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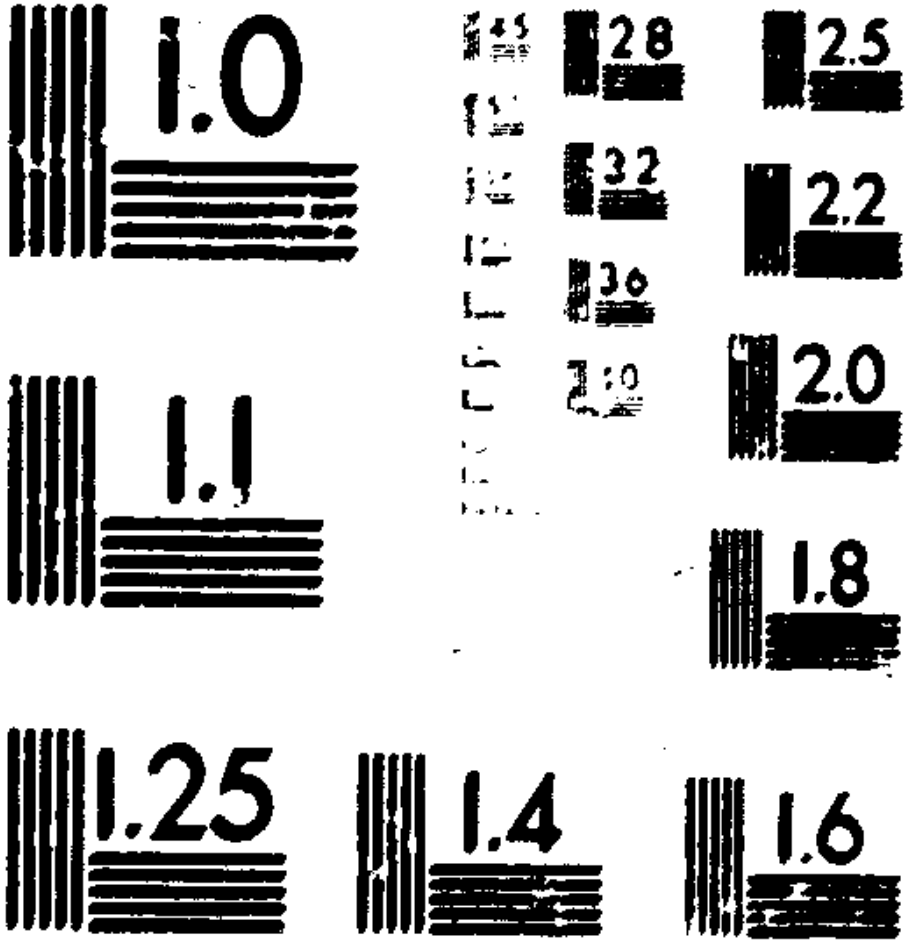

RESTRICTED

14 January 1985

14450

Sierra Leone.

USE OF LOCAL RESSOURCES IN COMPOSITE BUILDING MATERIALS

RP/SIL/84/001
SIERRA LEONE

Prepared for the Government of Sierra Leone
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Georges A. Patfoort, expert in Plastic Composites and Moniek E. Bucquoye, design expert.

United Nations Indusystrial Development Organization
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Key words

Sierra Leone, building materials, locally available ressources, composite materials

Abstract

The experts have been working on the project RP/SIL/84/001 with the SALHOC , Sierra Leone Housing Corporation - depending of the Ministry of Housing , Lands and Country Planning - from 27 december 1984 untill 11 january 1985.

After carefull examination of the building situation in the country , it appears that practically all building materials and building components are imported or are directly dependent on imported oil .

Taking into account the important and urgent needs for social housing and the concern of the country to maintain an equilibrium in the balance of payments and eliminate foreign trade deficit, Government Authorities want to investigate the possibilities of the replacement of imported building components. Hereat they want to investigate the possibilities of the use of local ressources and local workmanship . So, the initial duty of the experts viz."Assist the country's Government in identifying the exact functional requirements to establish a pilot plant for construction plastic composite roofing sheets for low-cost housing purposes", had to be extended to a more general study of the input of local ressources in several building activities

Finally a project proposal was formulated based on the fabrication and use of local available materials for ceiling panelling .

Table of content

page

Introduction

The experts arrived in Freetown on december 27th,1984 and it was scheduled that they would leave the country on the 7th of january 1985 . However the experts had the honour to be invited to present their views on the possible development of a project to his Excellency the President of Sierre Leone Mr.Siaka P. Stevens on 9.1.1985 . So they left the country on friday 11 january 1985 .
For a detailed schedule of the visits and activities :see annexe I

Taking into account the information received from SALHOC and other authorities as the ministry of Housing , Land en Country Planning , the ministry of mining, the University of Fourah Bay college , the Geological Survey, plantations and building estates , it appears that the unexploited , as well material as intellectual ressources of the country , are important and that there is a general will to create activities and industries adapted to the needs of the country using the locally available ressources in order to eliminate to a certain amount the economic problems arrising by excessive import of raw materials and building components.
In agreement with the Sierra Leonean Authorities and specially with SALHOC, a general review of all possible applications in building components was made up with emphasis on saving energy and imported raw materials.

