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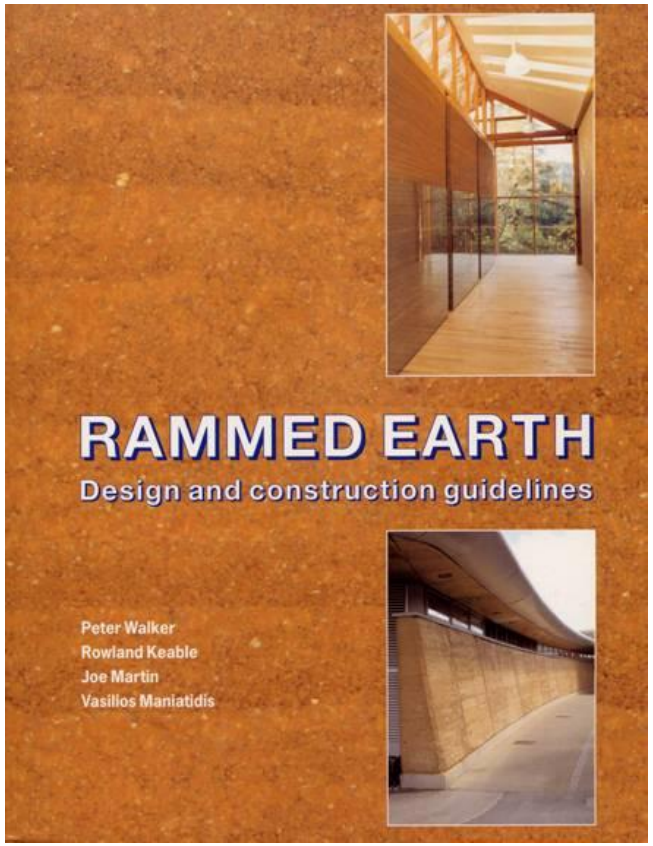

About this book

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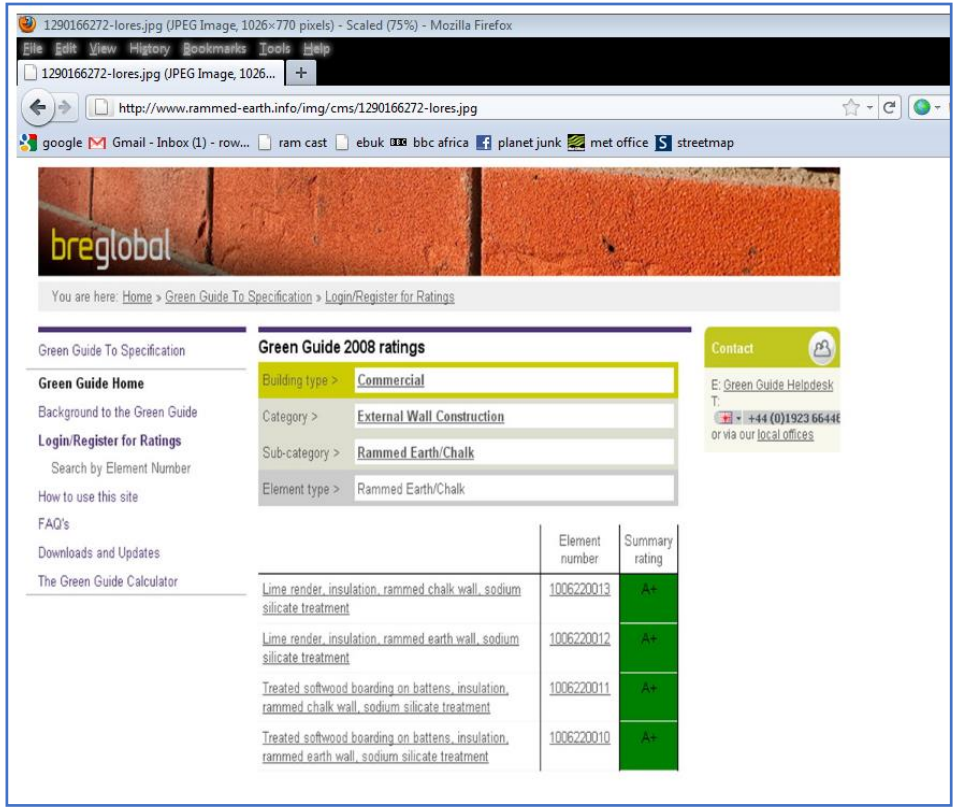

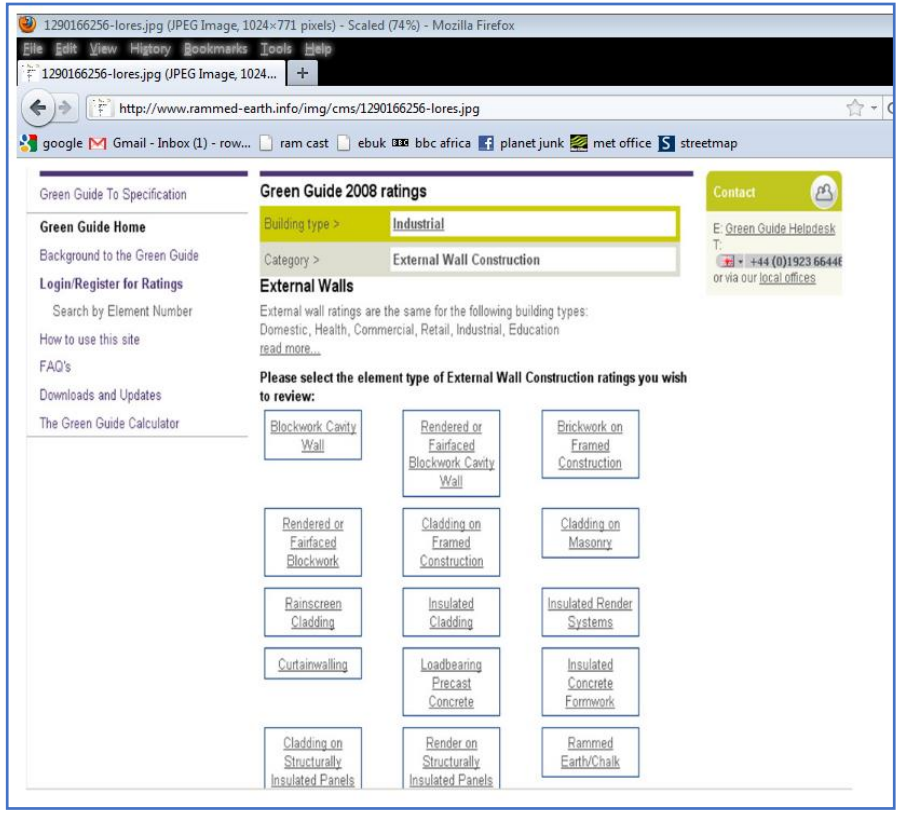

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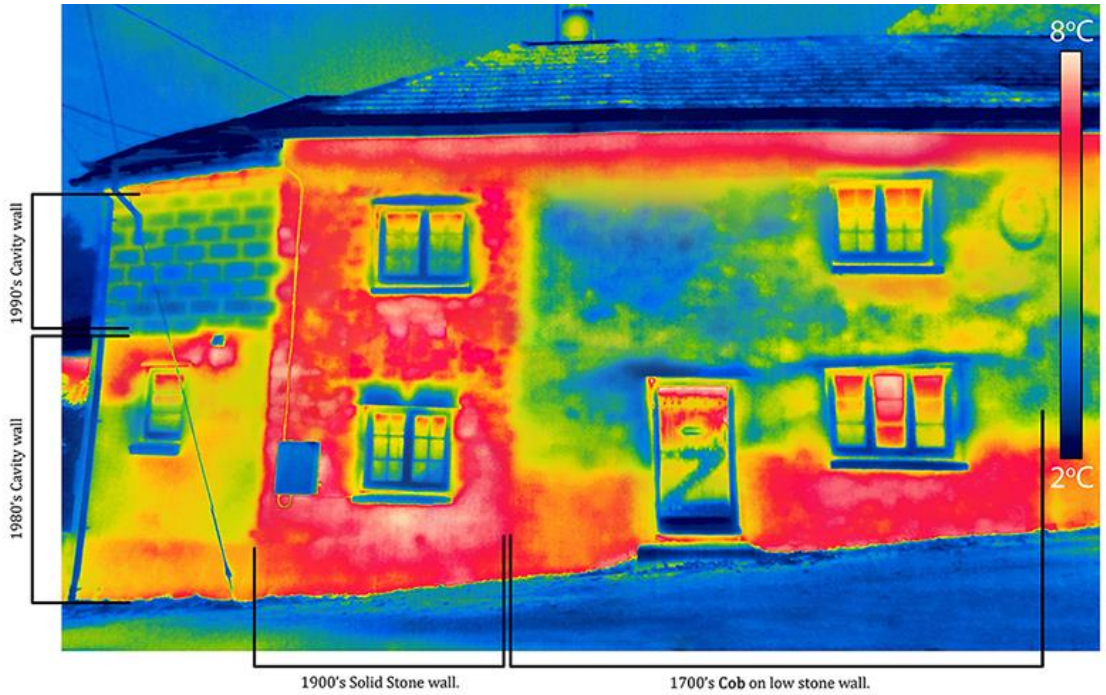

