BUREAU OF INDIAN STANDARDS

AGENDA

Panel for Timber and Bamboo, CED 46:P6	:	**Sixth Meeting**
Tuesday, 06 August 2024	:	**1030 h**

The Board Room, Forest Research Institute, Kaulagarh Road, PO. I.P.E. Dehradun, Uttarakhand 248 195.

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Online Using:

1) Meeting Link: https://bismanak.webex.com/bismanak/j.php?MTID=mbd38a9bdb02ccd946e255571a9b6d45d
2) Meeting number: 2514 036 2380
3) Password: Nbc@2025

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Convener: Shri K. S. Pruthi

NBC Officer: Shri Abhishek Sharma

Head (NBC Cell): Shri Arunkumar S

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Item 0 OPENING REMARKS

Item 1 CONFIRMATION OF MINUTES OF THE LAST MEETING

1.1 The Minutes of the fifth meeting of the Panel held on 29 February 2024 in Dehradun were circulated vide BIS DG letter No. CED 46:P6/A-2.5 dated 01 May 2024**.** No comments have been on the minutes.

The Panel may **CONSIDER** and **CONFIRM** the Minutes.

Item 2 COMPOSITION

2.1 The present composition of the Panel for Timber and Bamboo, CED 46:P6, as reconstituted in the last meeting is given at **Annex 1 (P-7)**.

The Panel may **NOTE**.

2.2 In the last meeting, it was decided to seek the interest of organizations involved in the fire testing and structural testing of timber and bamboo, such as IIT Roorkee, CEPT (Ms. Dhara Shah, Assistant Professor).

Ms Dhara Shah has since attended the last 2 meetings of the Core Groups.

The Panel may **NOTE**.

Item 3 PROJECT OF REVISION OF NBC

3.1 In the last meeting, the Panel noted the various Parts/Sections of NBC 2016, a list of which is given in **Annex 2 (P-9)** which are being comprehensively revised by the respective Panels, with a view to bring out the most modern and state-of-the-art revision of the Code. The Panel had also decided to revise the chapter taking into cognizance the latest developments in the field, while also ensuring coherence among various chapters of the code.

The Panel may **NOTE.**

3.2 The contents of existing Part 6 ‘Structural Design’ Section 3A ‘Timber’ & Section 3B ‘Bamboo’ as indicated in the last meeting are once again given in **Annex 3 (P-11)** and **Annex 4 (P-12)** respectively. In the last meeting, the Panel addressed several crucial topics related to timber and bamboo construction and also constituted four subgroups so as to take up the preparation of updates to the respective provisions in the two chapters of the Code.

The Panel may **NOTE.**

3.3 In the last meeting of the Panel, apart from other decisions the following were decided for suitable addressing in the revision of the chapters:

a) the need for an integrated approach to enhance fire and earthquake safety in timber structures.
b) local species with inherent fire resistance, fire ratings for timber buildings, and the design of large structural components.
c) blast-proof structures, focusing on resiliency, construction speed, and the use of cross-laminated timber (CLT) with varying layers.
d) Comprehensive works and subgroup formations, particularly in structural design codes, were proposed.
e) The significance of utilizing readily available Indian species and promoting plantation species to reduce the reliance on imported wood products, such as mango and seesham, was emphasized.
f) The fire-resistant nature of round bamboo and the importance of capturing species-level data were highlighted.
g) Additionally, discussions covered the reevaluation of nature, climate change risks, and sustainable aspects related to fuel used (coal) in manufacturing. The meeting underscored the occupancy aspects, favouring plantation and forest species.
h) The role of technologists in promoting faster-growing plantations for sustainability was acknowledged.
i) The focus on bamboo as a mainstream construction material, along with extensive testing across climatic zones, was emphasized. The meeting also referenced relevant International Standards (ISO 22156 : 2021 and ISO 22157 : 2019) and

proposed the creation of subgroups for engineered bamboo and bamboo composites. j) Overall, the discussions aimed to establish guidelines for the structural application of bamboo, considering its strength and potential as a mainstream construction material. k) Efforts were directed towards working on the top 10 bamboo species, aligning with the Bamboo Society of India (BSI) initiative, and exploring bamboo-based composites. l) The meeting agreed for a commitment to continuous testing and research across climatic zones to further develop design guidelines. m) Include the properties of other species of timber and bamboo for inclusion in the respective chapters (3A and 3B) based on the inputs/studies of FRI and IWST since the last revision of the Code. n) Provisions on cross-laminated timber (CLT) up to 8 layers. o) Provisions relating to bamboocrete. p) Bamboo composites for inclusion as structural and non-structural members in buildings. q) Standardized test methods on engineered bamboo and timber wood.