It is coviously impossible to solve all problems at the same time, but this survey permits to establish priorities and to choose the most adequate field to exploit .For reasons that will be explained later on , priority was given to establish a small plant for the production of ceiling panels .

Recommendations

1. Sierra Leonean Authorities , specially the SALHOC, should give full attention to the realisation of one building item , namely the production of ceiling panels in the shortest possible time schedule . The first realisation will give confidence in the fabrication , use and properties of new composite materials using local available materials . This can be a quick and easy step for further developments in the building industry .

2. At the same time , SALHOC should think about building-up a good intellectual infrastructure , so that the introduction of new technologies using local available materials in the production of composites as building materials , can progressively evolve and be user in new fields of applications.This point has been worked out in a training programme .

3. Once the realisation of a first kind of building components has been completed and the training of a team of engineers is done , a large field of new applications is possible . The experts recommend to UNIDO to give full attention to point 1 and 2.
Interesting future developments with important impact on the economy of the country are dependent on the realisation of the first steps .

4. The follow-up of the first short term project (2 months) including the fabrication of panels and training can have various outcomes in very different fields of industry, that will be illustrated in this report .
It is recommended that the continuity in the industrial and training activity would not be interrupted and that the trained human potential may be immediatly utilised in further developments of new products .

Evaluation of present situation

It is useless to come back on the housing situation of Sierra Leone. It has been analysed before in different reports by several institutions and organizations and has been discussed by the experts with the Authorities of SALPCC .
The encountered difficulties are not so much due to the problems of practical construction and building work . Indeed , the experts visited several building estates : some already built for several years, some very recent and others under construction. They are of good quality, urbanisation is well planned and the constructions seems to be realised with skilled workers. The main problem is the shortage of raw material, rapid increasing of raw material prices and the high level of dependence of raw material from import and consequently of foreign currency.

In the meaning of the experts, the main objective is to analyse how imported construction materials and building components can be replaced in the shortest possible time by locally available resources.
Of course, one has to make a global calculation or estimation of each product and product need taking into account labor cost, quality , energy consumption (oil , electricity or any equivalent that is needed to realise a finished product), material and machinery input.
A few exemples :
-a self-supporting roof does not need a wooden structure to be sustained. So its global price must be compared with the sum of a roofing material and its wooden infrastructure .
-drying and firing a brick needs a lot of energy (heat) in the form of oil , that has to be imported .

Thanks to the application of recent views in material technology, material properties can be adapted for exemple by the use of composite systems . The actual knowledge in material science . technology foresee that future progress in material technology have to be found in the combination of the most important basic properties(tensile strength stiffness, toughness and density) and their application properties (energy input,processability,environmental properties such as weathering and fire resistance) .

So, the view of not to be hypnotised any more by the use of classical construction materials is in complete agreement with any modern theory or view on material science and energy saving . However the attractiveness and simplicity of realization and production of composite materials , present the danger of forgetting quality requirements, specially long-term properties as weathering , maintenance cycle and longevity.
For each new material or component , an evaluation has to be made between qualities of the product(fire resistance, weathering etc) and price calculation taking into account investment, raw material input, processing and additionally the percentage of imported additives , for example synthetic resins, that the authorities estimates acceptable .

Identification of objective of project proposal

In view of fulfilling a practical realisation, following steps were taken during meetings, discussions and visits organised by SAL-OC:
- reviewing of the industrial potentialities and structure of the building activities in the country .
- identify the natural , industrial research and labor ressources including energy potentialities.
- a short survey of the building market in order to identify the practical output of the project proposal .
- price calculation of the proposed product (ceiling panels) in relation with the imported goods .
- estimation of the effect of the new product on the existing industry.
- analysis of the incidence of new composite technology on on other field of the economy , such as agriculture for example .

In agreement with the director of SALMIC S.r.l.Roma, it was decided that the fabrication of ceiling panels will ils all requirements :

sufficient potential market, attractive price calculation , competence with an exclusively imported product etc. and additionally a product to be realised in a short term project with very low investment and practically not dependent from imported machinery .

The production of ceiling panels has to be considered as an introduction into the generalised use of fiber reinforced composites. Mechanical and weathering properties can be adapted with the choice of reinforcement and binder . This development requires a good knowledge of composites material technology. Exchanges of knowledge (theoretical and practical) with a specialized institute and the training of a few engineers is an absolute necessity for the success of the project .

Remarks and proposals for future developments

During the meetings and after consultations of SALHOC , following remarks and proposals have been formulated .

- the immediate follow-up of the fabrication of ceiling panels is the production of : wall partitions, roofing panels, self-supporting roofs, corrugated sheets .
- composite technology can be applied for the fabrication of furniture , window frames, safety helmets,silos and others .
- different qualities of fibers have been identified in the country (palm fibre , urena lobata fibers, raffia, coconut fibers) . Several of high quality(urena lobata) as others (waste fibers) who are all suitable for different kind of panel requirements .
In some cases high quality synthetic or glassfibers can be used when applications requires it .
- following local binders may be uses after adaptation and experimentation : stabilised clay , cement, latex and several types of natural resins .
The existing laboratorium of the Ministry of Housing , Land en Country Planning is,with some small adaptation, suitable to conduct some experiments on local materials needed in the project .

