# How developing countries can best use the construction "know-how" of developed countries and apply it to local conditions

# How Developing Countries can Best use the Construction „Know-How" of Developed Countries and Apply it to Local Conditions

Engagement optimal du know-how des pays industriels dans les régions en développement

Optimaler Einsatz des Know-How der Industrieländer in Entwicklungsgebieten

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**SUMMARY**
This paper deals with the technical know-how of the developed countries in the field of planning, design and construction of buildings and how this know-how can be adapted to the technical level of the developing countries. The ability of a developing area to assimilate this know-how depends to a large extent on historical, religious, social, economic and climatic factors in that particular region.

**RESUME**
Cet article traite du know-how technique des pays développés dans le cadre de la conception, du projet, et de la construction de bâtiments et de l'adaptation de ce know-how au niveau technique des pays en développement. La capacité d'assimilation de ce „know-how" technique dans une région en développement, dépend dans une grande mesure des facteurs historiques, religieux, sociaux, économiques et du climat dans la région concernée.

**ZUSAMMENFASSUNG**
Dieser Beitrag befasst sich mit dem technischen Know-how der Industrieländer im Bereich der Vorbereitung, Projektierung und Ausführung von Bauwerken und dessen Anpassung an die technischen Möglichkeiten in Entwicklungsgebieten. Die Aufnahmefähigkeit der Entwicklungsgebiete in bezug auf den Transfer dieses Know-how der Industrieländer hängt wesentlich von den historischen, religiösen, sozialen, wirtschaftlichen und klimatischen Gegebenheiten einer bestimmten Region ab.

## 1. INTRODUCTION

Construction engineering has a long history not only as a science but also as an art in most countries of the world. There is no doubt that throughout history there have existed masterbuilders with great structural insight and enormous reserves of imagination. The first great structural engineer and builder of the stepped pyramid at Sakkara, Imhotep, was deified by the ancient Egyptians. Greek and Roman structures, the building of Moorish Spain, the Gothic cathedrals of Europe and the Islamic monuments of the Moguls and the Ottomans include works of construction that would be impossible to duplicate even today. Aesthetics, patronage and a high factor of safety appear to be the main basis of "design" and construction in all traditional structures. The application of the scientific process to design and construction took a long time even in countries that are developed in this field today. It had to emerge as the outcome of Industrial Revolution in Europe. The position of the neutral axis of a beam cross-section, as Heyman (1) has mentioned, was finally fixed only in the 19th century.

Over the last hundred years, developed countries have recognized and studied structural engineering as a science, have minimized the constraints of tradition and have begun to follow codified, rational procedures of design and construction. In developing countries, on the other hand, an overwhelming percentage of design and construction is still carried out empirically.

This paper describes the present-day techniques of design and construction of developed countries and discusses the uses and applications of these techniques and know-how in developing countries. The application of such know-how in a particular developing country will depend on the social, economic, religious and climatic conditions of that country. Attitudes in developing countries may be changed by the acquisition of wealth, by national aspirations, by suitability of geographical position or by cooperation with other countries. It is the contention of this paper that in the application of know-how, imitation of techniques can only be a first step; the logical approach is assimilation.

## 2. DESIGN AND CONSTRUCTION IN DEVELOPED COUNTRIES

The modern philosophy of design and construction is based on the three principal factors of economy, safety and aesthetics. The economic factor assumes the most importance in decision making, choice of structural system and selection of materials. Advancements in the fields of materials science, structural engineering and construction technology have led to a reduction in safety factors, while ensuring that the risk of structural failure is sufficiently small. Design and construction in developed countries are the result of a continuous process of research and development. Research is directed towards improvements in materials, analysis and design techniques, construction methods, education of engineers, codes and specifications.

Concrete and steel are the two main materials of construction in developed countries. It is now possible to obtain concrete with a compressive strength in the vicinity of 80 kN/mm$^2$ and steel with a yield stress of 520 kN/mm$^2$. By the year 2000, concretes with compressive strengths of over 400 kN/mm$^2$ might be obtainable (2) for special

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(1) Heyman, J., Coulomb's Memoir on Statics - An essay in the history of civil engineering, Cambridge University Press, Cambridge, 1972.

