological conditions. Where the size of the market and availability of raw materials permit, serious consideration should therefore be given to the establishment of capital-intensive high-technology industries producing high qualities of key materials such as cement, iron and steel. Such industries do not replace but rather supplement existing industries at a lower technological level and thus represent a good investment for scarce capital. By replacing imports, these industries help considerably in saving foreign currency; they tend to have a marked linkage and interdependence with other industries and may thus play a pivotal role in stimulating the

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<sup>44/</sup> Ibid. (part II)

<sup>45/</sup> Ibid.



establishment of ancillary economic activities. These are industries that have economies of scale which in a growing economy - where low building costs are especially important - can hasten over-all development. Because production will tend to be process-oriented and machine-paced, labour productivity and performance will tend to be closer to those in more developed countries. Moreover, the introduction of modern processes and technology will have a generally stimulating effect on the attitudes towards technology and industrial skills and will act as growth points in the economy.

63. However, there are also serious difficulties and obstacles in establishing mass-production factories in developing countries. First of all, the cost of establishing manufacturing plants in developing countries tends to be greater than in more developed countries and caution must therefore be exercised in making capital-cost estimates. The higher costs are caused largely by the transport of machinery and equipment and by higher construction and installation costs; initial costs of running-in the factory are normally higher than in more developed countries, as result of the lack of trained staff. It is also common for the cost of the capital invested to be high. than in more developed countries. All these factors easily result in production costs per unit which are higher than world market prices, and special measures might be required in the initial stage to protect the domestic industry until its products are firmly established on the market and are able to compete successfully with imported products, in terms of quality and price. For all these reasons, caution should be exercised and all the factors involved carefully considered, in regard to the feasibility of undertaking mass production of key materials, before decisions are taken.

#### Economies of scale

64. The scale of output is a special economic problem in developing countries, even where a minimum market size makes production feasible. Thus, for example, in cement production, it has been shown that the estimated unit cost of production of cement varies from US \$44 in Cameroon for a plant of 20,000 tons capacity to

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64/ Ref. No. 1 (part II).

US \$38 in Nigeria for a plant of 30,000 tons capacity and US \$31 in Upper Volta for a plant of 60,000 tons. Investment in factories of this kind, therefore, should always be made on the basis of middle- and long-term prospects of growing demand rather than on the basis of present requirements.<sup>47/</sup>

#### Regional co-operation in building materials production<sup>48/</sup>

85. The difficulties described in the previous section suggest an assessment of market possibilities in neighbouring countries in determining the feasibility and capacity of planned installations. Establishment of separate plants in a number of countries, each of which has only a limited market, may lead to the failure of all. The advantages of regional co-operation in the production of certain materials are numerous. Suitable raw material resources and other favourable production factors may be confined to a limited number of countries in a region or sub-region. Technical and managerial skills may be pooled among several countries in establishing industries with advanced technology to serve a regional market. Because of lack of transport facilities or high transport costs, it may be more convenient and economical for a country to enter into co-operative arrangements with a neighbouring country, whereby the latter produces certain materials for a particular geographical market conveniently located in relation to the neighbouring country, even though the "home country" produces the material for the remainder of the national market.

86. Realizing the dangers of duplication of effort and surplus capacity, and the advantages of regional co-operation, many developing countries have already embarked on the regional sharing of markets for building materials. In Central America, under the Economic Integration Programme, the projection of cement consumption assumed there would be trade between countries to offset shortages and surpluses in national markets. In relation to asbestos-cement sheets and plywood, it was also considered that free trade and co-ordination of activities would probably lead to a better use of productive capacity in Central America

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<sup>47/</sup> A theoretical discussion of the effect of repetition on the production costs of building materials and components, as well as examples of economy of scale in production of doors, windows, window assemblies, joinery, kitchen cabinets, prefabricated floor joists and panels, wall panels, concrete foundation slabs, sanitary cores and sanitary fitting, will be found in Ref. No. 7.

<sup>48/</sup> Ref. No. 1 (part II).



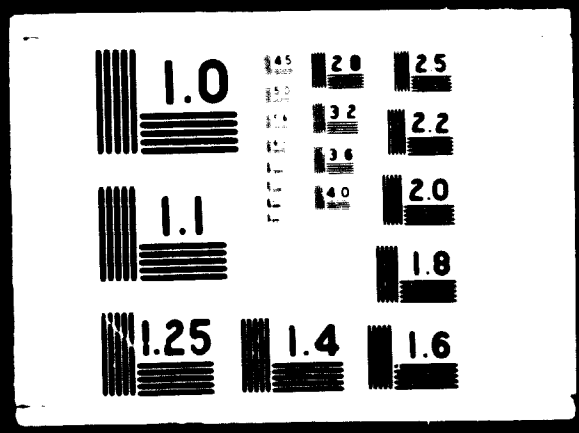
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as a whole. In West Africa, it has been suggested that there are strong reasons for an integrated sub-regional approach to cement production, as result of lack of raw materials in some countries and of the limitation of national markets. The individual markets for flat glass in Algeria, Libya, Morocco and Tunisia are insufficient to justify production for some years to come, but a factory with an initial production of 10,000 tons to serve the four countries has been recommended.

Standardisation and dimensional co-ordination<sup>49/</sup>

87. When the development of building materials production is being considered, a critical review should be made of existing building materials and components, in order to assess the possibilities of limiting the range of items used. The aim would be not only to reduce construction costs, but also to improve the market conditions for materials which can be produced domestically. In the early stages of a country's development, the demand for building materials and some components is met, to a large extent, by imports from developed countries. This often leads to the use of numerous patterns, sizes and scales of one and the same material or component. Attempts to standardise products and dimensions are sometimes resisted by traders who have a vested interest in the status quo. As long as building materials are imported, it may also prove to be a dangerous policy to achieve standardisation through giving preference to materials of a certain brand or imported from a particular country.

88. However, as soon as domestic production is envisaged, it is of the utmost importance to lay down, right from the start, adequate rules and regulations concerning the standardisation of products. Standardisation may involve the acceptance of definitions with regard to dimensions, composition, quality, performance, methods of manufacture and testing. The greater the degree of acceptance of and compliance with a standard by firms within an industry, the greater will be the industry-wide and national benefits which may be enjoyed.