- it would be advisable to look for posibilities in order to accuire some gypsum in the country or in a neighbour country . Idem for sulpnur (vulcanization and sulphur concrete) . Possibilities could be some waste materials from the petrochemical or phosphate fertilzer industry .
- a large amount of oil is needed in normal brick making (bricks out of clay). An important part of energy can be saved by making use of solar energy, with accumulation of heat in a stone bed . Construction of a solar still is of great simplicity, because only warm air is nected as transport meedum.Several successfull experiences , even with computer programmes have been executed during the last years .
- clay polymerization at lou temperature may be a good alternative to brick firing (± 1.000 ° C) . Sun energy can be used and oil energy saved . Huge investments in ovens and maintenance are eliminated . Mechanical properties of the bricks can be adapted to their use. Colour, appearance and density can be varied and adapted to the application. After consultation of the National Geological Survey and a geologist at Fourah Bay college , it seems that the right clay qualities are available in the country. A general survey and an analysis of the clay samples is necessary.Some lou price additives have to be imported for the polymerization .
- polymerized clay can be used as a binder for fibers in order to make panels , corrugated sheets etc. This applications have to be developed in a research programme .
- a special application of fiber reinforced composites, consist in forming rigid and semi-rigid membranes with the use of filament winding techniques . In different countries this technology was already applied by UNIDO for the construction of houses , self supporting roofs, water containers, silos etc . Generally glasfiber is used in this applications in view of the necessary high strengt of the construction. In spite of the relatively high price of glasfiber and binder , important savings are possitle , taking into account the high strenght and low density of the obtained structures.

- the latest development in this area is the foldable and collapsable silo . The wounded membrane can be folded and different membranes can be folded together for transport. Structures with a capacity of 100 m^3 can be handled and erected completly with man-power .
- interesting is the availability in the country of a natural white pigment in the form of TiO_2 .It is a very usefull product as an additive for surfaces exposed to the sun , because of its reflective power and its capacity to regulate the inside climate of dwellings f.ex.
- in the reinforcement of concrete , it is conceivable to replace the steel reinforcement by natural fiber in some applications . Data on reinforcing capacity are available .
- In most of the visited estates in Freetown , the wooden parts of the dwellings did not have any protective layer nor conservation treatment, deterioration is rapid in this case . By-products of wood distillations and some plant extracts may be produced locally for this purpose .
- all products or building parts produced - specially those made with natural products - have to be tested for their long term behaviour both in natural circumstances and in accelerated weathering tests . Also mechanical resistance must be investigated against rotting and bacteria in humic and warm climate . Ipes against insects and rodents. An elementary laboratorium for the execution of these tests is available at the Ministry of Housing , Lands and Country Planning .

Conclusion

It is obvious from the preceding remarks, that it would be utopian to attack all problems simultaneously .
In agreement with the SALPCC-authorities it was decided to propose a short term project, including the fabrication of ceiling panels and the training of 3 engineers and a geologist .
A long term project can be considered , but it has only a realistic meaning when the progress in the use and fabrication of composites out of local materials can be considered and evaluated during the first phase of the short term project . Priorities of the long term projects are the study of clay stabilization by polymerization and the problem of roofings .
The proposal for the short term project is to be found in annex II .

ANNEX I : CONSULTATIONS AND VISITS of the expert team

27.12.1984

- arrival Freetown-city

28.12.1984

- meeting at UNDP office . Briefing with Mr. M. Alemaychu , SIDFA-UNIDO
- meeting with Mr.D. YONA , director of the Sierra Leone Housing Corporation SALHOC .
  Mr. Yona explains to the experts the activities and objectives of SALHOC. SALHOC reports directly to the Minister of Housing , Land en Country Planning .
- discussins with the construction engineer of SALHOC , Mr. E. Forster. Briefing on the housing sit ation of Sierra Leone and exchange of ideas on new building technologies. Explaining of the Pat oort Housing System and other composite materials & technologies . Illustration with slides and samples .

29.12.1984

- lecture at SALHOC with slides and samples

31.12.1984

- discussions on the experts programme & meetings in Sierra Leone, needed to gather the necessary information on the building and housing situation in the country . Salhoc took all arrangements for the co sultations and meetings of the experts.
- visit to " Sierra Bricks" a private owned clay brick factory.
- visit to " Kissy estate " a Governmental programme on social and low-cost housing .
  The experts visited several dwellings of different types and age .
- visite to a palmtree farm and inspection of the available fibers and reeds(near Waterloo)
- visit at the Paloko clay digging works . Ampling of clay .

2.1.1985

- discussions at SALHOC on polymerization of clays
- visit to the Ministry of Mines, geological division . consultation of Dr. A.C. WURIE , director of the Geological Survey . Discussions on the Paloka clay types, latherite clays, the availability in the country of $Ti.O_2$, $Ca(OH)2$, limestone, gypsum and other building materials .
- visit of the National Workshop (repair maintenance of good for Government and private industries)
  Discussion with Radcliffe C.A. COLE, production manager of the workshop on the workshops possibilities and the new projects (production of corrugated sheets)

3.1.1985

- Meetings at Fourah Bay College in Freetown with :
  prof. IBRAHIM , Head civil engineering department,
    discussions on building materials in the country
    and the actual prospects in finding new binders in
    order to replace cement .

  prof. Dr. Victor STRASSER-KING (head department of
    geology)
    discussion on the availability of Kaolinitic and
    laterite clays in the country. the testing equip-
    in the geological department and the results of
    tested clays .

