THE PRODUCTION PERFORMANCE & POTENTIAL OF POLYMERS IN CONCRETE

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Concrete Polymer Composites in RILEM Activity: Current Status and Prospects

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SUMMARY

World wide research activity on concrete polymer composites has been briefly presented. In this framework the RILEM activity on C-PC have been described. The main goal of the RILEM C-PC Technical Committee have been characterized. The Standing Committee on C-PC is proposed for coordinating future works and identity areas where new work would be benefitial. The cooperation in the wide meaning should be involved not only with the composite components but first of all with composite founders.

INTRODUCTION

The very impressive Programme of the 5th International Congress on Polymers in Concrete has given the good evidence how large scientific and technical field is involved with this topic, how many authors in various countries are dealing with Conrete-Polymer Composites, C-PC /Fig.1/. "Bibliography on Polymers in Concrete" by Y.Ohama /1/ and the author's own collection have presented the list of various sucoesful results obtained with C-PC /Fig.2/. The total number of papers on C-PC is approximately 4200 and there are about 3000 patents /2/, also. The Congress brings also better understanding, that there still large number of questions to resolve, O.W.Nutt's statement about "mystery" of Concrete-Polymer Composites has given on the First International Congress in London-1973 is valid still to some extendt at least. There is a need not only and not solely for some particular new technical data, but first of all there is a need to find the way how arrange lots of technical information which are already existed. There is a need for better polymer composite material understanding and on this basis introduce general system of thinking - the general C-PC theory /e.g. 3,4/ with practical meaning.

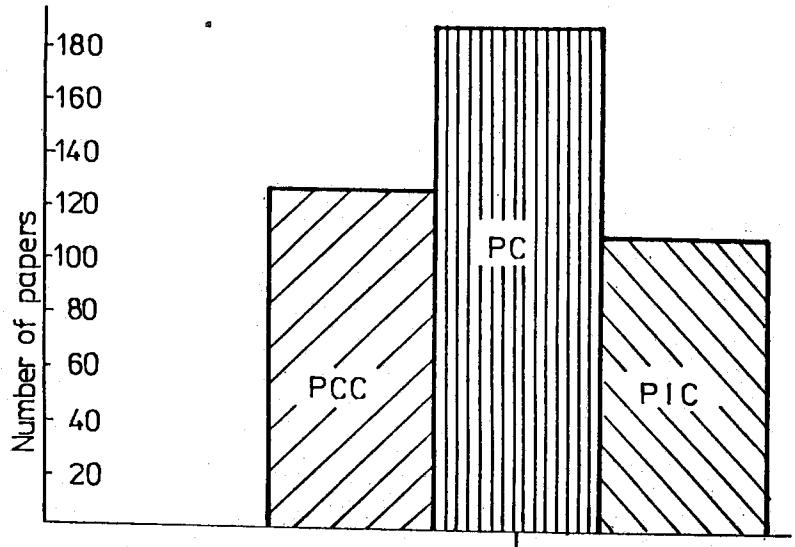
CONCRETE-POLYMER COMPOSITES IN THE FIELD OF RILEM TECHNICAL COMMITTEE ACTIVITIES

RILEM - the International Union of Testing and Research Laboratories for Materials and Construction was founded on 1947. The RILEM is an organization would provide both the focus and the forum to meet the contemporary and future needs in the range of building materials. The title of the First International RILEM Congress /Paris,1987/: "From material science to construction materials engineering" express in comprehensive way the philosophy of this international assosiation. RILEM gathered above 800 members from almost 80 countries. The purpose of RILEM is exchange information on, and to cooperate in, experimental research and tests on building materials and structures in the different laboratories from the various participating countries /5/. All the work of RILEM is conducted by committees /Fig.3/. At present there are above 40 technical committees /6/:

- on properties of regular concrete,
- on test methods for regular concrete,
- on special concretes,
- on special concretes - use of waste materials,
- on natural stones and facades,
- on polymers,
- on metals,
- on other materials,
- on prefabricated concrete structures,
- on structures /other materials than concrete/,
- on behaviour of structures,
- on modeling,
- on general test methods.

It is of interest to stress the similarity between the general field of RILEM activities /Fig.3C/ and C-PC material engineering desingning method /Fig.3.D/. That is refleoted here more general relation between Science, Technology and Composite Material. There is of significance in nowdays.

