

WHAT IS A RILEM TC ?

A group of international <u>experts</u> working together in a particular field in order to:

>assemble and evaluate research data >harmonize testing methods > suggest new topics for research >to promote their conclusions by publishing recommendations, technical reports or stateof-the-art reports for test methods Or construction practice.



A RILEM TC is in direct connection with a <u>RILEM Cluster</u>.

This body is entrusted with co-ordinating and monitoring RILEM TC activities, and to advise the RILEM Technical Activities Committee (TAC).

This co-ordination is convened by Clusters' conveners.



OBJECTIVES

Characterization of the hygrothermal behaviour of BBBM

Characterization of durability behavior of BBBM

1. Identification of

parameters

- Critical <u>review</u> of various <u>methods</u> to measure these parameters
- 3. <u>Selection</u> of parameters and develop methods to measure selected parameters
 4. Methods will be tested under Round Robin Test



EXPECTED ACHIEVEMENTS

- State of the art on hygrothermal behaviour characterisation of BBBM with the RRT results
- > State of the art on durability characterisation of BBBM
- Definition and <u>development of testing method</u> of a global parameter to qualify hygrothermal and durability behaviour of BBBM
- Organize the second ICBBM, in the continuity of the first ICBBM which took place in Clermont Ferrand in June 2015.



GROUP OF USERS

Researchers Market Professions (architects, craftsman, owners, contractors)



SPECIFIC USE OF RESULTS

To highlight the high performance of BBBM from the hygro-thermal point of view (not only conductivity).

To allow development of specific production and processing channels for these materials, including:

- a <u>non-food recovery</u> of agricultural products
- <u>short cycle distribution</u> of these low environmental impact building materials since these raw materials are available everywhere



MEMBERS

HYGROTHERMAL GROUP DURABILITY GROUP •IFSTTAR LMDC, Université Paul Sabatier, Toulouse Lafarge Holcim •ENS Cachan •Laboratorio Nacional de Engenharia Civil Universidade NOVA de Lisboa •IRDL, Université de Bretagne Sud COPPE/UFRJ University of Bath Queen's University Belfast •Belgian Building Research Institute LGCGM, Université de Rennes 1 Polytech Clermont Ferrand Università Politecnica delle Marche

•Lund University

Vicat



1° RILEM Meeting



Technical Committee:

Hygrothermal behaviour and Durability of Bio-aggregate based building materials

TC-HDB

Chairman:

Prof. Sofiane AMZIANE Polytech Clermont Ferrand Institut Pascal, UMR6602 Université Blaise Pascal Email: sofiane.amziane@univ-bpclermont.fr

Secretary:

Florence Collet Laboratoire de Génie Civil et Génie Mécanique, EA 3913, Université de Rennes 1 Email: florence.collet@univ-rennes1.fr

Minutes of the 1st meeting

Date and time: Thursday, November 17th, 2016, 10:00-16:00

Location: IFSTTAR Marne La Vallée, France

Participating members (11): Kamilia ABAHRI, Sofiane AMZIANE, Thibaut COLINART, Florence COLLET, Guillaume DELANNOY, Sara KORTE, Christophe LANOS, Mike LAWRENCE, Hoang LE-CHIEN, Vincent SABATIER for Camille MAGNIONT, Sandrine MARCEAU.

Participating by videoconference members (8): Laesitia BESSETTE, Paulina FARIA, Lina NUNES, Vincent PICANDET, Mohamed SONEBI, Paulien STRANBERG, Francesca TITTAELLI, Yassine DA GLORIA for Romildo TOLEDO FILHO.

Excused (2): Gilles ESCADILLAS, Camille Magnion



TECHNICAL ENVIRONMENT Previous TC BBBM



Maurials and Neuclassis (2017) 50.147 DOI: 10.1617/s11527-017-0229-5

BILEM TECHNICAL COMMITTEE

Recommendation of the RILEM TC 236-BBM: characterisation testing of hemp shiv to determine the initial water content, water absorption, dry density, particle size distribution and thermal conductivity

Soliane Amatane: Florence Collet - Mike Lawrence -Camille Magniout - Viacent Picaodet - Mohammed Sonehi

Received: 13 November 2016/Acceptor: 28 March 2017/Vahished online: 18 April 2017 O KILEM 2017

Abstract: This recommendation is the easenme of research conducted by a working group within the RILLM Technical Committee 226 (BBM 'Bio-aggregate-based building Materials' The work of the group related to the study of construction material make from plant particles. The major new material milliersh being renewable, recyclable and easily available plant particles. These particles are obtained from the

This recommendation was proposed by a 'working propagation BLLBM VC 256 cosming from right laboratorial infinite Parall (Corrested Education) and the Control for Innovative Constrainties Materials (University of Bath), BEE (University de Branges Nob.) DECB (SPNPE Lynn), LLCOM (Remeahand), DECB (University of Education), DECB (Control Age) (Control of the Trailmost (DSPR)), Contribute below), the contribution by the other contributions (Studbelow), the work of the VC on graphicity actives/bage).

