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PRESTRESSED CONCRETE TECHNOLOGY IN UNDERDEVELOPED COUNTRIES

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Prestressed Concrete Technology developed by the middle of the last century depending and the increase in material qualities steel and as well as concrete. Compared to the conventional reinforced concrete the P.C technology is not widely distributed and applied in all over the world. Knowledge, Materials, Equipment and so called 'Patents' are still under the monopoly of some Industrial Countries. Process to develop the P.C. technology in underdeveloped countries even in developed countries is a special issue and will be treated in this paper. Research and to develop 'Know-How' i.e. Procuration, Projecting, Consulting, Execution and the Monitoring as well as methodical approach of Marketing will be discussed with concrete examples and case studies. In due time the mistakes and failures which prevents the development of this High Building technology will be emphasized to have the attention of the investors and the concerning Engineers and Architects.

Keywords: Patents, Anchorages, High strength steel, Flowchart.

1 INTRODUCTION

Prestressed concrete systems can be defined as creating a compression zone of a structural member, in the region where tensional stresses are expected to appear, so that whole section under total load combination receives a stress level less than concrete compressive strength. Special attention has to be paid to avoid the stress increases in the section above allowable ones. The prestressed concrete is not the only instance of prestressing. In daily life prestressing is used to carry books before the development of prestressed concrete as seen in Figure 1.

A prestressed concrete structure is different from a conventional reinforced concrete structure due to the application of an initial load on the structure prior to its use. The initial load or 'prestress' is applied to enable the structure to counteract the tensional stresses arising during its service period. Generally, there are two types of prestressed application in the technology field. The first one is Pretensioning System, which is produced in factories, in prestressing bed and the second one is Posttensioning System which are mostly in-situ applications. In this paper only one of the two types Prestressed Concrete applications "Posttensioning System" will be discussed.

1.1 Advantages of Prestressed Concrete

Prestressed concrete systems have brought lots of advantages above all as a construction material, as well as in construction technology.

Figure 1. Man carrying books using prestressing.

From the construction material point of view, using prestressed concrete reduces the slab and beam thickness. Reduced slab thickness enables additional floors to be built for the same allowable building height. Prestressed concrete also allows crossing large spans. This is a reflection of freedom of design concept proposed by Le Corbusier, example shown in Figure 2. This feature improves freedom of design. The use of high strength steel reduces the mild reinforcement requirement. Therefore, cost and construction time of the projects can be reduced. As a construction technology prestressed concrete improves structural systems by producing monolithic structural elements, reducing dead loads and limiting displacements, prestressed concrete designs have also highly controllable construction sequences, which allows practical execution.

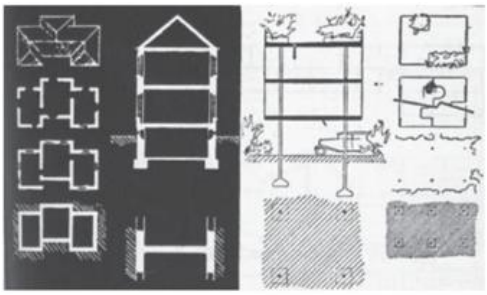

Figure 2. Freedom of design concept of Le Corbusier adopted from Robertson (1940).

2 PRESTRESSED CONCRETE TECHNOLOGY KNOW-HOW

The International Federation for Prestressing (FIP), a professional organization in Europe was established in 1952. Foundation of FIP is the beginning of the spreading of "Prestressed Concrete Technology" all over the World including developed as well as underdeveloped countries under license and know-how certified by FIP. Those companies, who have their "patents" certified by FIP, kept their know-how delicately.

It is apparent that Know-How is a result of a research and development operation. Not only the development of main parts of "Prestressed Concrete Technology" but also methodology in the structural calculations and the methods of application are the main issues in this stage.

3 PRESTRESSED CONCRETE TECHNOLOGY IN UNDERDEVELOPED COUNTRIES

Ersan Goksu who is the co-writer has 50 years of experience in prestressed concrete projects in both developed and underdeveloped countries. Based on his observations, main causes of limited

prestressed concrete use in developing and less developed countries can be explained in the following topics;

3.1 Lack of Information

New technology often increases the volume of the economy since it creates opportunities for investments. However, not paying attention to research and development activities in concrete engineering results in limited usage of these technologies in developing countries (Goksu 2004). In general, utilization of prestressed concrete technology in the structures, brings us, the reduction in mild reinforcement, formwork system, saving and economic gain from construction time, totally about 30% of total investment cost.