- Meeting at the Ministry of Trade and Industry with
  Dr. [illegible] (UNIDO expert) and his team
    discussion on the availability of local fibers and
    the possibilities of a small scale projects for the
    production of some new building materials based on
    local materials and composite technology .

- Meeting at the Ministry of Housing , Land and Country
  Planning with Mr. [illegible] , responsable of the la-
  boratory and testing division of the ministry.
    visit to the lab. and inspection of the installed
    testing equipment .

- Meeting at the Ministry of Development with Mr. [illegible] CURUMA,
  senior secretary .

- Discussion with [illegible] , [illegible] for the first
  findings and suggestions [illegible] the consul-
  tations and the [illegible] information .

4.1.1985

- Discussion with the Director of [illegible] , Mr. [illegible] on
  the following topics : conclusions [illegible] in-
  formation [illegible] building situation in Sierra Leone
  [illegible] . making houses using the Pat-
  [illegible] technology [illegible] suitable at this moment , the
  start of a small project in order to gain practical ex-
  perience on new building technologies , the use of com-
  posite materials seems to be more suitable .
  [illegible] the
  [illegible] of the project (practical work together with some
  research activities and [illegible]) .

- Meeting at the Ministry of Housing Land and Country
  Planning with :
  . Mr. Victor [illegible]LEY , permanent secretary of the minis-
    try
  . Ibrahim [illegible] KAMARA , Minister of Housing , Land and Country
    Planning .
    Discussed [illegible] the mission duties
    [illegible] actual [illegible] of the project proposals
    [illegible] of new building materi-
    als and technologies .

- Second meeting with Dr. WU FIE (geological survey) and the metereological department of the ministry

- Meeting with Mr. O.LEWIS , industrialist,and visit of his factory . Interesting information was obtained on coconut fibers, natural resins, local latex qualities and the fabrication of sanitary equipment (baths, shouers, toilet service etc) made of local materials. The is of good quality and needs only very small improvements (colour, polish, fixing pins etc.)

5.12.1985

- Meeting with Mr. MORGAN , officer at the ministry of Trade and Industry, Mr. O. LEWIS(industrial) and Mr. Mr. A. DURING
discussion on various practical problems in the production of composite materials out of local materials .

7.12.1985

- Final meeting with SALHOC authorities and the UNIDO SIDFA
final discussion on the project proposal, SALHOC inputs, UNIDO inputs , output and further prospects for a long term project .

- Lecture at SALHOC for the personal and invited persons from the visited Ministries .

- Informal meeting with Mr. Ibrahim M KAMARA , minister of housing , Land and Country Planning

8.12.1985

- departure date of the experts.

on special request of the Ministry of housing , Land and Country Planning the mission of the experts was extended, since there was a personal audience for the experts with the President of Sierra Leone Dr. SIAKA P. STEVENS.

After consultations of Mr. Alemayehu (SIDFA) the Resident Representative Mrs. Mary CHINERY-HESS has given permission to postpone the departure of the experts .
On the same day , a telex was send to UNIDO-Vienna .

- meeting at SALHOC with Mr. Forster in order to discuss some details of the project proposal .

9.1.1985

Audience with the President of Sierra Leone Dr. Siaka P. STEVENS at the State House.
Present at the audience :

- Mr. Ibrahim I. KAMARA , Minister of Housing, Land and Country Planning
- Mr. Victor MACAULEY , permanent secretary of the Minister I.M. KAMARA
- Mr. D. YONA , director of the Sierra Leone Housing Corporation
- Mr. E. FORSTER , Construction Engineer at SALHOC
- Mrs. M. CHINERY-HESSE , RR UNDP
- Mr. M. ALEMAYEHU , SIDFA UNIDO
- Mr. G. P TFOORT , UNIDO expert
- Mrs.F. BUCQUOYE , UNIDO expert

After the audience, there was a meeting at UNDP office with Mr.M.CHINERY-HESSE (RR) , Mr. ALEMAYEHU (SIDFA) and the expert team in order to discuss the project proposal and the recommendations of the mission .

10.1.1985

Final meeting with Mr. YONA , director of SALHOC in order to discuss the recommendations and the project proposal (short term, scholarships and furter prospects for long term project).

11.1.1985

Departure of the experts, end of the mission

I.B. Briefing : UNIDO Vienna 17.12.1984
Debriefing : UNIDO Vienna 30.1.1985

ANNEX II : PROJECT PROPOSAL

USE OF LOCAL RESSOURCES IN COMPOSITE BUILDING MATERIALS , 6 months

A. Sierra Leone Contribution

Management and man-power for 6 months

.head of project (1/6 time)	counterparts	2.400 L
.engineer (1/2 time)		3.600 L
.foreman		1.100 L
.six skilled workers, including two carpenters		4.100 L

Equipment

.use of workshop (200 m^2) and closed cool storage (100 m^2)	4.000 L
. press equipment (constructed locally)	5.000 L
.mixer	200 L
.workshop tools	1.000 L
.moulds (steel & wood)	5.000 L
.mat making equipment	1.000 L
.local raw materials	1.000 L
.vehicle(running cost, maintenance, driver wages etc.)	14.000 L