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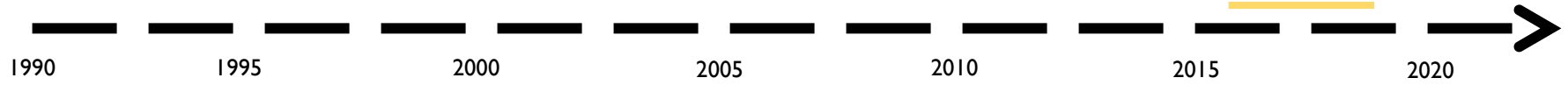

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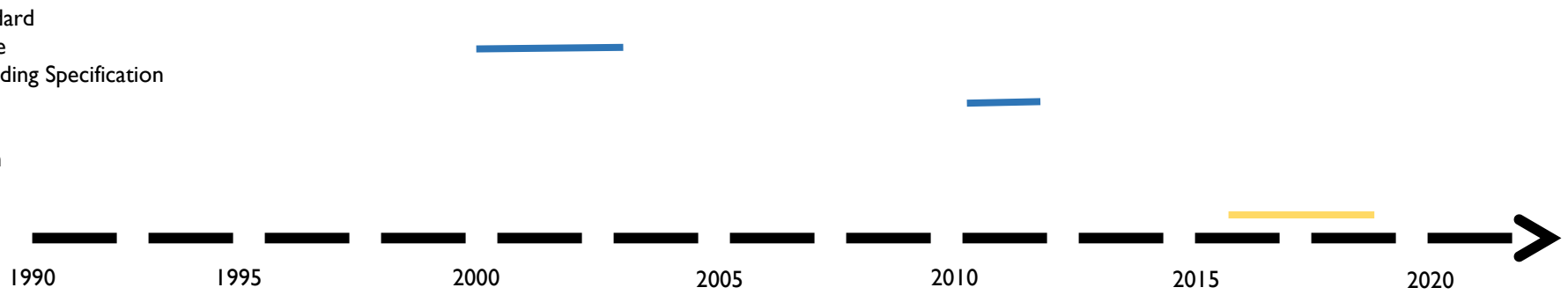

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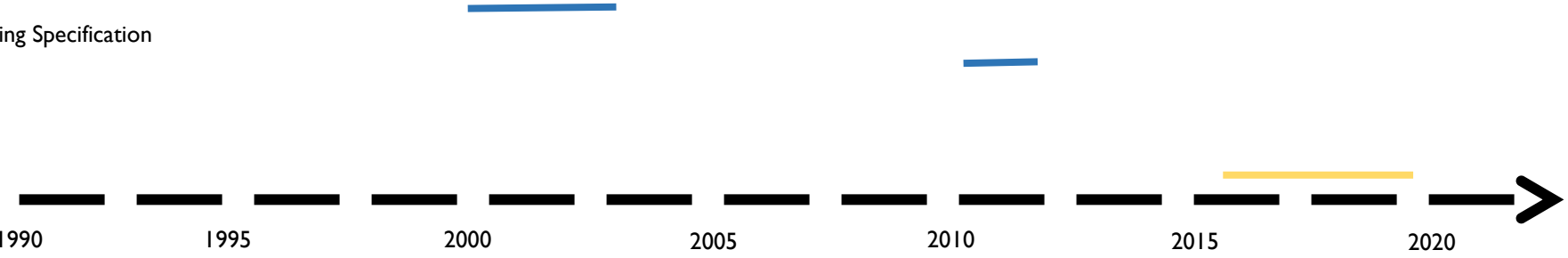

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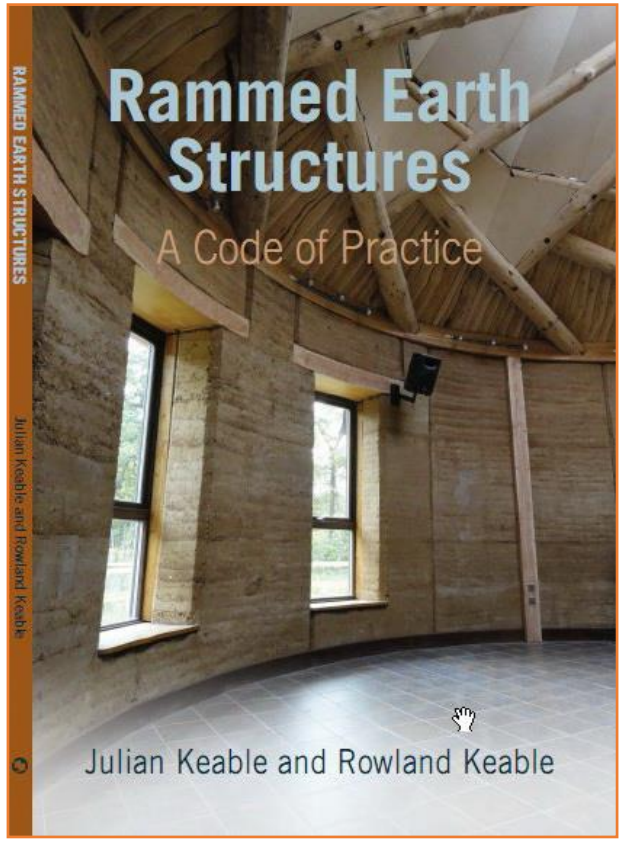