Utility, defined in accordance with the definition of "freedom of design" especially in high building applications, with a span of 4.00 m to 6.00 m. is increased in recent years due to the quality of concrete up to 8.00 m. Although with prestressed concrete technology up to 18.00 m the beam-free flooring openings can be attained (Goksu 2005). The inexperience of the designer during the preliminary project, especially because of the "fear reinforcement" that he/she will use, and the deficiencies caused by his inability to know the calculation methods, face the investor in the form that the structure will be suddenly uneconomical. Since the new technology conveyed to the investor, the more expensive alternative investors often reject the new technology.

3.2 Lack of Promotion

Companies who own know-how do not care enough about the promotion in these underdeveloped countries as far as the spreading of the know-how, with desire to protect their monopoly.

Fear resulting from lack of information leads to attitudes and the introduction of negative arguments to support this negativity (Studer *et al.* 1999).

3.3 Conservatism of Know-How Owners

Both the principles, the advantages and benefits arising from projecting and manufacturing and applications of this technology, and in due course protection of technology "patent" system by the FIP, prevent the spreading of the information abroad. Therefore, companies with the know-how increase their profits, whereas designers and contractors in underdeveloped countries could not generate feasible options due to the patent limitations.

Case: Institutions who have the Know-how executing the projects abroad by carrying out their own projects in accordance with their own interests, and so-called know-how transfer does not come to question. Thus, the system so called "hard-ware", is launched according to their profitability rates (Goksu 2004).

In addition, the ratio of mild steel, which is required to be used in parallel with the posttensioning system, to the materials in question – prestressed concrete (PC) materials-, provides companies the possibility to sell more or more profitable amount of PC materials. Even very similar to the material amounts – mild steel and PC – for a structure in two countries, could result in very different costs because of big unit price differences.

In order to increase the cost of the PC materials in a flat slab of a building project, to propose the bonded posttensioning instead of unbonded posttensioning is another case of an engineering trick.

Similarly, instead of using the type of anchors to be used in the project, using a large number of smaller anchors is a separate manufacturer tactic.

3.4 Tender System

Unit price method in tender systems hinders the application of new technologies, which proposes more economical alternatives to the implementer of a project.

In other words, the tendency to escape from the new technologies, which bring enormous amount of economy in the investments will be rejected as a result of the profits in the cost of structure will be completely owned by the owner and will not provide the contractor with a profit. Corruption is also a parameter that supports this tender system, which prevents the development of new technologies. In such kind of tender systems, it is clear that the principle, much material, occurs in the form of high price and high corruption sum.

FIDIC conditions prevent this procedure, especially the silver book, design and construct bidding method face difficulties in such auctions. In this type of tender systems, the alternative project proposition chance will be closed to the contractors.

The lack of optimization studies and Technology Research almost eliminate the development of 'Prestressed Concrete technology' in underdeveloped countries. On the other hand, the main problem of underdeveloped countries is the lack of cost analysis and control. Cost optimization and searching for economical solutions are duties of technical staff and engineers (Goksu 2005).

4 FRAMEWORK FOR DEVELOPMENT OF PRESTRESSED CONCRETE TECHNOLOGY IN UNDERDEVELOPED COUNTRIES

Developing a post-tensioning system needs a team work between civil, metallurgical and mechanical engineers, technicians and draftsmen in order to be able to attain the success. An example multidisciplinary organization chart is presented in Figure 3.