Based on the above, meetings of the four Subgroups constituted during the last meeting were held and they arrived at the following action items:

1) To develop a standard for fire testing of bamboo.

2) To conduct experiments to test the effects of moisture content on engineering properties of bamboo.

3) Share photographs and information about the bamboo steel composite machine.

4) To research European standards for predicting deterioration of wood based on temperature and rainfall.

5) To investigate the use of bamboo composites in construction and share details with the team.

6) Study the local bamboo species for their mechanical properties and update the data.

7) To include references to specialist literature on life cycle assessment of bamboo structures.

8) To explore the use of sheeting boards for protection and thermal efficiency in bamboo structures.

9) To explore guidelines for calculating CO_2 emissions for buildings using bamboo materials.

10) To explore the use of bamboo composites as structural members.

11) Rewrite Clause **7.3.5** regarding bamboo and direct contact with the ground.

12) Connect with the CED 39 team to discuss the proposed handbook on the revision of IS 1893.

13) Value addition in life cycle assessment for bamboo structures in the current version.

A brief document on the life cycle assessment of timber and bamboo buildings shared by Shri Amitava Sil is given in ***Annex 5 (P-13)****.*

14) The Subgroup decided to add new provisions for Cross Laminated Timber (CLT) and Glue Laminated Timber (GLT), and for more details regarding these types of timber, respective standards to be referred in the new provisions.

15) On Mass Timber Construction in Buildings, following points were agreed:

- The matter needs more discussion with the subject specialists who have performed full-scale tests.
- Towards considering the safety aspects, the engineering properties, the durability issues and standard deviation of timber for use of timber in construction of tall buildings, the matter will be referred to Constructional Practices Sectional Committee, CED 13 and the Panel for Timber and Bamboo, CED 46:P6.

Further work based on the above are to be executed by the 4 Groups.

The Panel may **NOTE** and **DISCUSS**.

3.4 In the 27th meeting of the Civil Engineering Division Council, CEDC, the parent body of the 38 sectional committees on standardization in Civil Engineering while discussing the matters to be taken up for standardization and reviewing the progress of activities, observed/noted the recommendations of an Advisory Group described below regarding the matter on <u>Use of Mass Timber Construction in Buildings</u>:

Recommendations of the Meeting of the Advisory Group comprising Chairpersons of the Committees under CEDC held on 30 May2024

<u>On Mass Timber Construction in Buildings</u>

BIS informed that timber construction in high rise buildings is permitted in USA and in Canada (from the existing 12 storeys mass timber buildings are now permitted up to 18 storeys in which engineered wood aplenty replacing concrete & steel). Timber construction in buildings is resorted to considering the advantage with respect to embodied energy, however with a caution that such buildings are susceptible to fire if the timber elements are not treated to protect them from fire. In the case of earthquake loading, considering the dynamic nature of load, Professor Ravi Sinha suggested for appropriately designed connections. Also, the MEPF systems need to be carefully planned and constructed in such timber buildings. The effects of imposed load on timber floors may not result in a uniform compression unlike in concrete buildings.

It was agreed that:

(1) The matter needs more discussion with the subject specialists who have performed full-scale tests.

(2) Towards considering holistically the safety aspects, the engineering properties, the durability issues and standard deviation of timber for use of timber in construction of tall buildings, the matter will be referred to Constructional Practices Sectional Committee, CED 13 and the Panel for Timber and Bamboo, CED 46:P6. They will be requested to meet jointly and address

i) Safety of structure,
ii) Safety from fire, and
iii) Serviceability (new MEP system).

(3) The Group preferably should include representatives from IPIRTI, CSIR-CBRI, Shri Santosh Warrick (Maharashtra Fire Services), Shri Atul Garg (Delhi Fire Services), Forest Research Institute, Dehradun and Prof Hemant Kaushik (IIT, Guwahati).

Accordingly, the above members have been invited to this meeting.

The Panel may **NOTE**.

3.5 Further, Arijit Sinha [Professor & JELD-WEN Chair in Wood-based Composites Science; and Director, Wood-Based Composites Center, Wood Science and Engineering, Oregon State University] requested BIS for a meeting with the NBC Committee a Presentation to discuss the implementation and benefits of mass timber (e.g., cross-laminated timber CLT, glue-laminated beams - Glulam) in modern construction. He has suggested to cover the following points during the discussions:

- Overview of mass timber and its applications in construction
- Benefits of mass timber-based construction in terms of sustainability and cost-effectiveness
- Case studies and examples of successful mass timber projects
- Potential collaboration opportunities within India and US.

Dr Sinha, mentioned that he will be accompanied Dr. Indroneil Ganguly (Professor at the University of Washington) both of whom have done extensive work on mass timber, its development and adoption in the US building codes, and understanding its sustainability attributes.