Research activities and testing

. use of laboratory	
. use and adaptation of lab.equipment	
. construction of some equipment	
. testing(strength, fire resistance, heat resistance, weathering, bacteriological attack etc.)	5.000 L

Raw materials

. bast fibers and long fibers	2.000 L
. several types of resins	1.000 L
	66.400 L

	60.400 L
Office and administrative work	
. rent , water, electricity etc.	300 L
. equipment	200 L
. technical literature, photocopies etc.	1.000 L
. secretary (1/2 time)	720 L
Miscellaneous	2.500 L
	64.620 L
Inflation rate = 1%/month	3.900 L
Total :	66.520 L

Official exchange rate 1 US $ = 2.50 L
(L = Leones)

Total : 27.400 US $

B. U.N Contribution

Experts		
• Project coordinator (2 months)	20.000	US $
• Construction expert (6 months)	60.000	
Materials and equipment		
• resins (polyester & phenolic resins)	1.500	
• glassfibers	1.500	
• small tools & spray equipment	1.000	
• mould sheet	200	
• demolding film(polyester)	200	
• demolding agents(several types)	100	
• six screw jacks	1.000	
• experimental small press (rent & transport)	1.000	
Miscellaneous	1.000	
Total	87.500	US $

Scholarship

• two scholarship for one month each on composite materials for an engineer or equivalent at V.U.B. Brussels, Belgium (see annex III)	* 5.000	(including travel)
• one scholarship for one year on new building technologies for an engineer or equivalent at V.U.B. Brussels, Belgium .	* 4.000	"
• one scholarship of two years in geology for a geologist (IFAG course at V.U.B. Brussels) . see annex IV	* 4.000	"

* provisory estimation(to be checked)

ANNEX III : PROGRAM OF THE INTERNATIONAL TRAINING COURSE ON COMPOSITE MATERIAL TECHNOLOGY at the Free University of Brussels (Belgium)

ORIGIN AND AIM OF THE ICT TRAINING COURSES

All over the world attention has been focused on the application of advanced composites in the field of space, air, water or earth transportation and other advanced technologies.
What has to be done is to emphasise the use of composites in consumer goods where they can meet the needs of the new world energetic and economic policies especially in development countries.

Following field will be covered with composite systems :

- use of local geological deposits in composites
- disaster resistant housing
- earthquake resistance of structures
- low-cost housing
- optimising of local resources
- design of consumer goods, furniture and housing with the minimum of energy input.

It has been demonstrated that a lot of goods can be redesigned with composites realising the most immediate and important saving of fossile fuel in energy conservation programmes.

In establishing the International Post-Graduate Training Course on Composite Material Technology, it is the organizers aim to create on an international basis a selected programme which should combine all major aspects of specialized theoretical and practical training in the field of composite materials technology.

Therefore ICT is linking up an international interdisciplinary and interuniversity group of specialized institutions and laboratories, thus continuing a long tradition of scientific research and collaboration amongst each other.

Although ICT is located at the Free University of Brussels (V.U.B.), the structure works on an interuniversity level. Most of the theoretical courses are given at the V.U.B., whereas practical training is completed in specialized laboratories at other associated universities. This should guarantee a genuine practical education, besides an initial theoretical one. It is thought and hoped that the selected programme with its wide group of affiliations will meet the demand for skilled engineers in composite material technology and low-cost housing, especially in developing countries.

To this programme are added courses in computer technology and on the application of quaternary geology in composite material technology as is offered by the International Post-Graduate Training Courses on Fundamental and Applied Quaternary Geology (IFAQ - V.U.B.).

From 1985 onwards, ICT spreads its activities over a two-year period for post-graduate studies. During the first academic year, participants will have to follow a serie of theoretical courses and practical exercices. The second year will cope with complementary courses and intensive training in laboratories, finally culminating in the preparation of the final report.

ICT will not remain strictly within the framework of the above described purely educational studies. Scientific and industrial cooperation is to be developed with former ICT participants within various fields of composite material technology, following their return to their native countries, especially with regard to national and international projects.

Finally, it should also be emphasised that demonstration and training courses can be organised in other countries. Research programmes can be set up working in clase cooperation with the Brussels Free University center and adapted to specific needs and resources of the interested countires.
Close cooperation with the IFAC programme (International Training Courses on Fundamental and Applied Quaternary Geology) is foreseen to emphasise the use and possibilities of locally available and low energy consuming materials in composites.