TC 236 BAM Manherts

Chairman Voltage AM/21ANE, Issiant Poaral, Clemens Université, France.

Secretary: Premice COBLET, Devenite or Rennes 1, 1/CCOM, France

TC Montene: Lowerst ARS/AFRE (state Yangunate Superviser of Ants or Mission, ERSSA (Cong., Forum: Latents BESSETTE, Comm Technique Latin VECAT, Palate d'Alema, Pranes, Faulten Do Brann, Latel Javversty, Forung of Ungenering (CTI), Thyn of Technique Marcenty, Enable of Ungenering (CTI), Thyn of Technique Marcenty, Enable (Seeder, Filler SECADERLA, University & Technique Marcenty, ERSA, LMOC, Fource, Eleman (CHRELAY, CSTE) de That Laboratione Regional de Staniburg, France, Classinghie Laboratione Regional de Staniburg, Parace, Classinghie (LMOR), Horestelli de Remark, J. LGCRM, France, Marcenty processing of hermy, face, microathus, pine, paint, undurine, humbers and rater plants; to this segment, the outcome of the Brand Bohim Testing is vestined an hermy because hermy site in the biologorogous mus is the most woldely must in building associate and the must and/or in the treatment. The first number for the set of the TC-BBM published in the State of The Ast Report of Technical Committee 236-BBM 'Bioagreguin-builded building Material' was certained to this.

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TECHNICAL ENVIRONMENT Previous TC BBM

Need to investigate how the <u>hygrothermal</u> <u>behaviour</u> of BBBM widely <u>impacts</u> the <u>global</u> <u>energy balance of building</u>.

Need to investigate the <u>durability</u> of BBBM. How aging can affect the properties of biobased materials?

- Colour and appearance
- Material disintegration
- Material cohesion (internal bond)
- Thermal insulation
- Acoustic insulation
- Moisture transport
- Vapour permeability
- Capillary absorption
- Dimensional variation
- Strength, stiffness and toughness

Prof. Francesca Tittarelli - UNIVPM

COPPE



WORKING PROGRAM - ACTIONS

A0 – Investigated BBBM

- Identification of the BBBM to be investigated
- Choice of bio-aggregate
- Choice of binders (mineral and/or organic binder)

> A1 – Hygrothermal behaviour of BBBM

- Identification of parameters
- Critical review of methods to measure parameters
- Selection of parameters and develop methods to measure them
- To test methods under Round Robin Test

A2 – Durability of BBBM

- Identification of parameters
- Critical review of methods to measure parameters
- Selection of parameters and develop methods to measure them
- To test methods under Round Robin Test
- What to do to increase durability



- A3 to build bridges between the functional (mechanical, acoustical, thermal and hygrothermal), bio-physico-chemical and microstructural properties during natural and accelerated (environmental and microbiological) ageing of BBBM.
- Survey about the different forms of <u>ageing</u> (natural, environmental and microbiological).
- Design and work out the <u>ageing protocols</u>
- Survey of the methods <u>characterising</u> the functional, bio-physicochemical and microstructural properties <u>before</u>, <u>during</u> and <u>after</u> <u>ageing</u>.
- Study on <u>how to correlate</u> the various properties, link them to the ageing of hempcrete, and to derive <u>usage-driven recommendations</u> <u>on formulations</u>.



2°-3° RILEM Meeting



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Technical Committee: Hygrothermal behaviour and Durability of Bio-aggregate based building materials TC-HDB

Chairman: Prof. Sofiane AMZIANE Polytech Clermont Ferrand Institut Pascal, UMR6602 Université Blaise Pascal Email: sofiane, amziane@univ-bpclermont.fr <u>Secretary:</u> Florence Collet Laboratoire de Génie Civil et Génie Mécanique, EA 3913, Université de Rennes 1 Email: florence.collet@univ-rennes1 fr

Minutes of the 2nd meeting

Date and time: Thursday, March 30th, 2017, 10:00-16:00

Location: IFSTTAR Marne La Vallée, France

Participating members (10): Kamilia ABAHRI (KA), Sofiane AMZIANE (SA), Florence COLLET (FC), Guillaume DELANNOY (GD), Lê-Chiên HOANG (LCH), Christophe LANOS (CL), Mike LAWRENCE (ML), Camille MAGNIONT (CM), Sandrine MARCEAU (SM), Stijn MERTENS (StM).