(2) ACI Ad Hoc Board Committee, "Concrete - Year 2000", Journal of the American Concrete Institute, No. 8, Proceedings V.68, August 1971, p. 581.

purposes. It will therefore be apparently feasible, using concrete as a construction material, to construct buildings having heights of 600 m to 900 m, bridges having spans of 500 m to 600 m, floating cities, underground or submarine cities.

Besides steel and concrete, research is also in progress on timber, aluminium, bituminous materials, plastics, articifial lightweight aggregates and waste products as sources of construction materials.

Rapid industrialization in the early 20th century and the demands for housing and work space in the cities have given a big impetus towards high-rise construction in developed countries. Tall buildings for offices, commercial and residential purposes have also created many problems of structural and construction engineering, transportation, city planning and the environment, and attempts have been made to solve these problems over the years. New structural systems and design concepts have been developed for tall buildings. Improved construction methods in the form of lift slab construction, slip forming, prefabrication and industrialized construction have been utilized. Transportation and parking facilities within and outside tall buildings have been designed. Effective water supply, waste water disposal and fire protection measures have been devised. A new concept of "city within the city" has also been started in the planning of tall buildings. In fact, tall buildings are regarded as symbols of national development in most countries.

Besides improvements in living and work spaces, the means of transportation have also been modernized in developed countries. Motorways, freeways, autoroutes and autobahns are frequently referred to as indicators of progress and development.

## 3. APPLICATION OF KNOW-HOW TO DEVELOPING COUNTRIES

Just as civil engineering in the world of today has ceased to be a national field of study and has acquired a universal character, the inevitable result of the application of engineering and technology to human problems, termed Development, has also become an international issue that calls for a healthy dialogue, a workable partnership and, above all, an absence of polemics.

In developing countries, the exploitation of national resources, economic growth and increases in agricultural output have intensified demands for improvements of housing, work space and recreational facilities in urban and rural areas.

Developing countries can use the know-how of developed countries in the preparation of codes, standards and specifications for design and construction. However, these codes should be prepared taking into account the socio-economic and climatic conditions of each country, local construction materials and methods.

Urban construction in developping countries is primarily carried out by using cast in-situ concrete. The present-day techniques of developed countries should be adopted to improve the manufacture and properties of concrete. Use of ready-mixed concrete should be encouraged. The facilities for testing of concrete and other materials are usually not available near the construction sites. In such cases, the use of non-destructive methods for proper quality control as specified in developed countries should be introduced. Recommended procedures and specifications for hot-weather and cold-weather concreting should be enforced.

As the pace of construction increases in developing countries, the demand for materials of construction will also increase. Investigations should be carried out on

local materials and wastes for utilization as constructional materials. A start has already been made in this direction. Research is in progress on the use of rice-husk ash as a cementing material. Bamboo has been used as reinforcement to form "bamboo reinforced concrete" in several countries. Stone dust from quarries is being tested as a fine aggregate in making concrete. Similar studies should be carried out on other waste materials.

Know-how in developing countries may also be inculcated by encouraging the use of small computers operating with the Basic and Fortran languages for the solution of design and construction problems. Large computers should be employed only if efficient use of remote terminals and time-sharing facilities is feasible.

The application of construction know-how of developed countries is urgently needed in the specific areas of low cost housing, large public works and continuing education, which are separately discussed below.

### 3.1 Low Cost Housing

The basic techniques of industrialized construction must be adopted by developing countries, in all of which the problem of shelter is acute. Of the three basic approaches, the post and beam system, the panel system and the box system, the first is specially applicable to countries where only simple machinery for manufacture and erection is available. Light and heavy panel systems may be envisaged in urban areas of developing countries. Box systems need special trailers for the carrying of units and excellent roads, and their application in developing countries is likely to be limited. Large cranes are also required in the erection of structures with box modules.