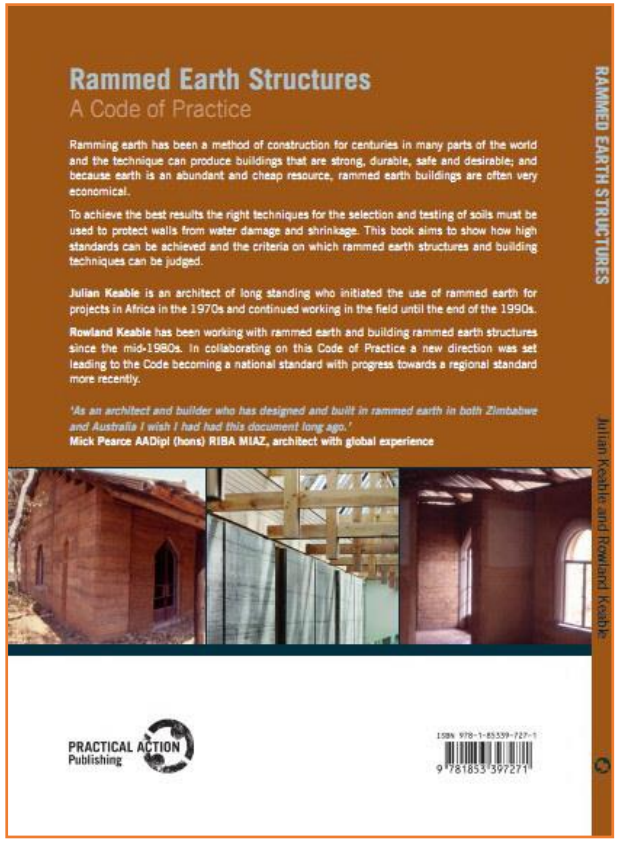

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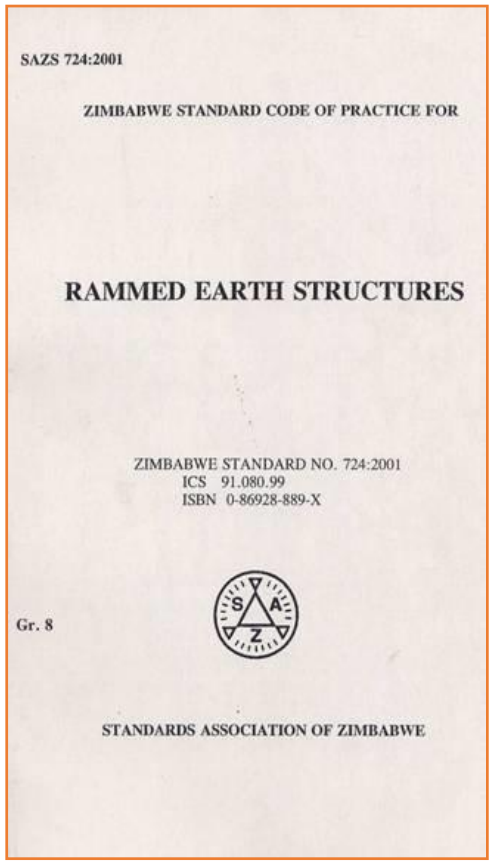

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ZIMBABWE STANDARD CODE OF PRACTICE FOR

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ZIMBABWE STANDARD NO. 724:2001
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Gr. 8

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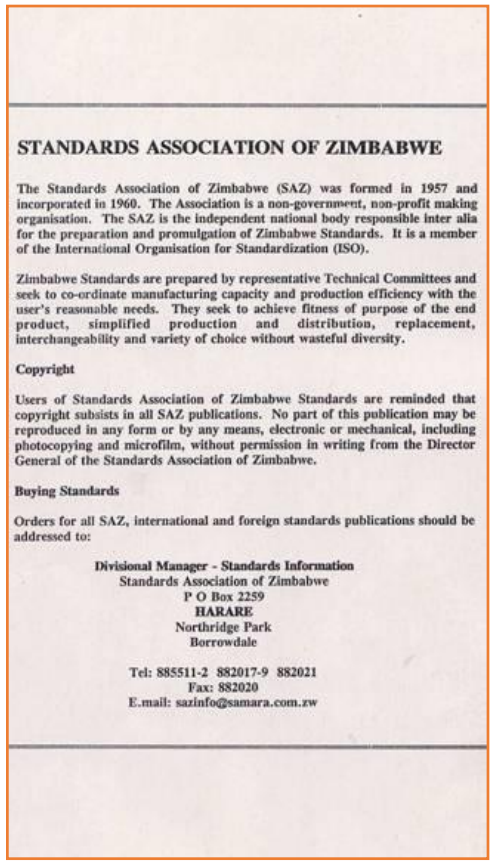

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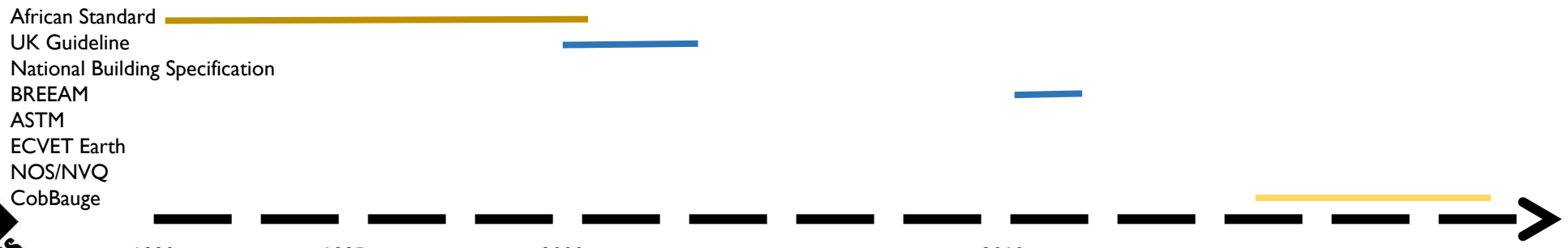

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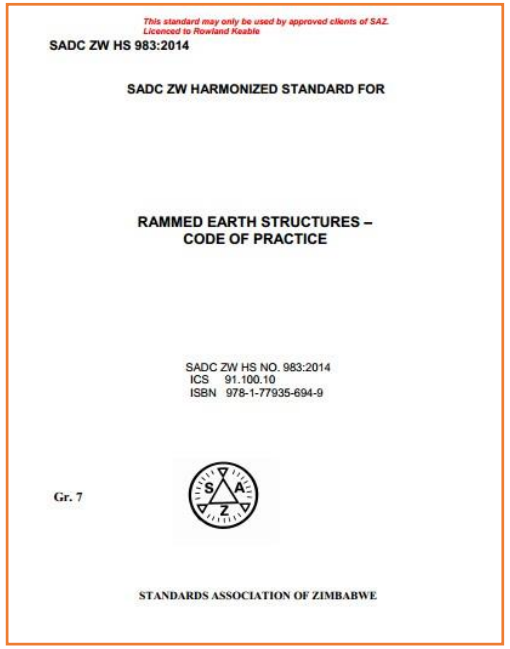

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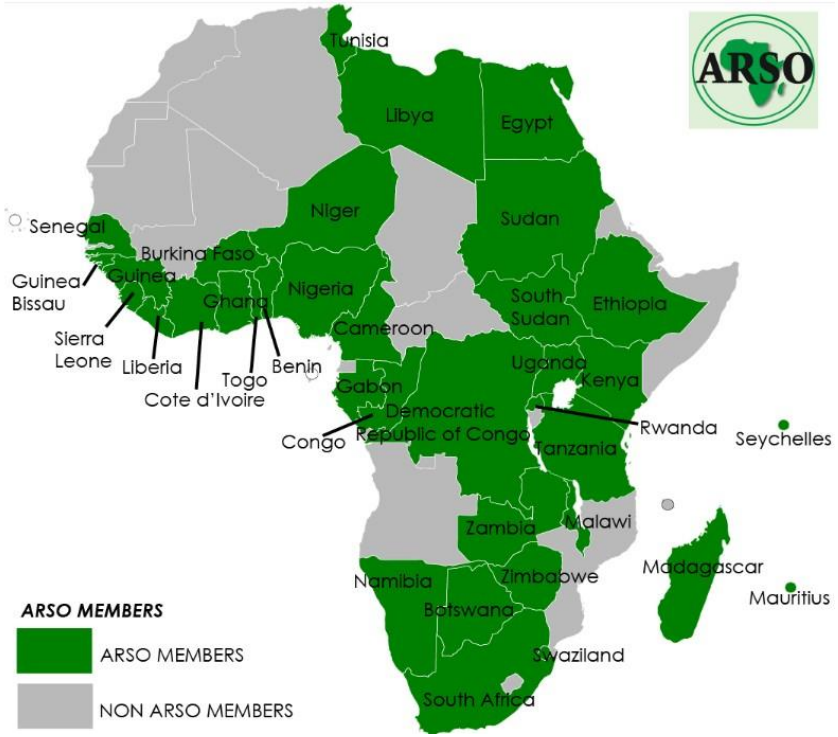
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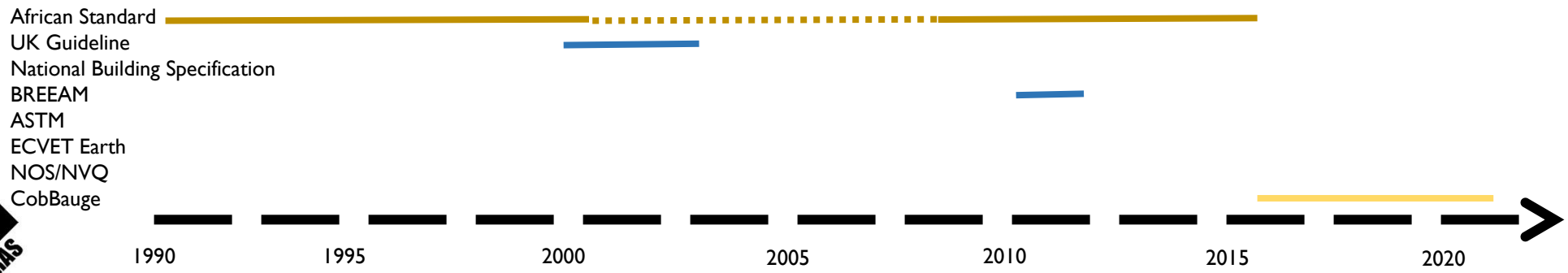
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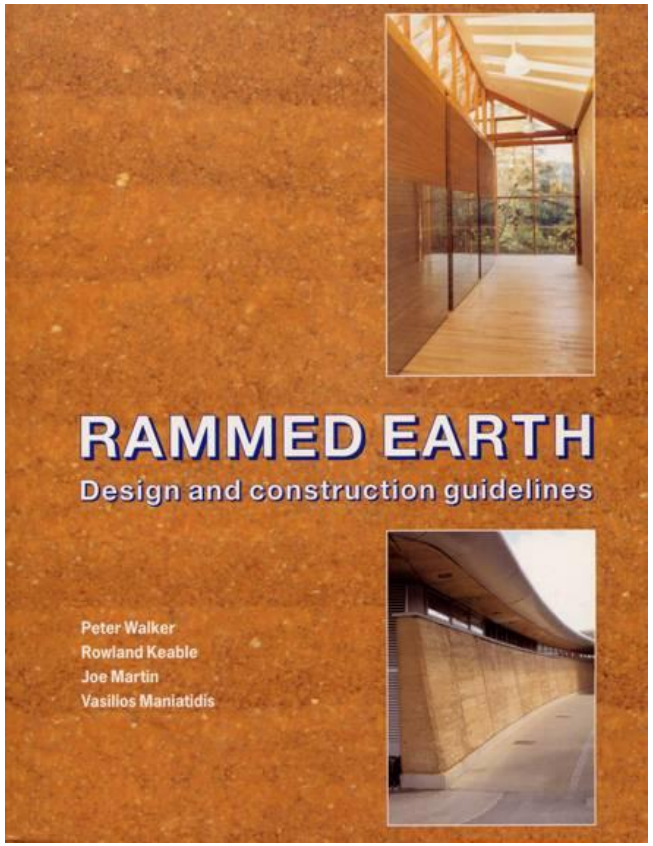