Accordingly, the following background information were received from Dr Sinha:

1. ANSI/APA PRG 320 – Standard for Performance rated CLT – *interested members of CED 46:P6 to contact BIS separately to gain access*
2. A presentation that documents the process of code changes that has happened in the US – *attached as a separate PDF (Annex 6) with this Agenda*
3. A link to National Design Specification https://awc.org/publications/2024-nds/
4. A link to APA website for various product reports for mass timber panels (https://www.apawood.org/product-reports). *Most of them are free to download*.

Based on the above, a presentation shall be made by the above two during the meeting on 06th August 2024.

In this matter, Shri Amitava Sil suggested to consider preparing a new chapter 3C on Mass Timber Construction.

The Panel may **CONSIDER**.

3.6 As decided in the last meeting of the Panel Shri Prakash Suthar has provided the following:

1) the White Paper *referred to in the minutes of last Panel meeting* – (**Annex 7**)
(2) the major aspects that were presented / briefly discussed: *in the last Panel meeting* (**Annex 8**)
(3) How NET - ZERO Buildings can be achieved through the Generation of the Biogenic Carbon Flow – *presented in the last Panel meeting* (**Annex 9**)

The Panel may **NOTE/CONSIDER**.

Item 4 COMMENTS RECEIVED ON PART 6 'STRUCTURAL DESIGN'/ SECTION 3A 'TIMBER' & SECTION 3B 'BAMBOO'

4.1 No comments have been received.

The Panel may **NOTE**.

Item 5 DATE AND PLACE OF NEXT MEETING

Item 6 ANY OTHER BUSINESS

ANNEX 1
(*Item* 2.1)

COMPOSITION OF THE PANEL FOR AIR-CONDITIONING, HEATING, AND MECHANICAL VENTILATION, CED 46:P14

SI No.	NAME OF THE ORGANIZATION	REPRESENTED BY	Participation in Meeting No.		
			3rd	4th	5th
1)	In Personal Capacity, Dehradun	Shri K. S. Pruthi (***Convener***)	P	P	P
2)	Bamboo Society of India, Bengaluru	Shri Punati Sridhar Shri K. N. Murthy (Alternate)	A	A	P
3)	Building Materials and Technology Promotion Council, New Delhi	Dr Shailesh Kr Agrawal Shri C. N. Jha (Alternate)	A	P	A
4)	CSIR - Central Building Research Institute, Roorkee	Shri B. S. Rawat Shri Mickey Mecon Dalbehera (Alternate I) Shri Prasanta Kar (Alternate II)	A	A	P
5)	Central Public Works Department, New Delhi	Chief Engineer (CSQ) Superintending Engineer (TAS) (Alternate)	A	A	P
6)	Creative Consultants & Engineers Pvt Ltd, Ghaziabad	Shri Aman Deep	A	P	P
7)	Forest Research Institute (ICFRE), Dehra Dun	Shri Rajesh Bhandari Shri R. S. Topwal (Alternate I) Shri Ashwath Hegde (Alternate II)	A	A	P
8)	Forum of Scientists, Engineers and Technologists, Kolkata	Shri Rabi Mukhopadhyay Dr. Parthasarathi Mukhopadhyay (Alternate I)	A	A	P
9)	Housing and Urban Development Corporation Ltd, New Delhi	Dr Deepak Bansal Ms Pooja Nandy (Alternate I) Smt Nirmal Batra (Alternate II)	P	A	P
10)	Indian Association of Structural Engineers, New Delhi	Dr Dulal Goldar Prof. Visalakshi Talakokula (Alternate)	P	P	P
11)	Indian Institute of Technology Delhi, New Delhi	Dr Suresh Bhalla	A	A	P
12)	Institute of Wood Science and Technology, Bengaluru	Shri Anand Nandanwar Shri Amitava Sil (Alternate I) Dr Narasimhamurthy (Alternate II)	A	P	P
13)	Iyer and Mahesh Architects, Thiruvanthapuram	Shri N. Mahesh	A	A	A