Participating by videoconference members (2): Joseph SHERIDAN (JS), Francesce TITTAELU (FT).

Intermittently, by phone (1): Vincent PICANDET (VP)

Excused (2): Laetitia BESSETTE, Thibaut COLINART, Yassine DA GLORIA, Gilles ESCADILLAS, Paulina FARIA, Ronelvy NIVESS, Lina NUNES, Mariana PALUMBO, Paulien STRANDBERG, Mohamed SONEBI (MS), Romlido TOLEDO FILHO.



Technical Committee:

Hygrothermal behaviour and Durability of Bio-aggregate based building materials

TC-HDB

Chairman

Prof. Sofiane AMZIANE Polytech Clermont Ferrand Institut Pascal, UMR6602 Université Blaise Pascal Email: sofiane amziane@univ-opclermont.fr Secretary: Florence Collet Laboratoire de Génie Civil et Génie Mécanique, EA 3913, Université de Rences 1. Empli: florence collet@univ-rennes1.fr

Minutes of the 3rd meeting

Date and time: Thursday, November 16th, 2017, 10:00-16:00

Location: ENS Cachan, France

Participating members [13]: Kamilia ABAHRI (KA), Sofiane AMDANE (SA), Ana ARMADA BRAS (AA), Lactitia BESSETTS (LB), Thibaut COLINART (TC), Florence COLLET (FC), Guillaume DELANNOY (GD), Christophe LANOS (CL), Mike LAWRENCE (ML), Camilie MAGNIONT (CM), Sandrine MARCEAU (SM), Rohelvy NIVESS (RN), Sylvie PRETOT.

Participating by videoconference members (9); Vassine DA GLORIA (VDG), Pauline FARIA (PF), Stijn MERTENS (StM), Peter NADRAH (PK), Mariane FALUMBD, Vincent PICANDET - afternoon (VP), Joseph SHERIDAN (JS), Mohemed SONEBI (MS), Francesca TITTAELLI (FT).

invited observer (3): Mohamed CHAOUCHE, Anne DAUBRESSE, Fares BENNAI

Excused (5): Gilles ESCADILLAS, Le-Chien HDANG (LCH), Line NUNES, Faulien STRANDBERG, , Romildo TDLEDO FILHO.



HYGROTHERMAL PROPERTIES: Identification of Parameters

Overview of previous works of TC members (hygrothermal)

Several labs

- Vapour diffusivity,
- Sorption-desorption,
- Moisture buffer value,
- Capillary water absorption,
- Thermal conductivity
- Specific heat capacity

Few labs

- Liquid diffusivity,
- Gas permeability
- Pore size distribution,
- Real time moisture front transport,
- Real time monitoring of outdoors cell
- Hygrothermal behavior at wall scale
- Drying
- Full-scale rain exposure
- Emissivity/absorptivity/reflectivity



HYGROTHERMAL BEHAVIOUR Identification of parameters

LACHAN

Multiscale approaches for the characterization and modeling of hygrothermal behavior of biobased materials

K. ABAHRI, PhDs: C. EI-HACHEM, F. BENNAI



March 30 2017

Contact: kamilia.abahri@Imt ens-cachan fr

Hygrothermal Research at the University of Bath

Dr Mike Lawrence Principal Investigator ISOBIO Project



- THERMAL CONDUCTIVITY
- WATER VAPOUR PERMEABILITY
- SORPTION/DESORPTION CURVE
- MOISTURE BUFFERING VALUE

HYGROTHERMAL BEHAVIOUR Critical review of methods to measure parameters

Measurement of Thermal Conductivity of bio-based building materials

Florence COLLET Laboratoire de Génie Civil et Génie Mécanique (EA 3913), Equipe Matériaux Thermo - Rhéologie Université de Rennes 1





Heat transfer in

porous media How to measure

thermal conductivity?

Thermal conductivity of BBM

Impacting parameters Comparison of

results from different

measurement methods

Conclusion

 only <u>guarded hot plate</u> is the method validated by standards

How to measure thermal conductivity ?