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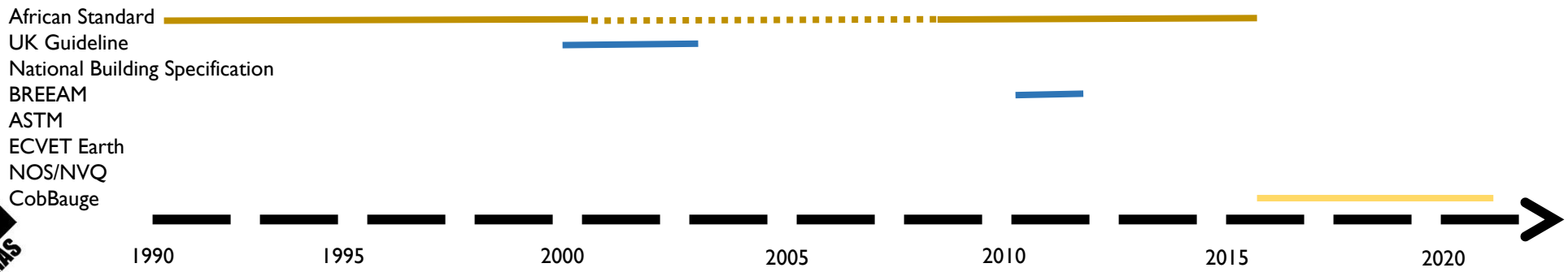

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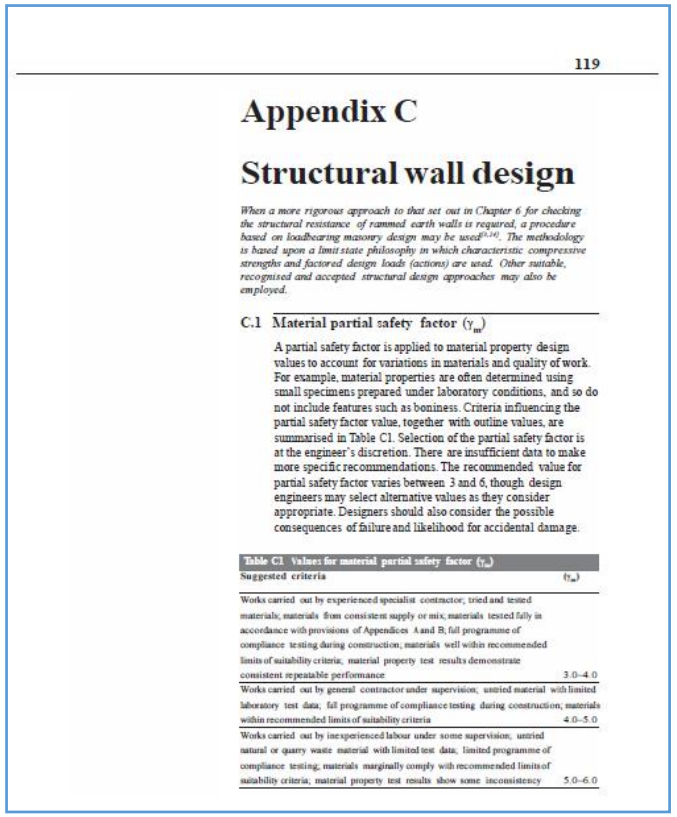

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Appendix C

Structural wall design

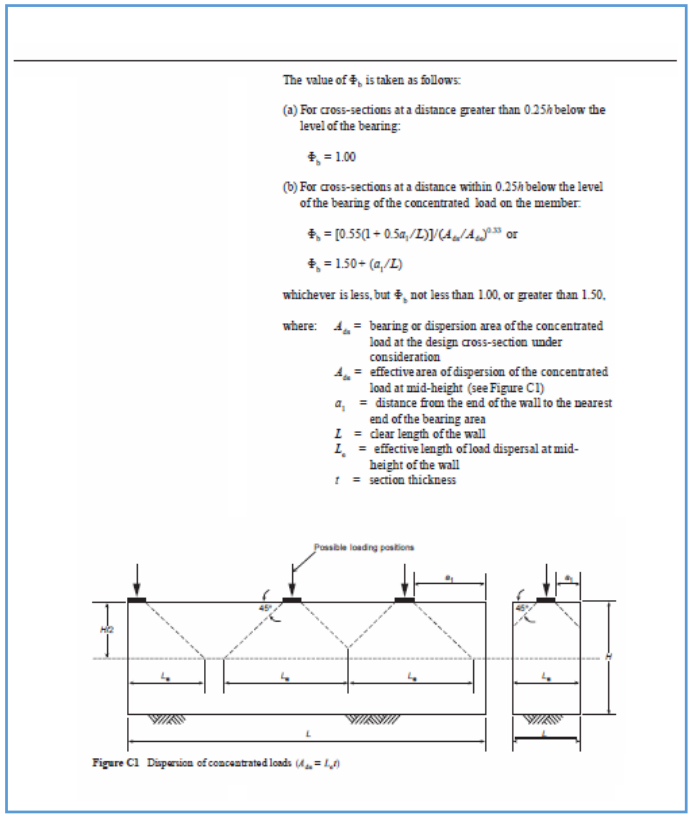
When a more rigorous approach to that set out in Chapter 6 for checking the structural resistance of rammed earth walls is required, a procedure based on loadbearing masonry design may be used[9,10]. The methodology is based upon a limit state philosophy in which characteristic compressive strengths and factored design loads (actions) are used. Other suitable, recognised and accepted structural design approaches may also be employed.