In principle, RILEM activities are related to all building materials. The most importand building material within RILEM's work is concrete and this topic is dominated in



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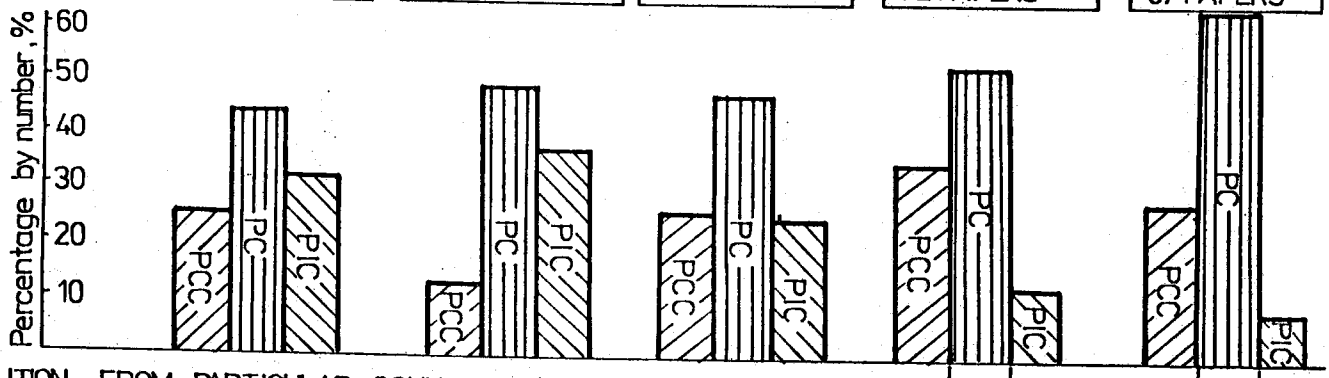
LONDON '75	AUSTIN TEXAS '78	KORIYAMA '81	DARMSTADT '84	BRIGHTON '87
22 COUNTRIES	10 COUNTRIES	18 COUNTRIES	19 COUNTRIES	16 COUNTRIES
54 PAPERS	38 PAPERS	90 PAPERS	72 PAPERS	67 PAPERS



CONTRIBUTION FROM PARTICULAR COUNTRIES (number of papers)

