Richard A. B A R E S
Czechoslovak Academy of Sciences
Prague, Czechoslovakia

Lech C z a r n e c k i
Warsaw Technical University
Warsaw, Poland

AN OVERWIEW OF CONCRETE POLYMER COMP[OSITES IN RILEM TECHNICAL COMITTEE (TC 105 C-PC) ACTIVITY

Abstract: The world wide research activity on concrete polymer composites (C-PC) has been briefly presented. In this framework the RILEM activity on C-PC has been described. The genesis, main approaches and scope of the Committee have been characterised. The tree basic documents: Terminology and Definitions, State-of-the Art Report and Classification Code have been elaborated as the result of the Committee work. The outline of general strategy for future has been also discussed.

1. INTRODUCTION

The technical Committee TC C-PC "CONCRETE POLYMER COMPOSITES" was established in 1986 to answer the need of the engineering community for a better understanding concrete-like polymer composites.The most important building material within RILEM's work is concrete and this topic is dominated in the technical committees. However, there was a common believe that "concrete needs polymers". In the RILEM history the first Technical Committee founded in 1949 by dr. L'Hermite was named "Cements and Concretes". The Technical Committee TC-52 RAC "Resin Adherance to Concrete" under chairmanship of prof. H.R.Sasse was followed by our committee in this area.

A massive volume of information and studies [1] are already available on concrete polymer composites:
- about 5000 papers have been published,
- over 3500 patents have been awarded,
- 7 International Congresses "Polymer in Concrete" (London '75; Akron '78; Koriyama '81; Brighton '84; Darmstadt '87; Shanghai '90; Moskwa '92),
- 5 ACI Symposia have been prepared,
- 6 RILEM Symposia (Paris '67; Prague '81; Liege '64; Liege '84; Aix-en-Provence '86; Capri '89) have been organised.

The problem arises how to organize this impressive flow

of information in a general C-PC system, with a practical meaning. How to find a link between science and technology in this area.

The committee members are selected out of over 100 specialists invited to cooperate. Finally , the TC 105 C-PC gathered 21 active (13 ordinary + 8 corresponding) members representing 14 countries and 3 continents: Belgium, Czechoslovakia, Finland, Germany, Great Britain, Israel, Italy, Japan, Jugoslavia, Netherland, Norway, Poland, Sweden,USA and USSR. The team is not only international but also interdisciplinary. There are specialists from universities, academy, research institutes and industry representing chemistry, civil engineering, physics and mechanics. Prof. R. A. Bareš (CS) is chairman and Prof. L. Czarnecki (PL) is secretary of the TC-105.

2. MAIN APPROACH AND TASKS

The main approaches of the committee work can be described as follows: generalization of the knowledge about the relation between the C-PC structure and components (kind, content) and this technical properties, so as to give the engineers the relevant data of C-PC for practical application. The relationship of Material Structure-Properties-Application with positive feedback has been accepted as the main approach viz. the way of thinking from material model to application.

The "composite" as the category in science implies aiming action in preparing and using - an optimization problem. On the field of Concrete-Polymer Composite it means also efforts in the transformation of the existing research and technical data in an order with the own intrinsic logic according to the current state of material science. This problem has been already defined by R. N. Swamy [2] on the First International Congress "Polymer in Concrete" as follows: "It is unrealistic to treat this new materials as modified forms of conventional concrete. Such an attitude will not only do little justice to this new class of materials, but will also lead to inadequate appreciation of both their potentialities and their limitations".

The tasks and the final results of the TC 105 are presented in three reports:

a. *C-PC terminology and definitions*
b. *C-PC state-of-the art report*
c. *C-PC classification code*

3.RESULTS

Results of the Committee work have been created during 9 working sessions (Prague, Nov. '86; Brussels, Jun. '87; Brighton, Sept. '87; Novgorod, Jun. '88; Göteborg, Oct. '88; Capri, May '89; Brioni, Sept. '89; Tokyo, Sept.90(together

with TC-113 CPT); Bochum, March '91 (together with TC-113 CPT)) and lots of direct contacts and letters exchange between committee members. The results arising also from several "homeworks" with have been done by the Committee members.