Steady state methods

- guarded hot plate,
- heat flow meter,
- guarded hot boxes

Transient state methods

- hot wire and line source,
- hot ring (*),
- flash method (*),
- transient plane source (*)
- hot disk (*)





HYGROTHERMAL BEHAVIOUR Critical review of methods to measure parameters



- The <u>cup method</u> is the standard to measure it
- The permeability depends on the specimen <u>thickness</u>.
- The permeability depends on the <u>air velocity</u> on the upper side of the cup.

HYGROTHERMAL BEHAVIOUR Critical review of methods to measure parameters



- Traditional methods: saturated salt solutions (equilibrium)
- Dynamic Vapour Sorption (not equilibrium).
- The <u>results</u> obtained from the two methods are <u>different</u>
- An <u>hysteresis</u> occurs between adsorption and desorption: a little is known about this phenomenon.





- <u>Several protocols</u> to characterize the MBV: Padfield (1999), Svennberg (2006), Japanese protocol (2002), Nordtest protocol (2005).
- The main differences are the <u>lap time</u> of the exposure at given RH (24h/24h for Japenese and 8h/16h for Nordtest), and the <u>air velocity</u> at the surface of specimen (to be adjusted for Japanese, about 0.1 ± 0.05 m/s for Nordtest).
- The <u>thickness</u> of the specimen must be higher than the penetration depth.



DURABILITY BEHAVIOUR Identification of Parameters



Overview of previous works of TC members (durability)

Several labs

- Artificial and natural climatic ageing (heat-rain, heat-cold, frost-thaw, UV, salt attacks)
- Pore size distribution
- Mechanical, acoustical and thermal properties

Few labs

- Surface cohesion
- Dry and wet abrasion
- Biological ageing



DURABILITY BEHAVIOUR Identification of Parameters



DURABILITY BEHAVIOUR Critical review of methods to measure parameters

Reference	Material	Description	Duration
Arizzi et al. (2016)	Hemp concrete	Dynamic: 3 Climatic simulations: variation of temperature, humidity, rainfall, influence of salts	12 days
Walker et al. (2014)	Hemp-lime concretes	Freeze/thaw cycles	10 cycles between -15 and 20 °C
		Exposition to salts (NaCl) during 12 h and drying during 12 h	20 °C during two weeks and 40 °C during the next two weeks
		Biological aging	Inoculation and storage at 30 °C and 80% HR during 7 months
Hellebois 2013, Hellebois et al. (2013)	Hemp concrete	Wetting and drying cycles	30 °C, 40 and 90% RH
		Immersion and drying cycles	20 °C, 2 cycles, 41 days, Drying at 40 °C
		Biological aging	3 months at 30 °C and 98% RH
Abdellaoui (2014), Marceau et al. (2015)	Hemp concrete	Wetting and drying cycles	30 °C, 40 and 98% RH
		Biological aging	3 months at 30 °C and 98% RH
Sonebi et al. (2015), Castel et al. (2016)	Hemp concrete	Full Immersion in water and drying cycles	Immersion at 20 °C, drying at 50 °C during 48 h
Magniont et al. (2012)	Hemp concrete	Storage at 25 °C and RH > 95%	Until 2.5 years
Bessette et al. (2015)	Precast hemp concrete	Storage in inside climate	90 days
		Storage in external climate	One year
Le Bayon et al. (2015)	Different bio-based construction materials	Development of a mould test method	



DURABILITY BEHAVIOUR What to do to increase durability ?

Hydration reactions can be delayed or stopped in presence of molecules present in shiv and soluble in water

Monosaccharides

Polysaccharides







RILEM: Durability of Bio-based Materials Influence of the retting of Hemp wood on the interaction "Biomasse/OPC"

Lê-Chiên HOANG, IFSTTAR Paris, 30/03/2017 le-chien.hoang@lafargeholcim.com



- Soluble organic molecules (saccharides, pectin), increased by the alkaline environment, are the main <u>retarders</u> of OPC hydration.
- The retting is the <u>enzymatic degradation</u> of the pectin and the hemicellulose to facilitate the separation of the fibre reducing the soluble organic content
- Change of <u>colour</u> with retting: good correlation between the color degree and the content of soluble organic.