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AUSTRIA	1	1	—	—	—	—	—	—	—	1	1	1	—	—	—
BELGIUM	—	1	—	—	—	—	—	1	—	1	1	—	—	—	—
BURMA	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—
BULGARIA	—	1	1	—	—	1	—	—	—	—	1	—	—	—	—
CANADA	—	—	3	—	—	—	2	2	5	1	3	3	—	2	—
CHINA	—	—	—	—	1	—	—	—	—	—	2	—	—	1	—
CZECHOSLOVAKIA	—	—	1	—	—	—	—	1	2	—	—	—	1	—	—
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POLAND	—	1	—	1	—	—	—	3	5	1	1	1	1	1	1
PORTUGAL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ROMANIA	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—
SOUTH AFRICA	1	—	—	—	—	—	—	—	—	—	2	—	—	2	—
SPAIN	1	—	—	—	—	—	3	—	—	—	—	—	—	—	—
SWEDEN	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
SWITZERLAND	—	1	1	—	—	—	1	—	—	—	—	—	1	—	—
THAILAND	1	—	—	—	—	—	2	—	—	—	4	—	3	9	3
U K	10	4	2	1	—	—	3	10	4	3	6	2	1	8	2
USA	2	2	4	3	13	13	2	10	1	1	5	1	1	4	1
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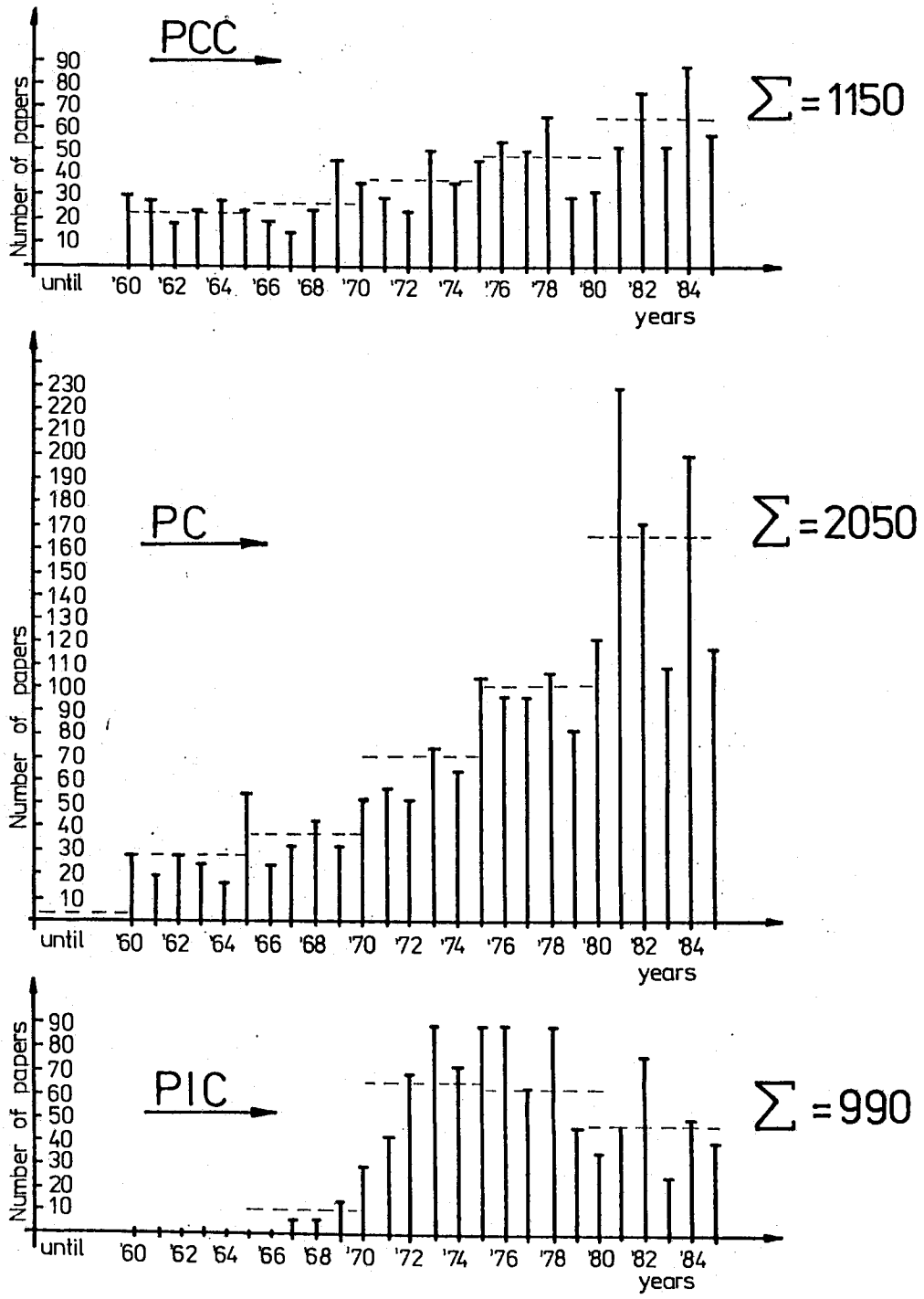
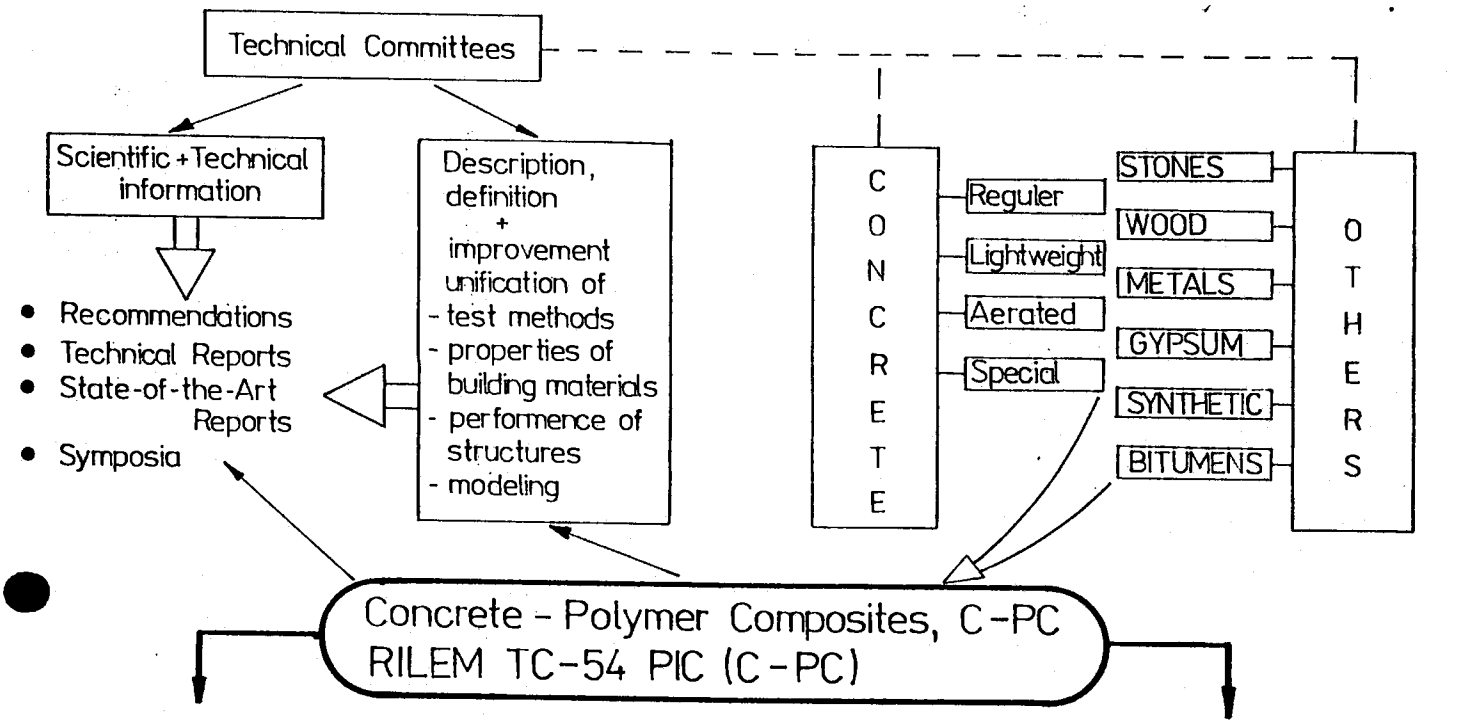