3. 1. TERMINOLOGY AND DEFINITIONS

Over twenty various specialists gathered in the RILEM Committee faced the communication problem. Our start situation can be described following the words of B. Porteus (1731 - 1808):

"It is what I feel
but cannot define,
It is what I know
but cannot express."

The presented elaboration [2] is the result of lots of working sessions, warm argues and discussions and some time even quarrels. For this reason the book is not just another set of selected terms in the field of materials. After 4 years of hard work together we have found a common language for communication, which we would like to share with all members of the world community involved in composites. There is not only the lexicon, but also an evidence of our way of thinking of polymer composite materials and their meanings. To some extent the book by itself is also an image of the main categories in composite science viz. STRUCTURE, INTERACTION and SYNERGY. The lexicon contains more than 400 entries. Separately each of those could be described for various ways. For the purpose of this book, the terms have been defined in particular meaning to establish uniform interdisciplinary system of Concrete-Polymer Composites. We hope, that the lexicon users share the opinion that this "whole is something more than just the sum up of singularities". This Aristotele's dictum (350 B. C.) can be treated as the first definition of composite materials.

According to Einstein's expression "Everything should be so simple as possible, but not more". The selected examples of the basic definitions from our lexicons are listed below:

COMPOSITE, any (solid) polyphase material, whose phases cannot be mutually transformed in each other by any treatment, which attains properties nor attainable by anyone of the constituting phases by itself, neither by the simple sum of them.

POLYMER CEMENT CONCRETE (PCC), is a composite where either a non-reactive polymer (latex) or a reactive monomer (resin) is added to the fresh cement concrete mix.

POLYMER IMPREGNATED CONCRETE (PIC), is a composite in which hardened concrete is impregnated with the reactive monomer (resin) in fluid form subsequently.

POLYMER CONCRETE (PC), is a composite in which sized aggregate (filler) is bonded by polymer.

CONCRETE-POLYMER COMPOSITES (C-PC), particular or hybride composite of the type of concrete using polymers.

SYNERGISM, co-operative simultaneous action of discrete components such that their total effect is greater than the sum of individual effects.

The English and Russian version of the lexicon have been already done. The German and Japanese versions are in preparation. The French version is also planned. The publishing of multilanguage lexicon with transverse index should be of special value for the international composite community.

3. 2. STATE-OF-THE ART REPORT AND CLASSIFICATION CODE

The RILEM TC 105 C-PC offers the focus and the forum to meet contemporary and future needs. The State-of-the Art Report [3] is an approach for ongoing technical information on the basis of the theory of composite structures and its scientific backgrounds.

Further developments in concrete material will be determined by energy considerations and new requirements. Polymer concrete development would lead to a new generation of materials suitable to extend the requirements. The problem is how to find most effective way for the use of suitable C-PC.There is the problem of proper material design. "Tailor-made" concrete polymer composites for particular application that is the guiding rule for the present and future. This State-of-the Art Report should serve this idea.

In the State-of-the Art Report we have tried to formulate answers for some fundamental questions:

- What are the C-PC?
- What is the forecast of further development?
- How to understand C-PC behaviour from the theoretical point of view?
- How to prepare C-PC?
- What are the advantages, disadvantages and possibilities of C-PC?
- What kind of C-PC applications already exist?

The main task of using polymer in concrete is always "better" concrete. From the practical point of view the economical effectivness should be pointed out, also. The State-of-the Art Report is focused on PCC, PC and PIC. However, the second generation of C-PC e. g. polymer impregnated polymer concrete have been also discussed. All types of C-PC can be reinforced. Besides steel or other bar reinforcement various fibers as steel or polymeric or carbon fiber are employed for reinforcing. An infinite number of different C-PC grades depending on the chemical nature of components their contents and manufacturing process could be found this way. The main and universal rule of composite categorization could be material structure [4]. Basically two criterions

have been taken under consideration:

- the way of inner stress transition
  and
- the kind and ammount of porous.