C.1 Material partial safety factor (γ_m)

A partial safety factor is applied to material property design values to account for variations in materials and quality of work. For example, material properties are often determined using small specimens prepared under laboratory conditions, and so do not include features such as boniness. Criteria influencing the partial safety factor value, together with outline values, are summarised in Table C1. Selection of the partial safety factor is at the engineer's discretion. There are insufficient data to make more specific recommendations. The recommended value for partial safety factor varies between 3 and 6, though design engineers may select alternative values as they consider appropriate. Designers should also consider the possible consequences of failure and likelihood for accidental damage.

Table C1 Values for material partial safety factor (γ_m)

Suggested criteria	(γ_m)
Works carried out by experienced specialist contractor; tried and tested materials; materials from consistent supply or mix; materials tested fully in accordance with provisions of Appendices A and B; full programme of compliance testing during construction; materials well within recommended limits of suitability criteria; material property test results demonstrate consistent repeatable performance	3.0–4.0
Works carried out by general contractor under supervision; untried material with limited laboratory test data; full programme of compliance testing during construction; materials within recommended limits of suitability criteria	4.0–5.0
Works carried out by inexperienced labour under some supervision; untried natural or quarry waste material with limited test data; limited programme of compliance testing; materials marginally comply with recommended limits of suitability criteria; material property test results show some inconsistency	5.0–6.0



The value of Φ_h is taken as follows:

(a) For cross-sections at a distance greater than $0.25h$ below the level of the bearing:

$\Phi_h = 1.00$

(b) For cross-sections at a distance within $0.25h$ below the level of the bearing of the concentrated load on the member:

$\Phi_h = [0.55(1 + 0.5a_1/L)]/(A_{da}/A_{de})^{0.33}$ or

$\Phi_h = 1.50 \div (a_1/L)$

whichever is less, but Φ_h not less than 1.00, or greater than 1.50,

where: A_{da} = bearing or dispersion area of the concentrated load at the design cross-section under consideration
A_{de} = effective area of dispersion of the concentrated load at mid-height (see Figure C1)
a_1 = distance from the end of the wall to the nearest end of the bearing area
L = clear length of the wall
L_e = effective length of load dispersal at mid-height of the wall
t = section thickness

Figure C1 Dispersion of concentrated loads ($A_{da} = L_e t$)

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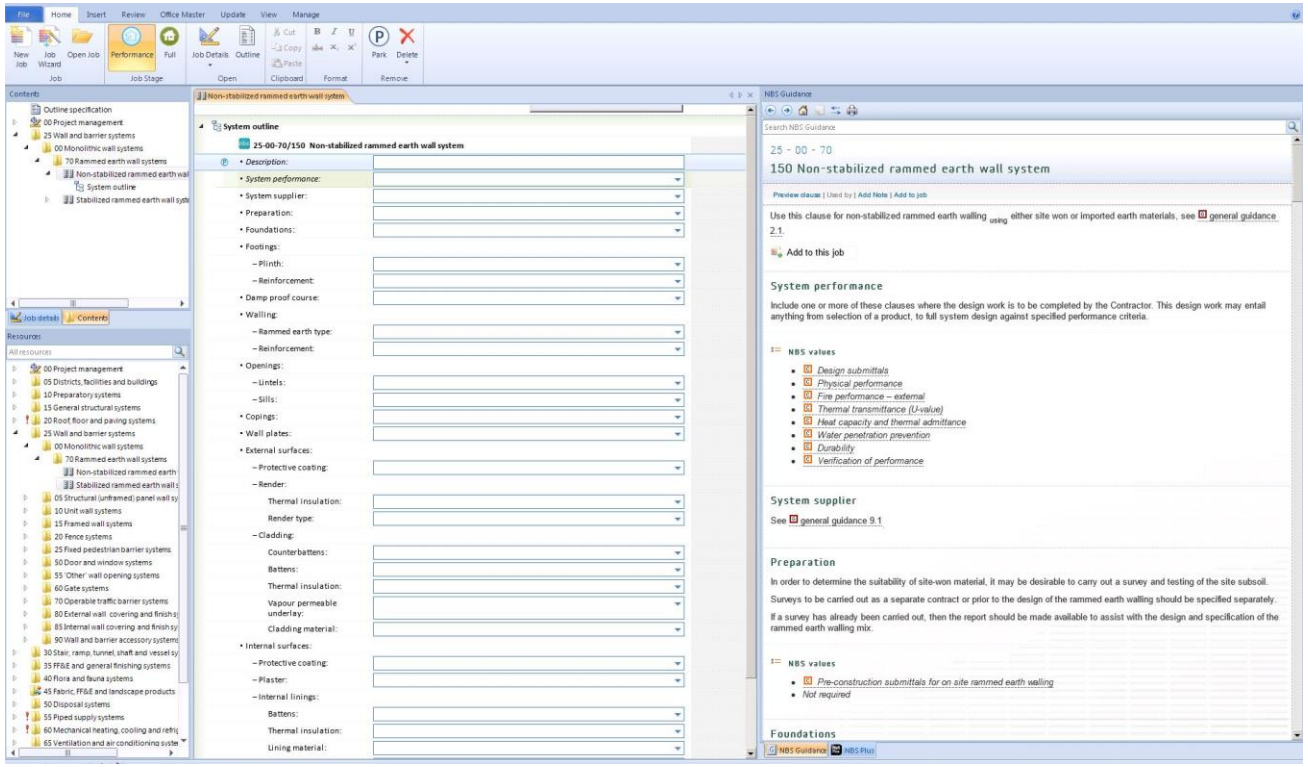

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Designation: E2392/E2392M – 10

Standard Guide for Design of Earthen Wall Building Systems[1]

This standard is issued under the fixed designation E2392/E2392M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard provides guidance for earthen building systems, also called earthen construction, and addresses both technical requirements and considerations for sustainable development. Earthen building systems include adobe, rammed earth, cob, cast earth, and other earthen building technologies used as structural and non-structural wall systems.

NOTE 1—Other earthen building systems not specifically described in these guidelines, as well as domed, vaulted, and arched earthen structures as are common in many areas, can also make use of these guidelines when consistent with successful local building traditions or engineering judgement.

1.1.1 There are many decisions in the design and construction of a building that can contribute to the maintenance of ecosystem components and functions for future generations. One such decision is the selection of products for use in the building. This guide addresses sustainability issues related to the use of earthen wall building systems.

1.1.2 The considerations for sustainable development relative to earthen wall building systems are categorized as follows: materials (product feedstock), manufacturing process, operational performance (product installed), and indoor environmental quality (IEQ).

1.1.3 The technical requirements for earthen building systems are categorized as follows: design criteria, structural and non-structural systems, and structural and non-structural components.

1.2 Provisions of this guide do not apply to materials and products used in architectural cast stone (see Specification C1364).

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1364 Specification for Architectural Cast Stone

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

E631 Terminology of Building Constructions

E2114 Terminology for Sustainability Relative to the Performance of Buildings

2.2 *ASCE Standards:*[3]

ANSI/ASCE 7 Minimum Design Loads for Buildings and Other Structures

2.3 *New Zealand Standards:*[4]

NZ97 Engineering Design of Earth Buildings, 1998

NZ98 Materials and Workmanship for Earth Buildings, 1998

NZ99 New Zealand Standard, Earth Buildings not requiring Specific Design, 1998 (including amendment #1, December 1999)

3. Terminology

3.1 *Definitions:*

3.1.1 For terms related to building construction, refer to Terminology E631.

3.1.2 For terms related to sustainability relative to the performance of buildings, refer to Terminology E2114. Some of these terms are reprinted here for ease of use.

3.1.3 *alternative agricultural products, n*—bio-based industrial products (non-food, non-feed) manufactured from agricultural materials and animal by-products.

3.1.4 *biodegradable, adj*—capable of decomposing under natural conditions into elements found in nature.