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<sup>49/</sup> Ref. No. 1 (part II and part IV, chapter A).







Quality standards are particularly important for key materials such as cement and steel, but they may also have a positive effect on the productivity and economy of simple items, such as stone aggregates. Dimensional standardisation is of primary importance, in the early stages of economic development, for the effective production and use of brick, concrete-block, sewer pipes and fittings, roof covering, doors and windows, fibre-boards, chip-boards, particle-boards etc. At a more advanced stage of technical development, when large and complex finished building components are increasingly used, dimensional co-ordination becomes an urgent need.<sup>50/</sup>

89. When standardization and dimensional co-ordination are contemplated on the national level, serious consideration should be given to the possibilities of adopting existing international or regional standards. Purely technico-economical considerations, however, may sometimes justify a deviation from the standards adopted in other countries, in order to achieve closer compliance with the real needs and conditions in the country. International or foreign standards, therefore, should not be blindly adopted. The standardization of each item should be carefully studied in each country, on the basis of extensive research and studies if necessary.

90. The importance of standardization and dimensional co-ordination as a means of promoting economy, high productivity and output in the building sector has sometimes been realized too late in industrialized countries. Developing countries have an unusual opportunity to decide upon and apply, at an early stage of development, a coherent system of standards which will regulate the dimensions and properties of building materials and components, as well as methods of testing and quality control. By determined action in this field, these countries may be able to take a considerable short-cut in technical development. This is not a theory, but a fact which has been proved and observed in many developing countries.

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<sup>50/</sup> Ref. No. 13

91. The working out of standards - and, in particular, a coherent and comprehensive system of co-ordinated standards - is not a simple technical task, and it may prove even more difficult to implement in practice. Once a standard has been decided upon, a campaign may be required to overcome conservatism, lack of initiative or vested interests. In the long run, however, standardization and dimensional co-ordination cannot be dispensed with; the battle is worth-while and is bound to give high returns.

Importance of transport costs and transport facilities<sup>51/</sup>

92. As repeatedly stated in this paper, transport forms an integral and important part of the building production process. The main problem today in many countries is not the availability of building materials, nor the cost of extracting or processing them, but the cost of transport. Building materials and components are often heavy and bulky or have to be transported over long distances, particularly in developing countries. Transport costs will therefore constitute an important part of their final cost on site. Apparently, savings in this field can be achieved only through reduction of the bulkiness and weight of materials, the shortening of transport distances, or an improvement in transport facilities, or a combination of these measures. Experience in industrialized countries shows that efforts of this type can bring high returns and have constituted one of the most important means of improving capacity and productivity in building production in the past decade.

93. Intensive research into building materials and construction methods has considerably reduced the consumption of materials per unit, through, for instance, the introduction of high-quality steel, pre-stressed concrete, prefabricated concrete, hollow bricks etc. It is reported from the Soviet Union, for example, that in the most favourable cases a reduction of up to 50 per cent of the weight per building-unit, as compared with traditional construction, has been obtained through the application of new building techniques. Along with a more economical

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<sup>51/</sup> Ref. No. 6

use of traditional building materials, reduction in weight has been achieved through the introduction and increasing use of light-weight concrete, aluminium and plastics. These materials are all expensive, but their light weight and other superior qualities make their use advantageous as a means of reducing transport costs and facilitating the use of industrial production methods.

94. Measures to shorten transport distances are to some extent in opposition to the major trend towards concentration and adoption of more advanced methods of production. The shortest possible distances are, of course, obtained if materials available near the building site are used, but this means that production machinery would have to be moved from site to site and be adapted repeatedly to different raw materials. It is evident that advanced methods of production cannot normally be used under such conditions.

95. For the reasons given, the main way of lowering the cost of transporting building materials and components will be to provide better transport facilities and to increase the efficiency of transport and handling operations. In the past decade, there has been a sort of revolution in the latter respect in industrialized countries. Containers, packages and specially designed transport vehicles are being extensively used, and steel-framed hoists and tower-cranes have become virtually indispensable on the building site. In other words, horizontal and vertical transport and the handling of materials have been mechanized to a large extent.

96. The importance of developing transport facilities on a priority basis in development planning can hardly be overstressed. The establishment of a well-planned network of main roads, railways, waterways and harbours is a prerequisite to the effective organisation of the economy as a whole. It may also be justified in the early stages of economic development as a means of rationalizing the building sector. In fact, there are many examples of important investment projects where the establishment of high-quality, permanent roads or railways proved

to be an economic investment as a means of obtaining the lowest possible total cost of a particular project. In this way, the long-term benefit of a permanent transport network was obtained practically without cost or, at least, without an additional allocation from the national budget.

97. However, a warning against short-term perspectives in the planning of transport networks is perhaps justified. The long-lasting nature of construction works in this field calls for the utmost foresight in regards to quality and location. In transportation, more than in most fields, future demand and requirements -- rather than present needs -- should guide decisions. The economies of many industrialized countries are currently suffering from a badly planned or out-of-date transport system. Another reason for foresight in this field is that the cost of re-organizing the basic transport network tends to rise enormously with economic development. "Over-investments" at the earlier stages of economic development, are therefore highly justified as insurance against excessive costs in the future. As far as construction is concerned, a highly developed transport network will give immediate returns, through the possibility of organizing building materials and components production in an optimum way from the start and through the reduction of transport costs.

Initial costs and durability of building materials<sup>52/</sup>

98. In the choice of building materials and methods, there is a consideration which must not be forgotten: the connexion between the quality of materials used and the nature of building methods employed in new construction, on the one hand, and future maintenance requirements, on the other. The structural components of a building normally have a technical life greater than the expected length of the economic and social use of the building. The only parts which actually wear out or become obsolete are the finishes and equipment. In traditional construction, there was a relatively clear separation of the structure and its finishes; provided that the latter was renewed, replaced or repaired at regular intervals, the life of the building could be assumed to be virtually indefinite. In certain forms of

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<sup>52/</sup> Ref. No. 6 (chapter VI).

non-traditional building, however, the concept of incorporating the finishes and equipment into the structural components has been introduced. When this is accompanied by finishes applied in factories, which can hardly be replaced or reproduced on site, the problem of maintenance and repairs becomes a serious one. The consequence may be that the life of the building as a whole will be determined by its shorter-lived components. It is therefore important that provision be made, at the design stage, for the future replacement of building components and equipment which may be obsolete within the foreseeable future.