Traditionally all concrete polymer composites (C-PC) can generally be devided into three groups (PCC, PC, PIC) due to three different methods of producing them (compare chapter 3. 1.). This simple categorization is not yet sufficient for two reasons at least. In practice combinations of these three production principles resulted in several materials which can be treated as the new generation of C-PC or superposition in comparison with "traditional" PCC, PC and PIC e. g. polymer impregnated - polymer cement concrete or polymer impregnated-polymer concrete. Researches found different types of material structure by analysing PC as well as PCC or PIC [5].

RILEM TC 105 attempted to classify [6] simply all these unclear varieties of concrete polymer composites under two very important conditions only.First, it should be possible to identify all materials based on thier typical material structure. That means, the classification system describes the CP-C materials according to specific characteristics in material structure. Second, the worldwide well-known abbreviations PC, PCC and PIC which are determined by preparation methods must be includded in the classification.Additional information can be given by the ammount and the kind of pores. The satisfactory solution for it has been found .

5. GENERAL STRATEGY FOR FUTURE

The adequate answer for challenges from the development of new building materials and continous progress of concrete polymer composites should be to create a permanent standing working committee. The actual TC 105 C-PC could be transformed into a Standing Committee SC-C-PC. The general task of the Standing Committee shoyld be the survey of the field of polymer composites and the challenges involved. Prof.Y. Ohama from Nihon University in Koriyama has been designated by members of TC 105 C-PC as the candidate for a chairman of the Standing Committee. The C-PC Standing Committee will act as the leader and creator of new, more specifically oriented technical committees or subcommittees. Among others, the following topics could be taken into consideration:

- C-PC data collection for a technical data bank, a reference bank and expert system [7],
- C-PC material design methods: linking components, structure and properties,
- C-PC deterioration and aging mechanisms,
- C-PC durability: serevice life and maitenance,
- C-PC selection procedure: ranking list,
- C-PC non-metallic reinforced concrete,
- C-PC steel reinforced concrete,
- C-PC polymer coatings on concrete,
- C-PC polymer coated rebars

- C-PC polymer impregnated polymer concrete,
- C-PC polymer impregnated polymer cement concrete,
- C-PC standards,
- C-PC testing methods.

Since 1989 a new Technical Committee TC 113 CPT (Cement Polymer Composites Test Methods) already started its activity under the chairmanship of prof. Y. Ohama (secretary Dr.K. Demura).

For futher activity basically the two topics have been discussed from the list mentioned above "C-PC - material design methods" and "C-PC - durability". Finally, the "durabillity" has been selected as the most important. The outline of the above program expresses our believe of further intensive C-PC development. This believe is strongly supported by a simple comparsion of energy consumption factors: cast iron and steel 34 - 57 kJ/kg, PE, PVC 18 kJ/kg,epoxy resin 16 kJ/kg, portland cement 9,5 - 14 kJ/kg, polymer concrete 3 kJ/kg portland cement concrete 1,5 kJ/kg. Up to now we mobilise only few percent of a potential technical possibilities [8] of polymer composite materials. It means that an enormous task still is in front of us.

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ACKNOWLEDGEMENTS:

The RILEM TC 105 C-PC documents have been elaborated by the Committees Members as follow:

Ordinary members: Bareš R. A. (chairman), Cardon A. H., Chandra S., Czarnecki L. (Secretary), Hranilovic M., Justnes H., Koblischek P. J., Ohama Y., Sandrolini F., Schorn H., Sutov F. A., Steijaert P., Van Gemer D.

Corresponding members: Fiebrich M., Fowler D., Kreis R., Paturoev V., Sarvaranta L., Sasse H. R. Staynes B. W.