3.1.5 *biodiversity, n*—the variability among living organisms from all sources including: terrestrial, marine and other

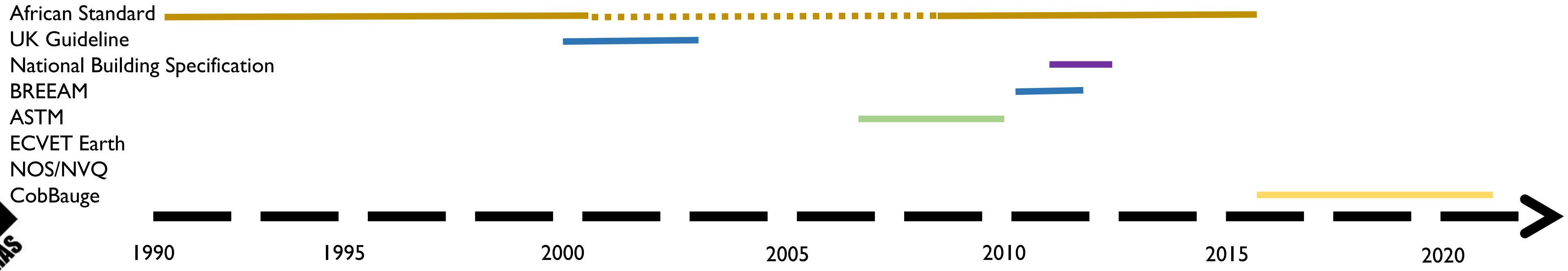
[1] This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.01 on Buildings and Construction.

Current edition approved Jan. 15, 2010. Published March 2010. Originally approved in 2005. Last previous edition approved in 2005 as E2392 – 05. DOI: 10.1520/E2392-10.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

[4] Available from Standards New Zealand, Radio New Zealand House, Level 10, 155, The Terrace, Wellington 6011, http://www.standards.co.nz.



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[4] Available from Standards New Zealand, Radio New Zealand House, Level 10, 155, The Terrace, Wellington 6011, http://www.standards.co.nz.

EuroNorm

African Standard
UK Guideline
National Building Specification
BREEAM
ASTM
ECVET Earth
NOS/NVQ
CobBauge

1990 1995 2000 2005 2010 2015 2020

ESTRUTURAS

ECVET Earth Building	Earth building market	Unit E

Learning outcomes Level 3

KNOWLEDGE	SKILLS

- Advantages and characteristics of earth construction
- Ecology and green building, tools, insulation materials, earth building products
- Local and regional techniques
 	
- Business and management principles
  o Basic maths, tender, quantity and specifications
  o Image and identity
  o Contracts, payment plans, insurance
  o Basic understanding of risk
 	
- Sourcing of materials and tools (producers and suppliers)
- Study of a regional market, specific target groups
- Strategic Plan
- Earth construction networks
 	
- Building regulations affecting earth works
- Health and safety regulations
	- Explain the characteristics of the earth building techniques
	- Develop a communication strategy
	- Present yourself professionally
	- Make a regional market study
	- Make a cost/material estimate and prepare data for a tender
	
	- Liaise with contractors, architect/engineer and clients about
	  o specific needs for earth elements
	  o earth building programme
	  o own scope of responsibility
	  o own scope of works

COMPETENCE

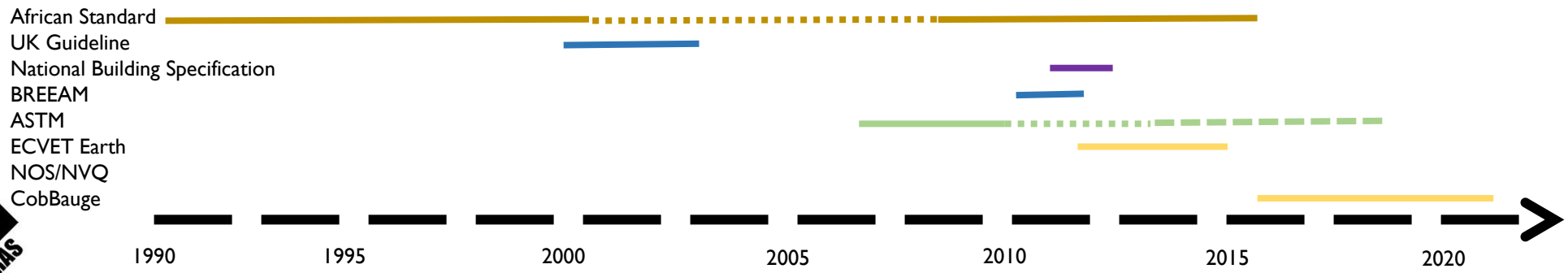
- Explain the advantages of earth over conventional building materials
- Identify targets and develop a business strategy in earth building, in scope to self-employment
- Give input for an active marketing strategy
- Coordinate work with own training/education
- Create contacts to other earth building professionals
- Inform non earth building specialists about earth building techniques old and new, about properties of clay, about the advantages of earth over conventional building materials

ECVET Earth Building	Earth building market	Unit E

Criteria and Indicators for the Assessment of Skills Level 3

Criteria	Indicators
Reading plans	- The quantities are correctly calculated on the basis of the plans
Quantity measurement	- The correct quantities are used - The processes involved are correctly identified and described - The prices quoted are substantiated
Estimate of costs	- The correct quantities are calculated - The correct use of material and machinery is calculated - When calculating hourly rates, all necessary factors are considered
Compilation of a tender	- The tender is clearly presented

Ensure that standards of work and materials comply with relevant codes of practice and to current standards.
Further skills in marketing cannot be objectively examined. It is only possible to examine knowledge of the subject.



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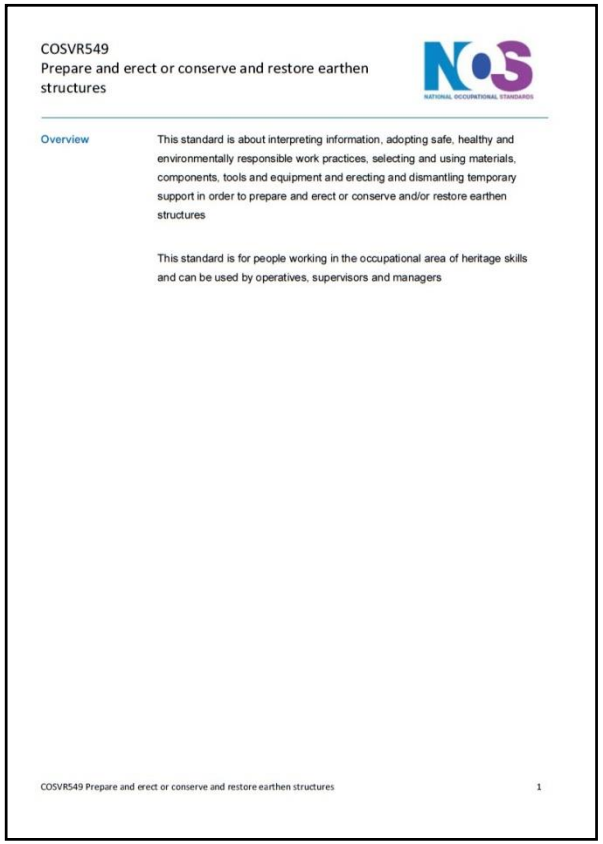
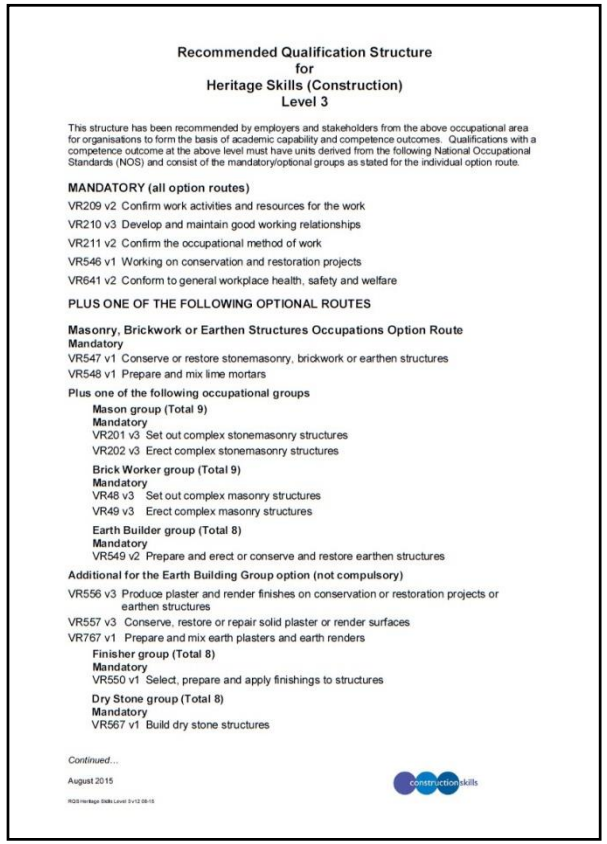


COSVR549
Prepare and erect or conserve and restore earthen structures

Overview

This standard is about interpreting information, adopting safe, healthy and environmentally responsible work practices, selecting and using materials, components, tools and equipment and erecting and dismantling temporary support in order to prepare and erect or conserve and/or restore earthen structures

This standard is for people working in the occupational area of heritage skills and can be used by operatives, supervisors and managers



Recommended Qualification Structure for Heritage Skills (Construction) Level 3

This structure has been recommended by employers and stakeholders from the above occupational area for organisations to form the basis of academic capability and competence outcomes. Qualifications with a competence outcome at the above level must have units derived from the following National Occupational Standards (NOS) and consist of the mandatory/optional groups as stated for the individual option route.