99. On the whole, too much emphasis is sometimes paid to simplification of construction and to limitation of the initial building costs, and too little attention to the future life and maintenance costs of the building. The possibility of comparing different technical solutions from the point of view of total costs (including not only initial investment outlay but also future expenditure on recurrent maintenance) might be worth mentioning in this connexion. Methods of making such calculations are discussed in a United Nations report.<sup>53/</sup> Further research, sponsored by the United Kingdom Ministry of Public Building and Works, is now under way in this field.

#### Employment possibilities and labour requirements

100. The characteristic situation in developing countries is one of unemployment among unskilled labourers, combined with a shortage of skilled manpower. There are even greater shortages of professional, managerial and operational skills, which constitute obstacles to industrial development. The training of skilled labour and of professional, managerial and supervisory personnel takes considerable time, and some personnel from abroad may have to be kept in the country for a certain number of years.

101. As far as the production of building materials and components is concerned, the conditions for employing unskilled labour seem particularly favourable, provided that suitable building policies and advanced technology are applied. The large-scale application of prefabrication methods, rather than on-site construction, may prove to be the key to not only a rapid increase in building output, but also the extensive employment of unskilled labour, without impairing the

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<sup>53/</sup> Ref. No. 7

<sup>54/</sup> Ref. No. 1 (part II, chapter B).

quality of the end-product. The unfavourable implication of applying traditional methods of building construction is shown by figures on the relationship between employment in the construction industry and in the building materials industry in Ireland.<sup>54/</sup> For that country, it is stated that the relationship is four to one, i.e. for every four persons employed at a building site or office, only one is employed in the manufacture of building materials.

Quality control and research<sup>55/</sup>

102. The setting up of testing and research institutes and the establishment and control of quality standards are vital necessities in developing countries. The institutes may, at first, be small and simple, but they should develop as quickly as possible into internationally recognised institutes and should base their tests as much as possible on recognised international standards. These institutes may also be responsible for surveying existing resources of raw materials for building, and laying down specifications for the quality and properties of all building. The early linking-up with testing stations in other countries, particularly in the same climatic and geological regions, is very desirable. The importance of avoiding duplication of work should be stressed. Most of the basic research in building materials and components has already been carried out in industrialized countries, and the result can be obtained through published reports and periodicals.

103. In developing countries, standardisation, testing and quality-control of materials and components, education and information represent primary activities, while research and development work unrelated to these activities are to be considered as secondary activities. This means that standardisation, material testing, quality-control, educational and information activities should be organised in the first instance, while independent research and development work should start at a later stage, on the basis of the progress made in the primary activities and in order to develop them. Furthermore, research should concentrate on the particular problems of the country and any necessary adaptation of research results achieved in other countries.

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<sup>54/</sup> Inf. No. 1 (part II, chapter B)

<sup>55/</sup> Inf. No. 1 (parts I, II and IV, chapters B and C).

Information and documentation

104. Manufacturers in developing countries tend to operate within a national horizon and often gain little from the experience of other countries which have undergone similar periods of development. A practical way of finding economic and viable solutions to problems is through personal inspection of similar situations in other countries, to be carried out by professional, technically trained personnel, who would have discussions on the site with their opposite numbers. It is also desirable that information on successes as well as failures of industrial undertakings in developing countries be systematically gathered and disseminated, preferably through international organisations such as the United Nations.

105. Of equal importance are the collection and systematic dissemination, at the national level, of objective information on available building materials and components, for use of clients, designers, building organisations and individuals. The most convenient way to organise such work is to set up a National Building Centre. It should have sufficient resources to keep track of the vast documentation available in this field, to give appropriate advice through information sheets and personal contacts, and to establish the necessary international contacts with other building centres and international organisations. Exhibitions of the most important building materials and components available in the country, particularly those recommended or standardised by public authorities, could be organised in co-operation with the National Building Centre.

Special Government incentives to promote domestic building materials and components production

106. Building materials and components industries, like other industries, may need some help and encouragement from Governments during the first stage of development. As a short-term measure, a system of import tariffs or other protective measures may be introduced, especially for materials subject to strong competition from abroad. Too high a degree of protection for a long period may, however, lead to preservation of high construction costs. Protective measures

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2/ Inf. No. 1 (part IV, chapter F).



should therefore be limited in time. Examples of incentives of a more permanent character may be advisable, such as the following:

- (a) Long-term loans with low interest;
- (b) Exemption from income tax, or from other local taxes and duties, and permission for rapid depreciation rates for an agreed period;
- (c) Development of industrial estates and infra-structures and the provision of cheap land, suitably located;
- (d) Use of locally produced building materials in all government or government-sponsored building and construction programmes;
- (e) Special advice and assistance to industries to develop the export of products, the manufacture and marketing of which the country has a real comparative advantage;
- (f) Special training grants for managerial and skilled labour;
- (g) Reduced rates of transport for industries located in development regions;
- (h) Subsidies for the rent of land or buildings for a period of five to ten years, or a grant of part of the cost of building factory premises. 57/

#### Technical assistance in establishment of building materials and components industries 58/

107. The establishment of industries for building materials and components proceeds in seven clearly distinguishable stages. Technical assistance may be needed for some or all of these. A greater understanding of the stages through which an industrial undertaking must pass would lead to more initiative at local levels and thereby to faster development. These stages are described below.

#### Stage 1: The establishment of national policies

108. This stage requires nation-wide demographic, geological, hydrological and topographical surveys. These are high-priority items in development and pre-investment planning; it is not feasible to await the creation of a cadre of indigenous surveyors and planners to carry out this task alone. Technical assistance usually must be sought; it may be especially needed for data collection, data analysis and planning. Requests for assistance must originate from ministries, government departments, economic planning commissions or similar bodies. Almost all developing countries have made use of technical assistance for surveys of this kind and, on the whole, international co-operation and help have been successful in this field.

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57/ Ref. No. 14.

58/ Ref. No. 1 (part IV, chapter G).