Fig.2 Number of papers on PPC, PC and PIC published in each year according to Chama's Bibliography /1/ and author's own collection

the technical committees /6/. Five committees are working on special conretes and only two of them /TC-52 RAC and TC-54 PIC /C-PC/ are involved with polymers. There have been five RILEM Symposia where Concrete-Polymer Composites have had a significant presence: Paris 1967, Prague 1981, Liege 1964 and 1984 as well as Aix-en-Provence, 1986. Once again, it is of interest to find the similarities between the scope of the RILEM-Symposia and IC PIC-Congresses.

CONRETE -POLYMER COMPOSITES AS THE TOPIC OF THE RILEM TECHNICAL COMMITTEE

In accordance to various forecasting for the period 1980-2000 the average annual increase of consumption of the leading materials could be awaited in building: steel +2%, regular concrete +4% and polymers + 12%. The nowdays are characterized by the apogee of concrete and the constant increase of the polymers consumption in building. Moreover, a maintenance and repair job are representing now over 40% of the value of the total construction output. Polymer concretes appear here as preventative, maintenance and remedial means. "Concretes needs polymers" this statement - one of the main conclusions from Int.RILEM Symposium ISAP'86 has been strongly confirmed also by the 5th Int.Congress "Polymers in Concrete". This situation should be reflected also in the RILEM activity. In 1980 RILEM Technical Committee: Polymer Impregnated Concrete /TC-54 PIC/ was established under Prof.A.Rio /Italy/ chairmanship. In 1984 the RILEM General Council nominated Prof.R.A.Bares /Czechoslovakia/ as the new president of the committee and asked him to ensure its active operation. After the consulting over one hundered leading specialists in the field and the long discussion during the Committee first