PROGRAM

1. NATURE OF COMPOSITES : 20 lessons ; 30 hrs practice (20 ℓ - 30 h)

   1.1. Continuous and discontinuous phases.

   1.2. Mixtures.

   1.3. Inclusions in matrix.

   1.4. Fibers in matrix.

   1.5. Interface and interphase relationship.

   1.6. Composite properties.

2. SCALE OF COMPOSITE SYSTEMS : 20 ℓ - 30 h

   2.1. Molecular

   Copolymers
   Polymers

   2.2. Colloidal

   Suspensions
   Emulsions
   Geochemie
   Elastomeric rubbers

   2.3. Physical

   Foams
   Fiber in matrix
   Laminates

   2.4. Technical

   Sandwich construction
   Coated textile
   Adhesive bonds

   2.5. Structural

   Integrated constructions

3. MATERIALS : 20 ℓ - 30 h

   3.1. Metal systems.

   3.2. Ceramic systems and concrete systems.

   3.3. Glass systems.

   3.4. Polymer systems and asphalt systems.

   3.5. Cellulose systems.

5

4. MECHANICS OF COMPOSITES : 65 £ - 105 h, subdivided into :

4.1. Anisotropic continua : 20 £ - 30 h

Stress-strain : - anisotropic
- orthotropic
- transversely isotropic
- isotropic

Plane stress

Examples of anisotropic and isotropic solutions

Plates and shells

4.2. Mechanics of continuous fiber lamina : 7 £ - 15 h

Stiffness of unidirectional composites

Transformation of stress and strain

Off-axis stiffness of unidirectional composites

4.3. Mechanics of laminate : 8 £ - 15 h

Description of laminate

In-plane stiffness of symmetric laminates

Flexural stiffness of symmetric sandwich laminates

Properties of general laminates

4.4. Advanced study of composites : 10 £ - 15 h

Failure criteria

Hygrothermal behaviour : - fabrication stresses
- heat conduction & moisture diffusion
- angle-ply laminates : unsymmetric
symmetric
antisymmetric

Effects of temperature

Micro mechanics

Fatigue

4.5. Numerical calculation methods : 20 £ - 30 h

Finite Element Methods : - theory
- application in composite technology

Boundary element methods : - theory
- coupling between experiment and numerical methods

Data bases : introduction.

5. TESTING OF COMPOSITES : 35 ℓ - 60 h, subdivided into :

5.1. Material testing : 20 ℓ - 30 h

What are the parameters to test related to fibers
lamina
laminate

Which is the comportment of a composite (models) : elastic
viscoelastic
plastic
viscoplastic

Testing methods : strain gage
Moiré
photoelasticity
holography
acoustical methods
coupling element + numerical methods

5.2. Structural testing : 10 ℓ - 30 h

creep
fatigue
prototypes
similitude
strain gage
Moiré
photoelasticity
holography
acoustical methods
computer technology

5.3. In situ testing : 5 ℓ - 10 h

6. APPLICATION (seminars) - 50 seminars = 50 h

6.1. Energy saving

Energy saving in product design
Composite systems

6.2. Light weight construction

House constructions
Space technology
"Matching"
Building applications

6.3. Structural engineering

Low cost housing system
Admixtures in concrete

6.4. Up-grading of material properties

Design charts
Cement and concrete upgrading (bamboo reinforcement)
Natural fiber reinforcement

6.5. Earthquake resistent design with composites

Characterization of earthquakes
Improving the properties of composites: earth based
others

7. DESIGN : 20 ℓ - 30 h

7.1. Design of composite materials

Matching
Design charts

7.2. Design with composite materials

Gluing
3-dimensional composites
Composite structures

8. USE OF COMPUTERS : 60 h seminars

8.1. Computers : introduction to their use

8.2. Programming language

8.3. Introduction to the use of finite element packages

9. FIELD EXCURSIONS : 10 days (± 80 h) ; (cf. IFAQ)

10. FINAL REPORT : 300 h

Result of a guided research.

OUTLINE OF PROGRAMME AND COURSES

1. Duration, diploma, certificate

The programme will consist of two academic years ; the first being devoted to theoretical courses, practical exercises in laboratory and in the field. The second year will be entirely devoted to the preparation of the Final Report, its presentation and defence. Complementary lessons will have to be followed.

Certificate : A certificate (with notification of marks obtained and orientation followed) will be awarded upon successful passing of the first year's examination which should allow the participants the preparation of the Final Report.

Diploma : ICT will issue a Master of Science Degree in Composite Material Technology to all participants who have followed satisfactorily theoretical and practical activities during the first academic year and presented a Final Report during the second academic year. The diploma will mention the degree, the orientation and the title of the Final Report.

2. Choice of the course

The choice of the programme of the theoretical courses and practical exercises (first academic year) and the orientation and topic of the final thesis (second academic year) will be established according to the reccmmendation by the Academic Board of ICT, taking into account the needs of the candidate. An individual programme will then be set up in compliance with the scientific backgroun of each participant as well as with his future occupation(s) and the requirements in his country of origin.

Courses during the second year will be directly related to the Final Report which has to be prepared for its presentation and defence at the academic year.

Seminars and conferences on specialized subjects will also be given by visiting professors, and are considered as part of the examination programme.

The teaching staff would consist of professors, research fellows and assistants of different Belgian Universities and research centra, and a selection of foreign lecturers. We foresee collaboration in :

1. Vrije Universiteit Brussel
2. Katholieke Universiteit Leuven
3. Rijksuniversiteit Gent
4. Université de l'Etat à Liège
5. Centre de Recherche Routière
6. Centre Scientifique et Technique de la Construction
7. Nationaal Hoger Instituut Bouwkunde en Stedebouw (Antwerpen)
8. Technische Hogeschool Eindhoven (Nederland)
9. Technische Hogeschool Delft (Nederland).

10

INFORMATION

Prof. W.P. DE WILDE
Vrije Universiteit Brussel
Faculteit der Toegepaste Wetenschappen
Afdeling Bouwkunde
Pleinlaan, 2
B-1050 BRUSSELS (Belgium)

02/641.29.22 or 02/641.29.20

ANNEX IV : PROGRAM OF THE INTERNATIONAL TRAINING COURSE ON FUNDAMENTAL AND APPLIED QUATERNARY GEOLOGY(IFAQ post-graduate course) at V.U.B. Brussels -Belgium.