Developing countries should concentrate on evolving prefabrication systems using reinforced concrete or prestressed concrete, possibly in conjunction with local available materials. As steel is imported by most developing countries, steel structures cannot be used extensively. Wood is also scarce in many such countries. However, masonry is an important building material for houses of up to 4 storeys. Research on masonry is not at a very advanced stage even in developed countries, where masonry is either employed for small residential buildings or as an infill. Research institutions in developing countries have an opportunity to apply scientific methods to the study of load bearing masonry and to assess the role of masonry construction in the field of labour-intensive construction which is an economic necessity in poor countries with large unemployed populations. Similar considerations apply to adobe construction, which in some form accounts for over half of all rural dwellings in developing countries. While research information on adobe construction from developed countries may be limited, the application of the technical know-how of developed countries with its emphasis on analysis, experimentation, systems approach and innovation can result in the creation of a local know-how in the area of adobe construction.

### 3.2 Large Public Works

It is not anticipated that over the next two decades more than a few developing countries will be able to apply the construction technology of developed countries in the field of large public works like dams, bridges, airports and harbours without the active cooperation of developed countries. Apart from know-how aspects, this situation is also brought about by the inability of many developing countries to finance large projects from their own resources. A start has to be made in the rational design of small dams and small bridges.

Care has also to be taken to ensure that in construction work a proper sequence of activities is planned and executed. For example, in road construction, underground pipes and ducts for utilities should be laid before the actual construction is undertaken.

In many cases, it may not be feasible to construct concrete roads in developing countries due to scarcity of cement, poor techniques of construction and lack of adequate maintenance.

### 3.3 Continuing Education

Continuing education is an extremely important aspect in the process of the application of construction know-how to developing countries. This is not to suggest that know-how can formally be taught, but rather that continuing education can help in bringing about the right environment for the application of know-how. Courses in computer applications, systems analysis, construction management, mass transit systems and new materials will stimulate interest in students as well as practising engineers. An engineering hour on television should be instituted in developing countries to discuss topical items and new developments in engineering. Stress should be laid on fields where available know-how could be applied immediately. Thus, rationalization of the design and construction of rural structures to resist earthquakes and other natural disasters, the building of a large number of temporary shelters for displaced persons, rapid construction and assembly of utilitarian structures like sheds, silos and storage tanks, modular design of structures and practical techniques of prestressing would evoke a positive response from all people in the construction industry.

## 4. LOCAL COORDINATION

While stressing the cooperative aspects of the flow of know-how from developed to developing countries, attention must also be paid to individuals and organizations on the spot whose job it is to effect this transfer. In this respect, the report by Wolak (3) on the role of a developer sensitively analyses the subtle interaction between a developer and his environment. Wolak has grouped some representatives of developed countries into "paternal pied-noirs", "desperate do-gooders" and "mercenaries", and has also mentioned the technical, administrative and political difficulties faced by developers in the countries which they seek to develop.

In developing countries, experts who possess and can apply technical know-how are rarely given representation in high-level decision making, which is treated as the exclusive domain of a few privileged civil servants. Fledgling industries, which might provide an alternative medium for the application of technical know-how are all too often geared only to earning quick profits. Industries could support and sponsor research in technical universities that whould not only help the solution of such problems but also raise the level of know-how in the country. Universities in developing countries are sometimes the last ivory towers. They do not often rise to the task of applying the know-how they possess to local conditions.

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(3) Wolak, Z.M., "The role of a developer in the low-cost housing programmes for developing countries", UNIDO Joint Consultation on Prefabrication for Industrial Construction, Warsaw, 1975.

An organic relationship between the government, industry and technical universities is an absolute necessity for the transmutation of theoretical know-how into tangible applied know-how. It is only after such a relationship is genuinely underway that the efforts of countries abroad can be channelled into the country in a productive fashion.

As an example, the provision of large scale low cost housing in developing countries may be considered. Attempts by various governments to deal with this problem within the official framework have not succeeded in developing countries, because it has not been realized that the problem is essentially an industrial problem and needs to be tackled in exactly the same manner as a large dam or steel mill project is handled. Furthermore, it is the job of technical universities to inform the government, industry and the public that the problem of mass shelter has fundamental research aspects and that industrial production may be preferable to rationalization of traditional construction methods alone.

The speedy development of the developing countries of the world is both a necessity and a challenge because in the ultimate analysis the development of the world is the sum total of the development of all the countries in it. Developed countries must share in this urgent task by providing technical expertise not merely to exploit developing countries as potential markets. Development should cease to be a basis of relative economic comparison between countries and should instead provide common minimum absolute standards throughout the world.