MANDATORY (all option routes)

VR209 v2 Confirm work activities and resources for the work
VR210 v3 Develop and maintain good working relationships
VR211 v2 Confirm the occupational method of work
VR546 v1 Working on conservation and restoration projects
VR641 v2 Conform to general workplace health, safety and welfare

PLUS ONE OF THE FOLLOWING OPTIONAL ROUTES

Masonry, Brickwork or Earthen Structures Occupations Option Route
Mandatory
VR547 v1 Conserve or restore stonemasonry, brickwork or earthen structures
VR548 v1 Prepare and mix lime mortars

Plus one of the following occupational groups

Mason group (Total 9)
Mandatory
VR201 v3 Set out complex stonemasonry structures
VR202 v3 Erect complex stonemasonry structures

Brick Worker group (Total 9)
Mandatory
VR48 v3 Set out complex masonry structures
VR49 v3 Erect complex masonry structures

Earth Builder group (Total 8)
Mandatory
VR549 v2 Prepare and erect or conserve and restore earthen structures

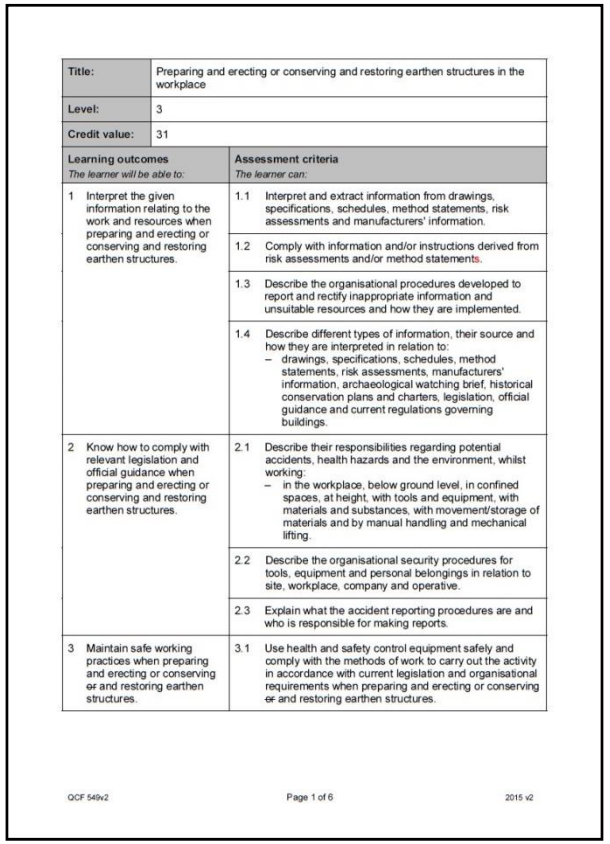
Additional for the Earth Building Group option (not compulsory)

VR556 v3 Produce plaster and render finishes on conservation or restoration projects or earthen structures
VR557 v3 Conserve, restore or repair solid plaster or render surfaces
VR767 v1 Prepare and mix earth plasters and earth renders

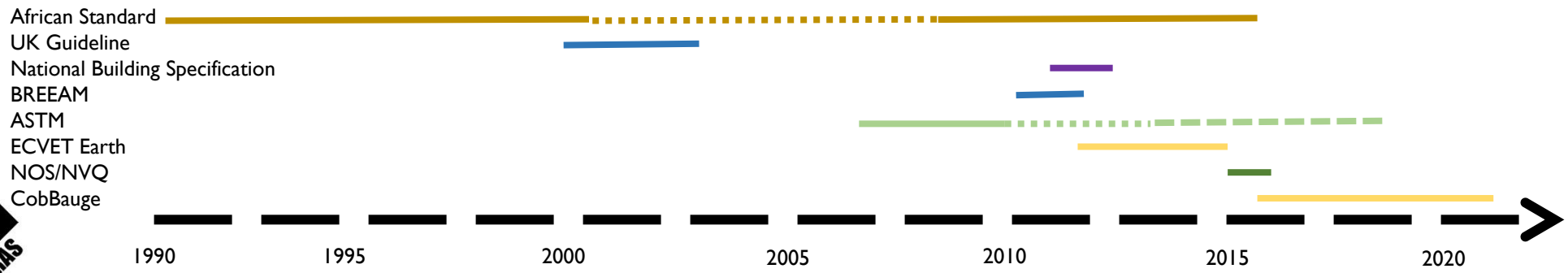
Finisher group (Total 8)
Mandatory
VR550 v1 Select, prepare and apply finishings to structures

Dry Stone group (Total 8)
Mandatory
VR567 v1 Build dry stone structures

Continued…



Title:	Preparing and erecting or conserving and restoring earthen structures in the workplace	
Level:	3	
Credit value:	31	
Learning outcomes *The learner will be able to:*		**Assessment criteria** *The learner can:*
1	Interpret the given information relating to the work and resources when preparing and erecting or conserving and restoring earthen structures.	1.1 Interpret and extract information from drawings, specifications, schedules, method statements, risk assessments and manufacturers' information.
		1.2 Comply with information and/or instructions derived from risk assessments and/or method statements.
		1.3 Describe the organisational procedures developed to report and rectify inappropriate information and unsuitable resources and how they are implemented.
		1.4 Describe different types of information, their source and how they are interpreted in relation to: – drawings, specifications, schedules, method statements, risk assessments, manufacturers' information, archaeological watching brief, historical conservation plans and charters, legislation, official guidance and current regulations governing buildings.
2	Know how to comply with relevant legislation and official guidance when preparing and erecting or conserving and restoring earthen structures.	2.1 Describe their responsibilities regarding potential accidents, health hazards and the environment, whilst working: – in the workplace, below ground level, in confined spaces, at height, with tools and equipment, with materials and substances, with movement/storage of materials and by manual handling and mechanical lifting.
		2.2 Describe the organisational security procedures for tools, equipment and personal belongings in relation to site, workplace, company and operative.
		2.3 Explain what the accident reporting procedures are and who is responsible for making reports.
3	Maintain safe working practices when preparing and erecting or conserving ~~or~~ and restoring earthen structures.	3.1 Use health and safety control equipment safely and comply with the methods of work to carry out the activity in accordance with current legislation and organisational requirements when preparing and erecting or conserving ~~or~~ and restoring earthen structures.