Stage 2: Determination of the distribution and location of industries

109. The development potential of each of the geographic and economic regions of a country should be established, and national economic plans drawn up in terms of regional investment programmes and targets. Technical assistance is needed for regional surveys and planning, the study of industrial location, and market research. Experts from the building materials and components industries should enter the discussion at this stage. Requests for assistance should originate locally and be routed through a co-ordinating agency in the national government. The record of technical assistance in this stage is not as good as in the first one. There has been a lack of local initiative and a shortage of suitable experts from abroad. In most countries, implementation at local levels has received far less attention than national planning, and has also been subjected to far greater pressure from local vested interests.

Stage 3: Feasibility studies.

110. This is the stage at which proposals for particular factories begin to be discussed. It should be started simultaneously with, or immediately after, the preparation of regional implementation plans. Assistance should come from consultants specializing in feasibility studies and experts from the industries concerned. It should include the analysis of raw materials and of transport, water and power resources, the labour market, housing accommodation, climate, local capital resources and marketing problems. Feasibility studies must be carried out in the shortest possible time, so that they will not be outdated before they are completed. Requests for assistance may originate from private developers, foreign investors or local authorities, and these should be channelled through the Government. Feasibility studies have been the most frequent form of technical assistance in the establishment of industries for building materials and components. Few, if any, factories that employ more than a handful of labourers are started without such studies.

Stage 4: The planning of individual factories

111. The design of the plant follows the establishment of its feasibility and the arrangement of finance. Many developing countries have architects capable of designing factory buildings, but require foreign assistance for the planning of industrial processes and the design and layout of machinery. Requests for assistance must come from the sponsors of the industrial undertaking. Developing countries have experienced no serious difficulty in obtaining assistance in plant design. The facilities offered by the United Nations for obtaining technical assistance from non-interested parties, however, have not been sufficiently utilized.

Stage 5: The erection of plants and the design of products

112. In theory, construction should follow design. In practice, the two often overlap - to the detriment of both. Loss of time and increased costs are the usual results. The establishment of new plants and machinery has become a specialized type of engineering know-how, which can be suitably supplied through technical assistance. Adapting building components and fittings to local requirements and conditions is a task that cannot wait until the plant is completed. The product designer must co-operate with the plant designer, and both must be present during the erection, calibrating, tuning and running-in period. Requests for help must come from the developer and financial backers. Both stand to lose through faulty design or poor programming. Stage 5 differs from the preceding stages in that help from independent consultants and international agencies is rarely needed.

Stage 6: Plant operation and industrial design

113. Operational assistance is essential during the running-in period and for a considerable time thereafter. Industrial design must be recognized as a continuous process throughout the life of the plant. The task of both the operational expert and the industrial designer from abroad should therefore be that of a teacher who makes himself redundant by the training of indigenous staff. Technical skills can be acquired quickly; managerial skills take longer. Industrialists and politicians in developing countries tend to underrate the

period of learning, while experts and advisers from developed countries are apt to overrate it and to appear paternalistic.

**Stage 7: Marketing and distribution**

iii. Preparatory work for this stage, including market research and the establishment of public relations, should begin long before the plant is ready to produce. The distribution system must be ready when the first products come off the assembly line. Expertise on all these subjects is essential to success. Technical assistance may be obtained through public relations and marketing consultants, preferably engaged through United Nations technical assistance or an international foundation. Independence from competitors in developed countries is essential.

## V. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

### Need, urgency and importance of action to be taken

115. No industrial, economic or social progress is feasible without considerable effort in terms of new construction, modernization and maintenance of buildings, civil engineering and public works. In virtually all countries, more than half of all investment expenditures are used for construction purposes and, in addition, considerable "consumption" expenditure goes for the maintenance and modernization of construction works. However, the unmet demand for new buildings, the evident need for slum clearance and urban renewal, and the backlog in maintenance of the built-up stock characterizing the situation even in some of the most industrially developed countries, point to the difficulties facing the building materials and components sector in satisfying requirements in step with economic growth.

116. There are numerous reasons for the shortcomings experienced in this field, many of them have their root in the very special characteristics of construction activities as such and the consequent diversified and unlevelled character of the building materials and components sector. The underdeveloped attitude in regarding construction as a service indispensable to other industrial sectors, rather than as an industry of its own, has until recently - even in industrialized countries - provided a major obstacle to efficiency and continuity in production of building materials and components. The "non-market" character of the construction industry has no doubt contributed in many countries to the preservation of traditional on-site methods of production, while in other industrial sectors, international trade and competition have provided a rapid rationalization and have contributed to a steady lowering of the relative prices of consumer products. Building costs, on the other hand, have tended, in most countries, to rise faster than the general cost level - a fact which, combined with a steadily increasing demand for higher-quality standards and equipment, has led to almost insurmountable difficulties of satisfying rising needs, particularly in the housing sector. The complex nature of the building production process, the many interests involved, and

local variations in building regulations have also prevented efforts from being made to raise the production of building materials and components to a higher level of industrialization.

117. Fairly recently, and only in some countries, it has been realized that it will never be possible to meet the needs and demand for construction works of all kinds -- whether in terms of cost and quality or in terms of quantity -- unless mass-production techniques, standardization and effective co-ordination of the building production process as a whole are ensured. Bearing in mind, in particular, the high cost and permanent character of end-products and the consequent importance of construction activities for the national economy, from the economic and physical planning points of view, as well as the many other responsibilities of public authorities in the construction field, it is unlikely that the necessary continuity of demand for building materials and components will materialize unless determined action is taken or, at least, encouragement is given by Governments.