Vrije Universiteit Brussel
Faculty of Science

Pleinlaan, 2
1050 Brussels - Belgium

IFAQ

International Post-Graduate Training Course on Fundamental and Applied Quaternary Geology

International Post-Graduate Training Courses on Fundamental and Applied Quaternary Geology (IFAQ):

- Organized by the Free University of Brussels (VUB);
- under the sponsorship of
  UNESCO (Earth Science Division)
  INQUA (International Union for Quaternary Research)
  NFWO-FNRS (Belgian National Fund for Scientific Research,
  Belgian UNESCO Committee
- with the interuniversitary collaboration of the members of the teaching staff and laboratories of the Universities of Liège (UEL), Brussels (VUB and ULB), Gent (RUG), Leuven (KUL), Louvain-la-Neuve (UCL), Antwerp (RUCA and UIA), Gembloux (FAEG), the National Higher Institute for Architecture and Town Planning, Antwerp (NHIAS), the Museum of Central Africa, Tervuren (MCA), the Royal Meteorological Institute (KMI).
- in collaboration with members of the Geological Survey of the Netherlands (RGD), the Belgian Geological Survey (BGD), the Geological Institute of the Academia NAUK/USSR, the Geological Survey of Czechoslovakia/CSSR, the Institute of Geography, Lille, the Laboratoire de Géologie du Quaternaire/Marseille, and the Department of Quaternary Geology in Uppsala/Sweden
- in collaboration with the Centre for Quaternary Stratigraphy (COS), (Belgian National Science Foundation — contact group).
- in collaboration with the Institute for Marine Scientific Research (IZWO) Oostende-Bredene).
- Governmental Marine Fisheries Station, Royal Belgian Institute Natural Sciences (KBIN), Management Unit North Sea Model- (BMMN) Governmental Center Agricultural Research Gnent (C.L.O.).

ORIGIN AND AIM OF THE IFAQ TRAINING COURSES

The steadily growing need for the study of loose sediments and their related economically valuable deposits is at he foretront of an increasing demand for research and survey in Quaternary Geology. The complex nature of Quaternary Geology, situated at the threshold of Geology, Geography, Pedology, Oceanography and Limnology fully dealing with environmental problems of the Present and the Past, asks for its own field of investigation, choice of methods and basic philosophy.

In establishing the International Post-Graduate Training Course on Fundamental and Applied Quaternary Geology, it is the organizers aim to create on an international basis a selected programme which should combine all major aspects of specializec theoretical and practical training in the field of Quaternary Geology.

Therefore IFAQ is linking up an international interdisciplinary and interuniversity group of specialized institutions, laboratories and surveys thus continuing a long tradition of scientific research and collaboration amongst each other.

Although IFAQ is located at the Free University of Brussels (VUB), the structure works on an interuniversitary level. Most of the theoretical courses are given at the VUE, whereas practical training is completed in specialized laboratories at other associated universities and national geological surveys. This should guarantee a genuine practical education, besides an initial theoretical one. It is thought and hoped that the selected programme with its wide group of affiliations will meet the urgent demand for skilled geologists in Mineral Prospection, Engineering Geology, Quaternary Mapping and Fundamental Stratigraphy, especially in developing countries.

To this « continental » Quaternary programme are added courses in Oceanography and Limnology (VUB) and a widening scope of practical training in the field of geology as is already offered by members of the Geological Surveys.

From 1979 onwards, IFAQ spreads its activities over a two-year period for post-graduate studies. During the first academic year, participants will have to follow a series of theoretical courses and practical exercises in one of the possible orientations. The second year will cope with complementary courses and intensive training in laboratories and in the field, finally culminating in the preparation of the Final Report. It is also foreseen that some fieldwork should be carried out in the country of origin of the IFAQ participants from where samples may also be brought to be studied in the laboratories in Belgium.

2 Duration, Diploma, Certificate

The programme will consist of two academic years, starting about 1 ~~February~~ SEPTEMBER of each year. The first year will be devoted to theoretical courses practical exercises in laboratories and in the field, completed by field excursions in Belgium and neighbouring countries.

The second year will be entirely devoted to the preparation of the Final Reports, its presentation and defence. Complementary lessons will have to be followed.

Certificate

A certificate (with notification of marks obtained and orientation followed) will be awarded upon successful passing of the first year's examination which should allow the participants the preparation of the Final Report.

Diploma

IFAQ will issue a Master of Science Degree in Quaternary Geology to all participants who have followed satisfactorily theoretical and practical activities during the first academic year and presented a Final Report during the second academic year. The diploma will mention the degree, the orientation and the title of the Final Report.

3 Choice of the course

The choice of the programme of the theoretical courses and practical exercises (first academic year) and the orientation and topic of the final thesis (second academic year) will be established according to the recommendation by the Academic Board of IFAQ, taking into account the needs of the candidate.

An individual programme will then be set up in compliance with the scientific background of each participant as well as with his future occupation(s) and the requirements in his country of origin.

Ten courses are obligatory while a minimum of six compulsory examinations per orientation must be taken totalising a minimum of 350 lecture hours.

Selected courses during the second year will be directly related to the Final Report which has to be prepared for its presentation and defence at the end of the second academic year.