4° RILEM Meeting



Technical Committee:

Hygrothermal behaviour and Durability of Bio-aggregate based building materials TC-HDB

Chairman:

Prof. Sofiane AMZIAIVE Polytech Clermont Ferrand Institut Pascal, UMR5602 Universite Blaise Pascal Email: sofiane,amziane@univ-opclermont.fr Secretary: Florence Collect Laboratoire de Genie Civil et Génie Mécanique, 54 2013 Universite de Rennes 1. Email: Florence collet:Buniv-rennes1.ff

Minutes of the 4st meeting

Date and time: Wednesday, March 28th, 2018, 10:00-16:30

Location: IFSTTAR Marne La Vallée, France

Participating members [13]: Sofiane ANCIANE (SA) , Lastitia BESSETTE (LB), Parence COLLET (PC), Guillaume DELANNO (GD), Christophe LANOS (CL), Camille MAGNIONT (CM), Sanarine MARCEAu (SM), 3Ejn MERTENS (SSM), Ramery M. 635 (RN), Manana PALUMBO (MP), Vincent PICANDET (VP), Sylvie PRETOT (3P).

Participating by videoconference memoers (9): Yassine DA GLORIA (YDE), Pauline FARIA (FF), Faser NADRAH (F), Joseph SHERIDAN (JS), Mohamed SONEBI (VS), Francesca T/TTAELLI (FT), Romitide TOLEDO FLHO (RTF).

Excused (5): Kamila ABAHRI, Ana ARMADA BRAS, Tribaut COUNART, Sillet ESCADILLAS, Mike LAWRENCE, Hoang LE-CHIEN, Line NUNES, Paulien STRANDBERG.

1 Welcome and introduction by Chair

The meeting started at 10:30. A verticime talk and an introduction were done by Softene AM2IANE, Each participant has introduced himself.

 Approval of the agenda The time table was approved.

3 Acceptance of the minutes of the 3rd meeting The minutes of the third meeting are approved.

4 Update on membership At date, there are 27 members in TC HDB. SA underlines that the membership is free for students.



ROUND ROBIN TEST Specimens



BIOSYS: Interlocking hempcrete blocks

In conjunction with Vieille Matériaux, a precast concrete products manufacturer in eastern France, Vicat group is backing an innovative concept of mechanically interlocking 100% natural dry-stack hemp crete blocks.

HEMP CONCRETE from BIOSYS
Cube or Prisms
3 specimens for each test
Initial stabilisation of specimens at 23°C, 50% RH.





ROUND ROBIN TEST Hygro-thermal behavior

Parameter: THERMAL CONDUCTIVITY Method: HOT PLATE, HOT WIRE, HOT RING (Protocols) Specimens: HEMP CONCRETE (cubes 10×10×10 cm³ or 15×15×5 cm³)



Conditions:





- T =23°C, RH = 50% and at dry state
- Measured in two directions: parallel and perpendicular to shiv



ROUND ROBIN TEST Hygro-thermal behavior

Parameter: WATER VAPOUR PERMEABILITY Method: CUP METHOD ISO 12572 (Protocol)



Specimens: HEMP CONCRETE (adapted to the cup), Two thicknesses



- The assembly is then placed in a climatic chamber at 50% RH => a vapour flow occurs through permeable specimens.
- Periodic weighings of the assembly are made to determine the rate of water vapour transmission in the steady-state.



ROUND ROBIN TEST Hygro-thermal behavior

should correspond to a

5.0x107 m2sPa/kg

surface film resistance of

Parameter: MOISTURE BUFFERING VALUE **Method: NORDTEST Protocol** Specimens: HEMP CONCRETE (cubes 10×10×10 cm³)

NORDTEST Protocol



Industrial Standard

Test procedure is not

given for the S.F.R.



Prof. Francesca Tittarelli - UNIVPM

practical application

✓ a thickness larger than the1% penetration depth for daily humidity variations



ROUND ROBIN TEST Durability behavior

Parameters: WATER ABSORPTION Method: to be defined







ROUND ROBIN TEST Durability behavior

Parameters: SHRINKAGE AND SWELLING Method: to be defined





ROUND ROBIN TEST Durability behavior

Parameters: FREEZE-THAW behaviour Method: to be defined





5° RILEM Meeting



The next meeting will be on the 14th of November 2018 at VICAT.



International union of laboratories and experts in construction materials, systems and structures

Cluster A. Material Processing and Characterization (Convener: Barzin MOBASHER)

New Technical Committee AMC : Use of Agro-Based Materials as Cementitious Additions in Concrete and Cement-Based Materials

> Chair: Prof. Said KENAI Deputy Chair: Dr. Mike B. OTIENO Activity starting in: 2018