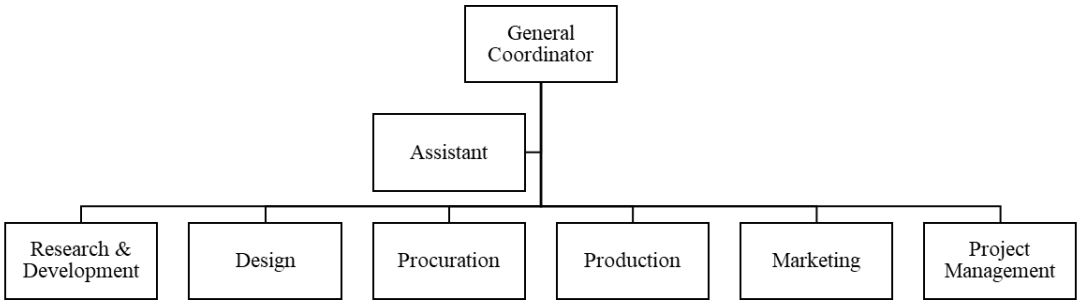

Figure 3. Example organization chart for successful multidisciplinary prestressed concrete technology development team.

4.1 Development of Prestressing Systems –Patents & Technology

All prestressing systems that are proposed for use in Switzerland shall be submitted in the following form to expedite approval of the system or systems. The following checklist includes the minimum required information necessary for approval by the EMPA - Switzerland (Eidgenössische Materialprüfungs und Forschungsanstalt /The Swiss Federal Laboratories for Materials Science and Technology) for a new or modified post-tensioning system:

1. Description

This part includes current product description literature of the system or systems being proposed. Prior listing of the system including specific details of projects, where it has been

used. Complete records of tests run on the system and explanation of how seating loss is to be controlled and measured.

2. Hardware

In the hardware section anchor head, bearing plate, wedges or nuts, and trumpet are described with detailed drawings. Mill certificates and quality control documents are shared.

3. Calculation

Calculations for stresses behind bearing plate at service load after losses and stresses behind bearing plate at 95% specified ultimate tensile strength are shown in this section. Maximum bending stress in bearing plate of 95% specified ultimate tensile strength calculations are presented.

4. System

Detailed drawings of the anchorage system, jacking system as well as duct and grouting details are shown in this section. Complete information on grouting procedures and equipment to be used are explained. Description of how system components are protected from physical damage and corrosion, description of tendon repair or replacement occur and description of how qualified technical assistance provided in the field for the contractor performing the work are detailed.

Therefore, development of the anchorages and their complementary parts, anchor head, anchor plate, spirals, trumpets, grouting bores and ducks – sheaths and static and dynamic analysis and design of those part and verification of their conformity of standards, norms, rules and regulations should be performed. All the devices i.e., all part of prestressing segments should be manufactured according to the corresponding standards (FIP) and fulfill the prescribed rules and regulations with conceivable certificates patents and quality testes necessary.

4.2 Presentation and Marketing

Presentation of this technology includes multiple tasks beginning from the preliminary design such as; consulting the other engineers, architects and design offices, evaluation of bill of quantity, preparation of bidding documents, comparison with the other alternatives and presenting the economy of the system, and convincing the client on this technology till to the execution plans and details. Presentations should also have basis on structural calculations, stability verifications, detail studies in the domain of the mission.

Marketing is another principal task to make system and the technology familiar with state institutions, private investors, architects, and especially engineers and the students. Common efforts with professional organizations to attract attention of the leaders through courses, seminars, colloquiums, and meetings are invaluable for this mission. Marketing also includes preparation of the technical documents, publications and all kind of advertisements is covered in his duty range.

Marketing situation in underdeveloped countries is completely different from the industrial countries as far as the state structures and private investments concerned:

- State Structures: Mostly projected in abroad by foreign engineering groups and approved by the local officials and executed without taking into account of the economy.
- Private Structures: Local engineers do not have the necessary experiences to attack the projects and to propose the alternative technologies and solutions. Prestressing

technology does not only need well qualified materials but it needs quality engineers and workmanship as well.

Marketing and project consultants of the firm have to take as well the corresponding responsibility with the partner engineering group and/or architects against the owner and laws. As a result, the local engineers are afraid to proposing alternative solutions to the owner because of the risks and the amount of projecting and planning tasks. On the other hand, they make the projects without the support of specialists and make designs in very safe side without taking any risks. In both ways solutions become uneconomical and as a result, prestressing know-how could not be cultivated.

5 CONCLUSION

Prestressed concrete technology can be very beneficial for underdeveloped countries by increasing structural quality and by providing economically optimized options. For successful integration of research and development into construction site, private and state organizations should pool their efforts. By promotion campaigns and supportive legislations know-how of prestressed concrete could be more widespread.

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