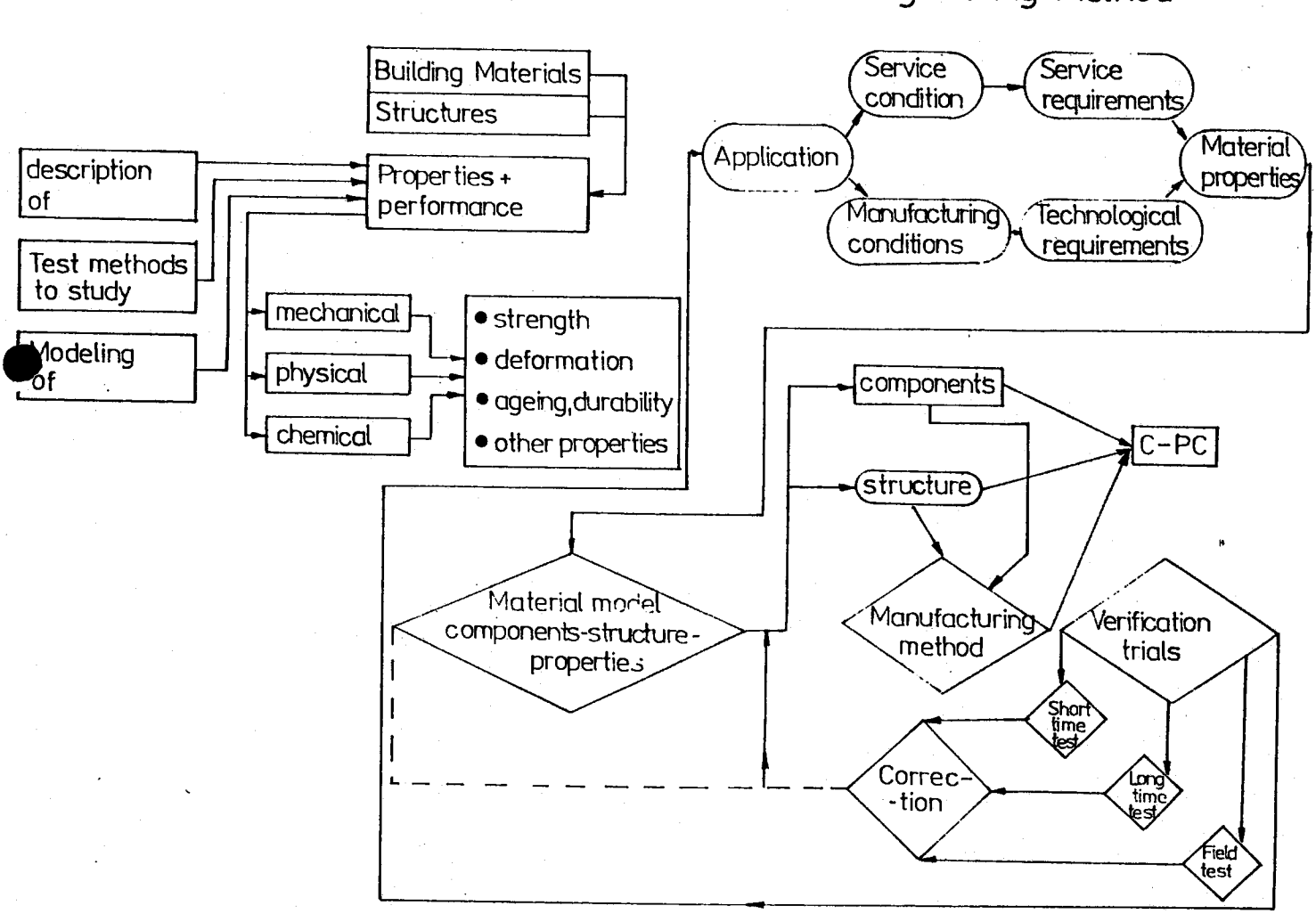


Fig. 3 Concrete – Polymer Composites in the framework of RILEM Technical Activity

working session /Prague, 1986/ it has concluded to propose to the RILEM authorities the change the name and the scope of the Committee to "C-PC:Concrete-Polymer Composites" covering PIC, PC, PIC and PIPC viz. Polymer Impregnated Polymer Concretes. The Conclusion has been result of the carefully consideration all reasons "in favour" and "against". All arguments "against" belong to the "embarras de riches" : too large area, too many specialists and too long time consumed. However, there are lots arguments "in favour" from various reasons like: the conviction of the majority specialists, having features in commons, application needs, boundary problems and historical as well as existing precedents. At present RILEM Committees deal individually with rather narrow area reflected needs of the contemporary stage of development of portland cement concrete technology. However that is not the case of polymers in concrete. Regarding to CPC the first Technical Committee founded by dr L'Hermite in 1949 should be served as the pattern. The committee was named "Cements and concrete" just paralel to our "polymers and concrete" problems.