118. It would seem that the conditions prevailing in developing countries, combined with the nature of construction activities (drawing mainly on locally available resources in terms of materials and manpower), could provide the ground for more rapid progress in the building materials and components sector than in many other industrial sectors, provided that the most up-to-date experience and the most advanced technology of industrialized countries are made use of at the earliest possible stage of economic development. In many respects, the necessary pre-conditions for effective building materials production and low building costs are more favourable in developing countries than in some industrialized ones. Thus, the concept of long-term national economic planning as a prerequisite for economic growth is generally accepted in most developing countries, a fact that greatly facilitates the kind of long-term programming and planning of construction activities (advocated in chapter III of this paper) as a primary means of establishing desirable market and production conditions for building materials and components. Standardisation, dimensional co-ordination, quality-control and similar measures which substantially help to

facilitate effective production, generally are more easily introduced and accepted when public building programmes form the predominant share of the demand and before - or in connexion with - the start of domestic production on an industrial scale. Furthermore, land, raw materials and unskilled labour are normally abundant and cheap, and the investment required for machinery and equipment is very small indeed when compared to the vast funds invested every year in construction works. The millions invested in machinery and equipment for effective production of building materials and components and in effective transport facilities in these early stages of economic development will have a decisive effect on the economy and the return of the milliards to be invested in construction works in the future. Every effort must therefore be made to avoid mistakes in the investment policy in this field. What is most needed to ensure an effective organization and a rapid development of the building materials and components sector is largely of a non-material nature (administrative advice; technical know-how; managerial, operational, organizational and planning skills). Advice and assistance of this kind should not be too difficult to obtain through international organizations or bilateral arrangements.

#### Recommendations for action on the national level

119. The main responsibility of Governments and public authorities is to provide an effective institutional framework for sound development of the building materials and components sector. In addition, recommendations may be made - or regulations issued - concerning technical questions, in so far as they affect national interests, such as employment, over-all national economy, use of investment resources, use of energy, prevention of air and water pollution etc. Governments should comprehend the building materials and components sector as a whole; promotional measures may particularly be required to encourage improved efficiency in the provision of "non-industrial" building materials.

120. The following general measures for promoting the establishment and rapid development of an efficiently working domestic building materials and components sector are suggested for consideration by Governments:

- (a) The surveying of locally available organic and non-organic raw materials suitable for the production of building materials, components and equipment;
- (b) Study of the present use and mis-use of locally produced building materials, as well as of quantities and end-uses of imported building materials;
- (c) Establishment of long-term targets for the building materials, components and equipment industries on the basis of long-term plans of construction activities;
- (d) Rapid development of transport facilities, in order to ensure accessibility to raw materials resources and to enable an optimum over-all organization and co-ordination of producing units, employing mass-production techniques, when justified;
- (e) Establishment of a coherent system of standardization, dimensional co-ordination, quality control and building regulations in close conjunction with corresponding measures relating to construction activities;
- (f) Acquisition of technological, managerial, organisational and operational know-how regarding the most effective methods of producing and using locally available building materials, and dissemination of this information to the various interests concerned;
- (g) Introduction of special incentive systems in order to encourage the setting up and development of domestic building materials and components industries, based, as far as possible, on locally available raw materials;
- (h) Encouragement of self-help, co-operative and other spontaneous building activities, insofar as domestically produced materials are used and provided that the activities are carried out according to adequate physical planning and health standards. This will help to enlarge the market for mass-produced standardised building materials and components and is likely to be the only realistic way of achieving acceptable housing standards in the short run;
- (i) Encouragement of modern mass-producing techniques (when feasibility studies indicate that this is justified) for the production of high- and even-quality key materials such as cement and steel, but also of aggregates and ready-mixed concrete, so as to ensure the utmost economy in the production and use of these materials and the lowest possible transport costs;
- (j) The seeking of regional co-operation with neighbouring countries, whenever desirable, to obtain maximum efficiency and economy in the provision of building materials and components, to save hard currency and to avoid duplication and uneconomic investments in the production of identical products.



Recommendations for action on the regional level

121. The regional economic commissions and other regional bodies and organisations in the developing regions may assist and advise (and/or channel assistance and advice to) Governments regarding all the measures proposed to be taken on the national level. They should be particularly active as regards the promotion of co-operation between the countries of the region. They should systematically analyse basic information collected and compiled on the national level and, if necessary, secure supplementary first-hand information on the spot, so as to be able to pool information and technical assistance within the region. These bodies may also be responsible for feeding back, to the international central body concerned the experience gained from feasibility studies as well as experience regarding successes or failures of investment in the building materials and components industries in their regions. Regional bodies could also assume a more active role as "regional catalysts", bringing together industrialists and financiers from developed countries with the Governments of the region for a mutually beneficial partnership.

Recommendations for action on the world level

122. The main activity of an international body in the field of building materials and components production should be to provide a focal point for the collection and systematic analysis of information and experience from industrialised countries in various regions, regarding government policies in relation to this industry sector as well as technical, organisational, managerial and operational know-how of general interest in this field, and to channel the relevant parts of this information, presented in suitable form, either directly to individual Governments or through regional bodies.

123. It would further be necessary to collate the information received directly, or obtained through regional bodies, regarding raw material resources, external conditions and other relevant factors affecting building materials and components production in developing countries, as well as the experience gained from feasibility studies and investment projects already implemented. When appropriate, steps should be taken to ensure inter-regional co-operation

and exchange of information.<sup>59/</sup>

124. It would be most desirable to carry out independent studies and research into problems of general interest to all countries, in particular to developing countries, regarding suitable strategies for development of the building materials and components industries under various external conditions and at various stages of economic development.

125. It would be very useful if "type models" could be established of the entire building production process under various conditions and using alternative technologies, illustrating the importance and effect of policy decisions regarding the organisation of and investments in this industry sector.

126. In view of the foregoing, UNIDO should:

- (a) Be responsible for collecting accurate data regarding the required material inputs for various kinds of construction works, including alternative materials and components, and for following technological-economic trends in the use of various materials for different purposes;
- (b) Compile and present, in suitable form, the information available on the effect of scale of production in the manufacturing of various building materials, components and equipment. Any complementary research in this field should be carried out;
- (c) Elaborate a guide for the organisation and management of labour-intensive building components production, including information about the channels through which individual Governments may obtain technical assistance in the practical application of this guide.

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<sup>59/</sup> In the field of building materials and components production, consideration might be given to the classifying of countries according to climatic conditions, raw materials resources and stage of economic development, rather than according to geographical location.