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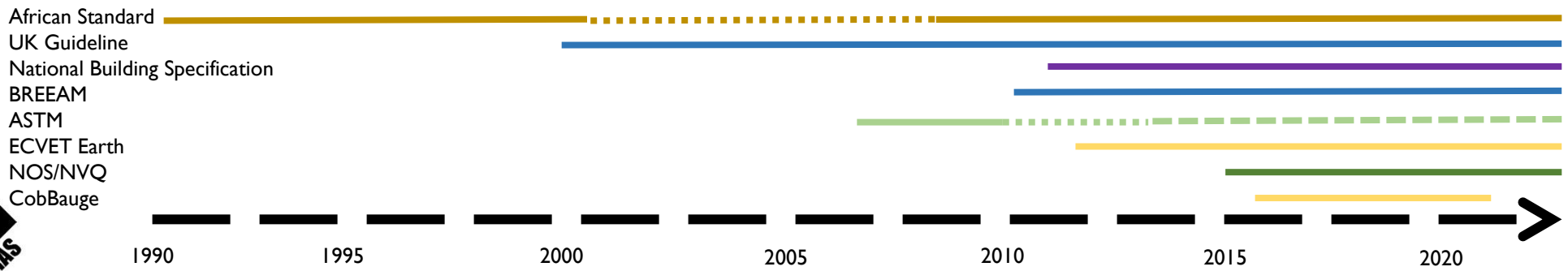
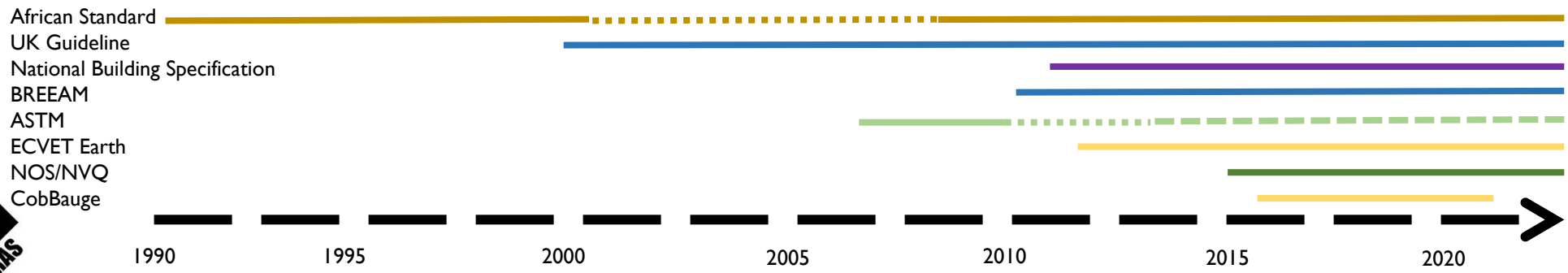
Lessons learned:



Lessons learned:

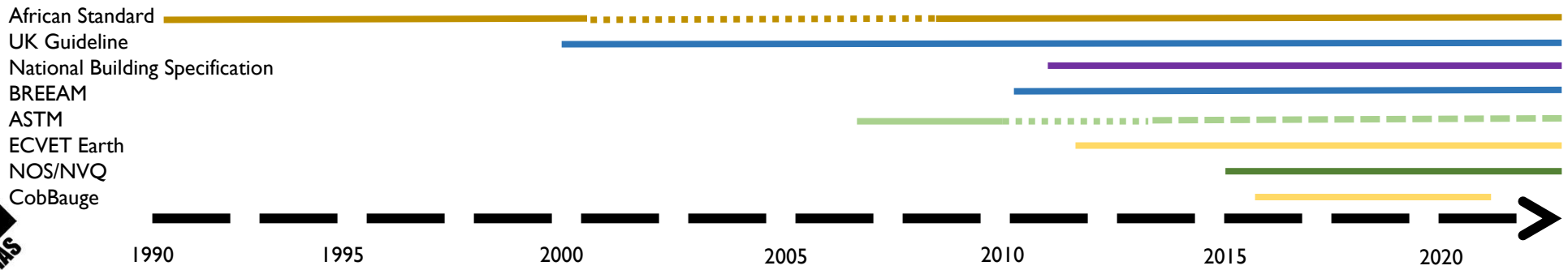
Standards take time



Lessons learned:

Standards take time

Multi country approach often faster

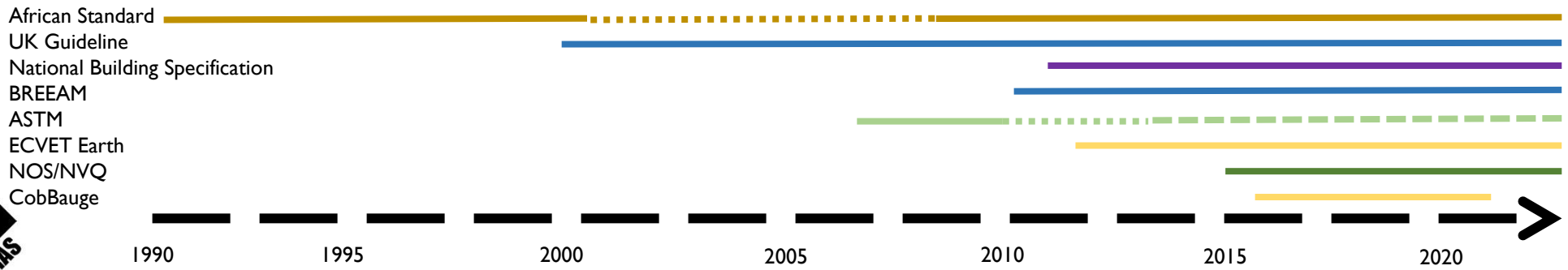


Lessons learned:

Standards take time

Multi country approach often faster

If it looks and feels like a standard then it can act as one



Lessons learned:

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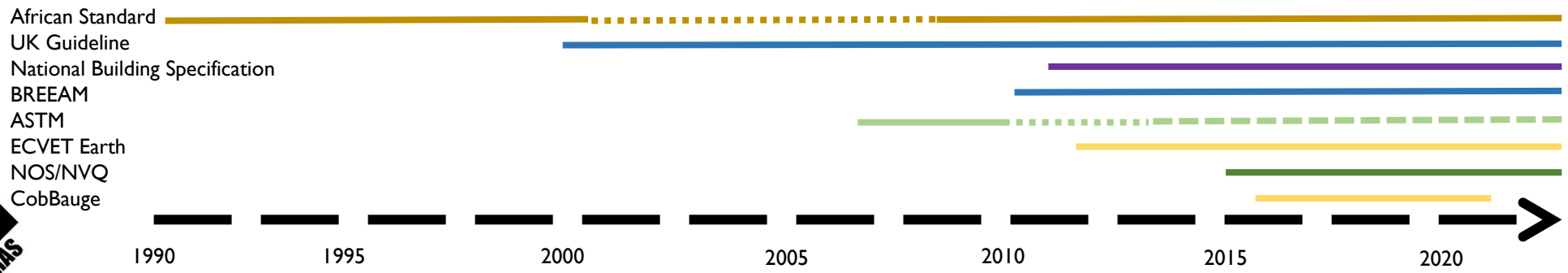
Research can be useful in making the case but should not be confused with standard writing



Lessons learned:

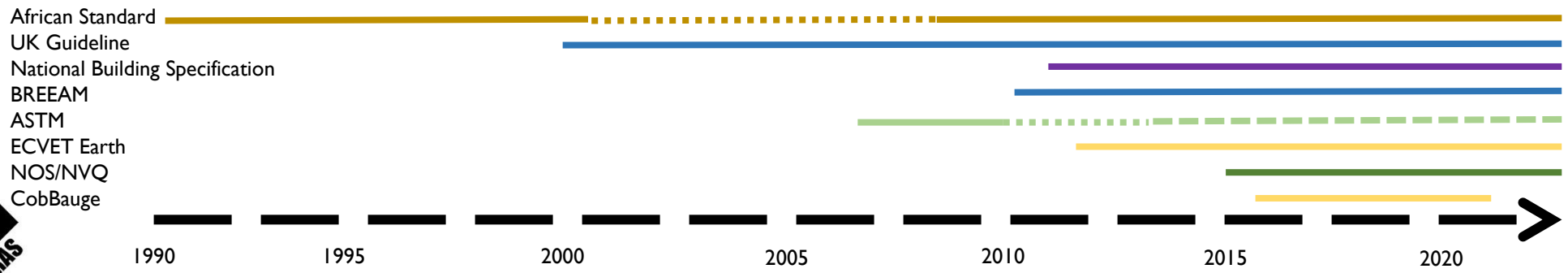
Standards take time

Multi country approach often faster

If it looks and feels like a standard then it can act as one

Research can be useful in making the case but should not be confused with standard writing

Actors working together have greater agency than individuals, but committed individuals can drive processes



Obrigado por ouvir