I.P.A.Q. PROGRAMME

Academic year 1984-1985.

- FIRST YEAR -

		LECTURES	PRACTICUM
1. GENERAL COURSES			
1. R. PAEPE + T. DOEKI	Quaternary Resources	15	
2. R. PAEPE + P. DOCKMANS	Quaternary Stratigraphy	7,5	15
3. R. PAEPE + L. ILLERCA	Sedimentological Structures	7,5	2,5
4. R. PAEPE + R. VAN OVERLOOP	Palynology	7,5	2,5
5. R. PAEPE + J. BACCAERT	Micropaleontology	7,5	2,5
6. R. PAEPE + M. [illegible]	Pleistocene mammals	7,5	2,5
7. C. [illegible]	Coastal Plain Geology	7,5	15
8. J. BOUCKAERT	Introduction to the geology of the pre-permian in Belgium	7,5	
9. M. DECLEER	Climatology	7,5	
10. M. VAN MOLLE	Applied Geomorphology	7,5	
11. M. DE DAPPER	Tropical Geomorphology	15	
12. A. OZER	Marine Geomorphology	7,5	
13. R. CHARLIER	Applied Oceanography	15	15
14. R. LAMOUREUX	Pedology for Quaternary Geology	15	
15. F. DE BREUK	Basic Hydrology	15	20
16. A. TASSIN 17. M. DESPONTIN	Introduction to Computer Programming	30	15
18. B. STEENSTRA + A. BOUEN	Exercises on geological maps and structures		30
19. B. STEENSTRA + A. BOUEN	General Field Prospection Methods	15	
20. J. HUS	Paleomagnetism, Rockmagnetism and Archeomagnetism	15	20
21. I. MARIOLAKOS	Neotectonics	15	
22. L. DAELS	Remote Sensing and air-photointerpretation	7,5	15
23. J. THOREZ	Clay Mineralogy	15	20
24. P. PASTEELS	Geochronology and Isotope geology applied to the Quaternary	15	
25. W. VIAENE	Geochemistry	15	15
26. A. CAPTIER	Quaternary mammals and archeozoology	7,5	
27. R. VANHOORNE	Paleobotany	15	45
28. P. POLK	Marine Biology	7,5	
29. P. VERMEERSCH	Prehistory	15	
30. T. VAN AUTENBOER	Glacial Geology + Glacialogy	15	
31. E. KEPPENS	Oxygene Isotope Geochemistry	7,5	
32. P. CAMELS	Seismic Geotechniques	15	15
33. G.A. PAEPOORT	Industrial Applications of Geological Materials	15	15
34. J. HUS	Geophysical Prospection Methods	15	30
35. Pat. JACOBS	Heavy Mineral Studies	7,5	20
36. J. VERHECKEN	X-Rays Techniques	7,5	20
2. CAPITA SELECTA (by Guest Professors)			
A. BERGER	Paleoclimatology (Climatic variations and modelling)	15	
		420	395
3. FIELDWORK			
R. PAEPE + J. HUBE	Löss area, Campine, Coversand area and Coastal Plain		3 days
R. PAEPE + E. BRUBACKER	Rhinevalley		4 days
J. BOUCKAERT	Belgium		3 days
E. HELE	Netherlands		2 weeks

I.F.A.G. PROGRAMME — Academic year 1954 - 1955

- SECOND YEAR -

ENGINEERING

+

PROSPECTION

		LECTURES	PRACTICUM
1) GENERAL COURSES			
R. PAEPE	Regional quaternary geology	15	
J. THOREZ	Geology of clays and micromorphology	15	15
B.P. HAGEMAN	Special problems and environment	7,5	
I. MARIOLAKOS	Special problems Mediterranean	7,5	
P. JACOBS	Drilling techniques in quaternary deposits	15	15
P. CAREL'S	Seismic Geotechniques I + II	15	7,5
P. MIGNONSIN	Thermoluminescence	15	
P. MIGNONSIN	Nuclear methods in geological prospection and radioprotection		
	Part I : Nuclear methods in geological prospection	7,5	7,5
	Part II : Radiation dosimetry. Radioprotection and radioactive wastes disposal	7,5	7,5
W. DE BREUCK	Engineering geology	7,5	
J. HUS	Geophysical prospection methods	15	30
F. DE SMEDT	Hydrogeology	15	15
T. VAN AUTENBOER	Geology and magnetic anomaly	7,5	
P. POLK	Marine ecology	7,5	
B. STEENSTRA	Dam sites	15	20
J.P. HENRIET	Marine seismic stratigraphy	7,5	
P. DE WILDE	Stability calculations on loose quaternary deposits	7,5	
B. STEENSTRA	Raw materials	7,5	
B. STEENSTRA	Gemmology	15	
H. NEYBERGH	Mineral prospection : organisation and methodology	7,5	
J. HERMAN	Phosphate prospection	7,5	
2) MAPPING and FIELDTECHNIQUES			
R. PAEPE + F. BOGEMANS	Quaternary		15
E. GUBEL	Archaeological techniques	15	
3) CAPITA SELECTA (by Guest professors)			
4) N.N. PROMOTOR	FINAL REPORT		200
5) EXCURSIONS		240	332,5
B. STEENSTRA	Dam Sites		3 days