**Annex I**  
**BACKGROUND DOCUMENTATION**

- Inf.D.1:** "Development of the Building Materials and Components Sector". Report prepared by the ECE secretariat in collaboration with a group of consultants, whose names and functions are given in the preface of the report. Geneva. 1967.
- Inf.D.2:** "Construction Industries". A sectoral study prepared for the Symposium by the United Nations Centre for Housing, Building and Planning (document ID/CONF.1/24).
- Inf.D.3:** "Proceedings of the Seminar on Changes in the Structure of the Building Industry Necessary to Improve its Efficiency and to Increase its Output" (document ST/ECE/NOU/13, 3 volumes). United Nations. 1965.
- Inf.D.4:** "International Standard Industrial Classification of all Economic Activities" (document ST/STAT/SER.M/L/Rev.1/Add.1). United Nations. 1959.
- Inf.D.5:** "Year Book of National Accounts Statistics", published annually by the Statistical Office of the United Nations, New York.
- Inf.D.6:** "Major Long-term Problems of Government Housing and Related Policies" (document ST/ECE/NOU/20, 2 volumes). United Nations. 1966.
- Inf.D.7:** "Cost Repetition Maintenance - Related Aspects of Building Prices" (document ST/ECE/NOU/7). United Nations. 1963.
- Inf.D.8:** "Report of the Inter-regional Seminar on the Cement Industry" (ST/TAC/STR.C/71). United Nations. 1965.
- Inf.D.9:** "The Use of Steel in Construction" (document ST/ECE/STEEL/10). United Nations. 1964.
- Inf.D.10:** "Trends and Problems of the Iron and Steel Industry and its Markets" (document NE/51/67/D.2). Paper prepared by the ECE secretariat on the basis of a study entitled "World Trade in Steel and Steel Demand in Developing Countries", carried out under the auspices of the ECE Steel Committee. Geneva. 1967.
- Inf.D.11:** "Aspects of Competition between Steel and Other Materials" (document ST/ECE/STEEL/17. United Nations. 1967.
- Inf.D.12:** "A Forecast of the Evolution of the Consumption of Plastics in the Building Industry Until 1975". Report on a study carried out by the Battelle Institut. Geneva. 1967.

Ref. No. 1) "Dimensional Co-ordination in Building - Current Trends in ECE Countries" (document ST/ECE/NOU/10). United Nations, 1967.

Ref. No. 2) "Industrial Estates: Policies, Plans and Progress" (document ST/CIB/10) New York, 1966 United Nations publication, Sales No: 66.II.B.16)

Ref. No. 3) "European Timber Trends and Prospects". A new appraisal, 1950-1975, prepared jointly by the secretariats of the Food and Agriculture Organization and the United Nations Economic Commission for Europe. New York, 1966 (United Nations publication, Sales No: 66.II.B.4).

Ref. No. 4) "Materials Usage in New Building". Design series 58 of "Current Papers", published by the Building Research Station, Ministry of Technology, United Kingdom, 1967.

Annex II

**TOTAL INVESTMENTS AND INVESTMENTS IN NEW CONSTRUCTION WORKS IN COUNTRIES AT DIFFERENT STAGES OF ECONOMIC DEVELOPMENT (1960-1963)**

	GDP per capita in 1963; U.S.\$	Total investments; % of GNP	Investments in new construction works; % of total investments	Investments in new construction; % of GNP
<b>Group I: Up to US \$200</b>	(1)	(2)	(3)	(4)
<b>GDP per capita</b>	127 <sup>(a)</sup>	14.5 <sup>(a)</sup>	55.2 <sup>(a)</sup>	7.9 <sup>(a)</sup>
Viet-Nam, Rep. of	73	8	38	3.0
Burma	75	16	66	10.6
Uganda	75	11	48	5.3
Tanzania	79	11	63	6.9
Sudan	80	13	58	7.5
Kenya	88	14	53	7.4
Nigeria	102	13	68	8.8
Thailand	112	18	44	7.9
China, Rep. of	121	25	51	12.7
Korea, Rep. of	124	13	67	8.7
Philippines	127	12	36	4.3
Ceylon	141	14	66	9.2
Syria	142	18	63	11.3
Morocco	144	10	64	6.4
Rhodesia and Nyasaland	175	19	60	11.4
El Salvador	178	12	40	4.8
Ecuador	189	13	54	6.9
Honduras	193	12	64	7.7
Tunisia	199	19	46	8.7
<b>Group II: US \$200-500</b>				
<b>GDP per capita</b>	315 <sup>(b)</sup>	17.9 <sup>(b)</sup>	58.2 <sup>(b)</sup>	9.9 <sup>(b)</sup>
China	204	19	69	12.9
Jordan	204	14	66	9.2
Malaysia	222	14	67	9.4
Mauritius	270	18	60	10.8
British Guiana	296	26	41	6.8
Colombia	298	18	61	11.0
Portugal	381	18	58	10.4
Cyprus	403	17	56	9.5
Greece	412	23	61	14.0
Chile	457	12	44	5.3

Annex II (continued)

	GDP per capita in 1963; U.S.\$	Total investments; % of GNP	Investments in new construction works; % of total investments	Investments in new construction % of GNP
	(1)	(2)	(3)	(4)
<b>Group III - US \$500-1000</b>				
<b>GDP per capita</b>	825 <sup>(c)</sup>	24.7 <sup>(c)</sup>	54.4 <sup>(c)</sup>	13.4 <sup>(c)</sup>
Trinidad and Tobago	650	28	31	8.7
Venezuela	716	18	61	11.0
Ireland	793	16	54	8.6
Finland	812	39	60	23.4
Israel	826	29	60	17.4
Puerto Rico	886	21	67	14.1
Austria	936	24	46	11.0
Italy	980	23	56	12.9

Source: Ref. No. 1 (part II, chapter A, table 1).

- (a) Simple average of 19 countries.
- (b) Simple average of 10 countries.
- (c) Simple average of 8 countries.