The tasks and the final results of the TC-54 a[illegible]characterized as follows:
- [illegible]PC state-of-the art report,
- C-PC classification criteria for the break-up of C-PC into individual types,
- C-PC terminology and definitions /in four languages/.

Material Structure-Material Properties -Application relationship /9/ with positive feedback has been established as the main approach. Regarding to the C-PC classification the discussion has been focused on the composite structure types as the main classification criterion /3/ included also chemical nature /10/ of the materials - component properties, interface interaction and solidification way. Manufacturing process, serviceability and durability of composites have been taken into consideration as the auxiliary criteria /11/. Alternatively the engineering classification system /12/: Components - Composite - Application - Quality Control has been also discussed. Final decision in this very fundamental question will be done during the next RILEM TC-54 s[illegible]on.

GENERAL STRATEGY FOR FUTURE

The adequate answer for challenges from the development of leading materials in building and continuous progress of the Concrete Polymer Composites should be the standing /permanent/ working committee. After three years work the Technical Committee TC-54 PIC /C-PC/ should be transformed into a Standing Committee /SC-C-PC/. New established the RILEM Coordinating Committee for Concrete /CCC/ under prof.C.D.Pomeroy chairmanship is favourable precedent and a good pattern for solution of such problem. The entry point to the SC-C-PC activity should be expressed the appreciation for the succesful efforts which have been already done in this area. The 5th ICPIC as well as the results of the previous ones have shown as the very difficult task to attempt in any respect to sum up the contributions. It is difficult also to over-estimate the meaningful results of various international- and national organizations like among others Concrete Society in Great Britain and Plastic Industry in USA as well as Society of Material Science in Japan, ASTM Committee C.3.02 and ACI Committee 548 with its very valuable five Symposia on polymers in concrete /published as the ACI - special publications: SP-40 Polymers in Concrete 1973, SP-58 Polymers in Concrete: International Symposium 1976, SP-69 Polymer Concrete: Uses, Materials and Properties 1980, SP-99 Polymer Modified Concrete 1987/. The ACI548. 1R-86 "Guide for the use of polymers in concrete" and the first Japanese National Standarts /JIS 1181-1186/ should be treated as the mile-stones in the C-PC development. It is impossible to mention here all outstanding authors, universities and other research and industry centers involved with the topic.

The general task of the Standing Committee should be the reconnaissance in the field of polymer composites and the challenges involved. The CPC Standing Committee will serve as the originator of new, more specifically oriented Committees /Subcommittees/ in this field and will inspire their working programs, identify areas where new work would be beneficial. The following subjects should be taken into account /among others/:

- Technical characteristics of C-PC ranking list - selection procedure /decesive material parameters/, cataloguing criteria,
- Data collection for a Technical Data Bank /TDB/, a Reference Bank /RB/ and an expert system /ES/,
- Testing methods. Selection of decisive parameters to be determined experimentally and the determination of criteria,
- Standardization,
- C-PC material designing methods, relating components - structure - properties,
- C-PC deterioration mechanism,
- C-PC durability, service life and maintenance.

The outline of the program mentioned above express our believing for further intensive C-PC development. The believing should be rationalized even by simple comparison of the energy consumption factors, MJ/kg: cast iron and steel: 34-57; PE,PVC: 18; epoxy resin: 16; portland cement: 9,5-14; polymer concrete: 3 and portland cement concrete: 1,5. From the other hand the material efficiency factor expressed by the ratio of technical and ideal strength is very low viz. we've used only few percent of potential /theoretical/ strenght of composite materials. It means enormous task in front of us.

Triple M - driving forces are required to keep alive C-PC devolpment trends: Men-Material-Machines. There is a tremendous need for people educated in building material engineering - who can join chemical knowledge with modern concrete technology and transform that into end-use properties of polymer concretes. It is difficult also to overestimate the significance of mixing and casting machines for further PC particularly application development. Not only the increase of production velocity, but further improvement of polymer concrete mixture homogenizing and lowering of material cost should be expected /13/.

The meaning of the term "Composite" can be derive from Aristotle's dictum: "the whole is something more than just the sum of components". This meaning should be extend on

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