Annex III<sup>a/</sup>

ESTIMATE OF THE SHARE OF CONSTRUCTION EXPENDITURES SPENT ON THE  
 PURCHASE OF BUILDING MATERIALS AND COMPONENTS IN GROUPS OF  
 COUNTRIES AT DIFFERENT STAGES OF ECONOMIC DEVELOPMENT

	Country group		
	I	II	III
<b>A. New construction</b>			
<b>1. Composition of total investment costs</b>			
(i) housing	27 <sup>(a)</sup>	38 <sup>(b)</sup>	34 <sup>(c)</sup>
(ii) non-residential buildings	29 <sup>(a)</sup>	16 <sup>(b)</sup>	34 <sup>(c)</sup>
(iii) other construction and works	44 <sup>(a)</sup>	46 <sup>(b)</sup>	32 <sup>(c)</sup>
<b>2. Estimated building materials and components input % of share in total cost</b>			
(i) housing (incl. equipment)	60	60	60
(ii) non-residential building (excluding equipment)	60	50	40
(iii) other construction and works (excl. machinery)	50	60	60
<b>3. Calculation of weighted average of building materials and components input % share in total cost</b>			
(i) housing	16.2	22.8	20.4
(ii) non-residential buildings	17.4	8.0	13.6
(iii) other construction and works	22.0	27.6	19.2
<b>Total</b>	<b>59.6</b>	<b>58.4</b>	<b>63.2</b>
<p>(a) Simple average of data from eight countries for which relevant information was provided in <u>Ref.No.1</u> (part II).</p> <p>(b) Simple average of data from seven countries for which relevant information was provided in <u>Ref.No.1</u> (part II).</p> <p>(c) Simple average of data from five countries for which relevant information was provided in <u>Ref.No.1</u> (part II).</p>			

<sup>a/</sup> It should be noted that the estimates made in this annex merely serve the purpose of illustrating the method of calculation. Statistical data or other reliable information is not available to provide firm estimates.

	Country group		
	I	II	III
<b><u>Maintenance and modernisation works</u></b>			
<b>1. <u>Estimated relative size of the stock of buildings and construction works in the monetary sector of economies</u></b>			
(i) housing	2	14	42
(ii) non-residential buildings	2	6	18
(iii) other construction and works	3	26	74
<b>Total</b>	<b>7</b>	<b>46</b>	<b>134</b>
<b>2. <u>Corresponding estimated expenditures on maintenance and modernisation (\$ of GNP)</u></b>			
<b>Total</b>	<b>0.2</b>	<b>1.4</b>	<b>4.0<sup>(a)</sup></b>
(i) housing	0.06	0.43	1.25
(ii) non-residential buildings	0.06	0.18	0.55
(iii) other construction and works	0.08	0.79	2.20
<b>3. <u>Estimated building materials and component input &amp; share in total costs</u></b>			
(i) housing	20	30	40
(ii) non-residential buildings	30	40	50
(iii) other construction and works	60	30	40
<b>4. <u>Calculation of weighted average of building materials and component input &amp; share in total cost</u></b>			
(i) housing	5.6	9.9	12.5
(ii) non-residential buildings	8.6	5.2	6.7
(iii) other construction and works	25.8	28.3	22.1
<b>Weighted average</b>	<b>40.9</b>	<b>42.6</b>	<b>41.3</b>

(a) Secretariat estimate based on information provided in Ref. No. 7.



#### ANNEX IV

### SUB-DIVISION OF THE BUILDING MATERIALS AND COMPONENTS SECTOR IN BRANCHED ACCORDING TO TYPE OF PRODUCT AND IMPORTANCE OF PLANT LOCATION

#### Introductory Note

The possibilities, usefulness and economy of producing various building materials and components in development countries, apart from their importance as construction inputs, to a large measure depend on the locational factor. This is why the main branches of the sector have been sub-divided according to the importance of the location of plant, as follows:

- (a) Input-oriented products: The location of the production of these is mainly determined by the availability, purity and transport costs of the raw materials and other important inputs used, such as water and energy. They will therefore have to be produced where these input factors are readily available and then transported to the building site or to factories for intermediate processing.
- (b) Production-oriented products: The location of factories producing these products depends mainly on the availability of production factors, such as managerial, supervisory and operational skill, know-how, and the economy of production is largely determined by the scale and technology of production. The cost of the raw materials and of other inputs required forms a comparatively small share of total production costs; they may thus be transported over long distances. The value-weight ratio of the end-products is normally high enough to allow their transport over long distances.
- (c) Site-oriented products: These products are too heavy, bulky, costly, or otherwise difficult to transport over long distances to allow the production unit to be placed too far from the construction site. They are, in fact, often produced on the site by the construction industry or off the site as an auxiliary to this industry. It is only at the latest stage of technical development that independent factories for the production of products of this kind have developed.
- (d) Flexible products: These products may be economically produced either near the suitable raw materials resources or near the building site (or even on site). The production technology covers a wide range of possibilities from simple handcraft production to automated processes. The choice of the location and technology of the production unit is determined by the external conditions in each specific case, in terms of available transport facilities, costs, competition and concentration of demand etc.

**Branch A: Extraction, simple processing and transport of natural building materials and semi-finished building elements**

**Input-oriented production**

- (a) Extraction of clay, mud, soil and other natural raw materials available in bulk form;
- (b) Quarrying and shaping of natural stone elements (sub-divided according to raw materials);
- (c) Extraction, washing and grading of sand, gravel and other natural aggregates;
- (d) Quarrying, crushing, washing and grading of rock and stone for use as aggregates;
- (e) Extraction and simple shaping of natural wood (sub-divided according to raw materials used, e.g. hardwood, softwood, bamboo etc.);
- (f) Production of sun-dried bricks.

**Flexible production**

Wood milling (sub-divided according to raw materials used).

**Branch B: Production and transport of synthetic building materials and semi-finished elements**

**Input-oriented products**

- (a) Lime (sub-divided according to type);
- (b) Cement (sub-divided according to type);
- (c) Ceramsite aggregates;
- (d) Gypsum;
- (e) Clay bricks, blocks, tiles, slates, pipes, ducts etc. (sub-divided according to type, e.g. solid and hollowed bricks or blocks);
- (f) Sand-lime bricks, brick blocks etc.;
- (g) Light-weight concrete blocks and other semi-finished light-weight concrete elements (sub-divided according to raw material used and method of production).

**Production-oriented products**

- (a) Asbestos-cement sheet;
- (b) Constructional steel and iron products (reinforcing bars, nails and bolts, steel wire and mesh, bars, pipes and ducts, corrugated steel sheets etc.);

- (c) Galvanized steel sheets;
- (d) Stainless steel sheets;
- (e) Aluminium sheets;
- (f) Zinc metal;
- (g) Plywood, hardboard, particle board and chipboard;
- (h) Wood-wool slabs;
- (i) Asphalts and bituminous products;
- (j) Linoleum;
- (k) Paints, oils and varnishes;
- (l) Plastic pipes, tiles, sheets etc.;
- (m) Joint sealants and mastics;
- (n) Plaster board;
- (o) Stoneware tiles, slates, pipes, ducts etc.;
- (p) Ceramic tiles, slates, pipes, ducts etc.;
- (q) Window-panes and other basic glass products used in building;
- (r) Copper-brass pipes;
- (s) Bituminous felts and fabrics

#### Flexible products

- (a) Ready-mixed concrete and plaster;
- (b) Concrete blocks (solid and hollow), tiles, slates, pipes, ducts etc.;
- (c) Timber frames, door-leaves and other semi-finished wood-based elements;
- (d) Semi-finished plywood and hardboard elements;
- (e) Matting (sub-divided according to raw material used: organic wool, mineral wool, sea-weed etc.).

#### Branch C: Production and transport of finished building components, assembly and equipment

##### Production-oriented products

- (a) Partition-wall components (subdivided according to material used);
- (b) Non-load-bearing exterior wall-panels and assemblies (sub-divided according to main material used);
- (c) Roofing panels and felts (sub-divided according to material used);
- (d) Interior and exterior cladding;
- (e) Floor coverings;
- (f) Ceramic sanitary-ware;
- (g) Sanitary fittings;
- (h) Electrical fittings;
- (i) Heating, cooling ventilation and air-conditioning equipment and fittings;
- (j) Piles, structural-frame components, beams, columns etc. made of steel or pre-stressed concrete;
- (k) Structural floor panels and load-bearing inner wall panels made of hollow slab-reinforced concrete, pre-stressed concrete or light-weight concrete;
- (l) Load-bearing exterior wall panels and assemblies, insofar as they are composed of several layers or produced according to advanced technology;

- (m) Prefabricated components, parts and assemblies for civil engineering and public works made of steel or pre-stressed concrete.

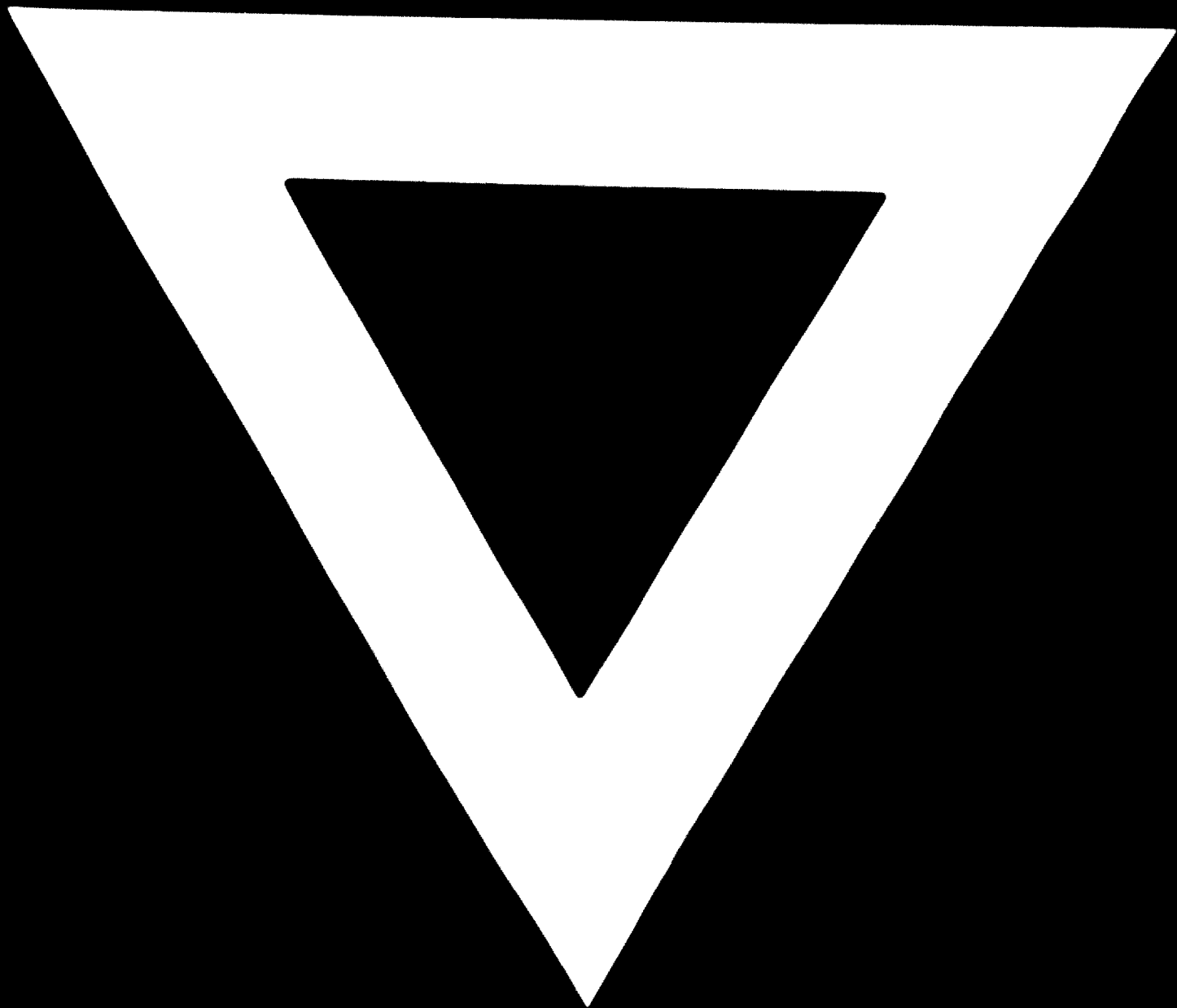
End-use-oriented products

Foundation components, structural-frame components, beams, columns, floor panels, inner-wall panels and similar components, made of steel-reinforced concrete or post-stressed concrete.

Flexible products

- (a) Staircases and landings;
- (b) Refuse-shute components;
- (c) Windows and window assemblies;
- (d) Doors and door assemblies;
- (e) Joinery and fixed furniture;
- (f) Prefabricated sewerage components.





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