SI No.	NAME OF THE ORGANIZATION	REPRESENTED BY	Participation in Meeting No.		
			3rd	4th	5th
14)	Manasaram Architects, Bengaluru	Smt Neelam Manjunath Smt Sanjita Shrikant (Alternate I) Shri Gurudayal Sharan (Alternate II)	A	A	P
15)	Military Engineer Services, Engineer-in-Chief's Branch, Army HQ, New Delhi	Smt S Gayatri Mukherjee Shri Shekhar Gupta (Alternate)	P	P	A
16)	MUTHA Industries Pvt Ltd, Maharashtra	Shri Anil Mutha Shri Neeraj Mutha (Alternate I) Shri Sudip Chakraborty (Alternate II)	P	A	P
17)	North East Centre for Technology Application and Reach, Shillong	Shri Krishna Kumar Ms. Lyngksiar khongwir (Alternate)	P	P	P
18)	The Institution of Engineers (India), Kolkata	Shri Manoj Kumar Singh Er. Kumar Arvind (Alternate)	P	A	P
19)	Windsor Wood (India) Pvt Ltd, Mumbai	Shri Prakash Narmadashankar Suthar	A	A	P
20)	Wonder Grass Initiative Pvt Ltd, Nagpur	Shri Vaibhav Kaley	P	A	P
21)	In Personal Capacity, Dehradun	Shri S. S. Rajput	A	A	A

ANNEX 2
(*Item* 3.1)

Details of Chapters of NBC 2016

	Part/Section	*Title*
1	**PART 0**	**INTEGRATED APPROACH – A PRE-REQUISITE FOR APPLYING THE PROVISIONS OF THE CODE**
2…….	**PART 1**	**DEFINITIONS**
3……..	**PART 2**	**ADMINISTRATION**
4……..	**PART 3**	**DEVELOPMENT CONTROL RULES AND GENERAL BUILDING REQUIREMENTS**
5……..	**PART 4**	**FIRE AND LIFE SAFETY**
6……..	**PART 5**	**BUILDING MATERIALS**
	PART 6	**STRUCTURAL DESIGN**
7………………………	Section 1	Loads, Forces and Effects
8……………………	Section 2	Soils and Foundations
	Section 3	Timber and Bamboo
9………………………………	3A	Timber
10……………………………	3B	Bamboo
11…………………	Section 4	Masonry
	Section 5	Concrete
12………………… …………	5A	Plain and Reinforced Concrete
13………………… …………	5B	Prestressed Concrete
14……………………......	Section 6	Steel
	Section 7	Prefabrication and Systems Building and Mixed/Composite Construction
15………………………………	7A	Prefabricated Concrete
16………………………………	7B	Systems Building and Mixed/Composite Construction
17..............................	Section 8	Glass and Glazing
18……	**PART 7**	**CONSTRUCTIONAL PRACTICES AND SAFETY**
	PART 8	**BUILDING SERVICES**
19…………………	Section 1	Lighting and Ventilation
20…………………	Section 2	Electrical and Allied Installations
21…………………	Section 3	Air-conditioning, Heating and Mechanical Ventilation
22…………………	Section 4	Acoustics, Sound Insulation and Noise Control
	Section 5	Installation of Lifts and Escalators and Moving Walks
23………………..	5A	Lifts
24……………….	5B	Escalators and Moving Walks
25........................	Section 6	Information and Communication Enabled Installations
	PART 9	**PLUMBING SERVICES**
26…………………	Section 1	Water Supply
27…………………	Section 2	Drainage and Sanitation
28…………………	Section 3	Solid Waste Management
29………………	Section 4	Gas Supply

ANNEX 3
(*Item* 3.2)

CONTENTS OF PART 6 'STRUCTURAL DESIGN' SECTION 3A TIMBER (OF NBC 2016)

ANNEX 4
(*Item* 3.2)

CONTENTS OF PART 6 'STRUCTURAL DESIGN' SECTION 3B BAMBOO (OF NBC 2016)

ANNEX 5
(*Item* 4.1)

**INPUTS RECEIVED FROM SHRI AMITAVA SIL
ON
LIFE CYCLE ASSESSMENT OF TIMBER AND BAMBOO BUILDINGS**

Definition :

Lifecycle analysis (LCA) is a systematic method for evaluating the environmental impacts of a product or system throughout its entire lifecycle, from raw material extraction to disposal or recycling. When applied to timber and bamboo buildings, LCA can provide insights into their sustainability and environmental footprint. Currently, the most popular technique for developing environmentally friendly technologies and goods and assessing their environmental impact is life cycle analysis, or LCA. Aspects of the sustainable energy management plan can also be successfully implemented using this way.

General description about LCA :

The origins of LCA may be traced to the early 1960s, when scientists started to worry about the depletion of fossil fuels. The LCA approach was first created to gain understanding of the environmental impact of fuel production, distribution, and use. Owing to the oil crisis, a number of resource and environmental profile evaluations (also known as resource and environmental impact assessments) were carried out between 1970 and 1975. Both the protocol and the conventional methods for carrying out these kinds of investigations were devised during this study. Following a review of the effects of energy production and consumption in the late 1970s, life cycle assessment (LCA) turned its attention estimating the life of waste produced in various processes. Lifecycle analysis is a flexible technique that promotes sustainability in a number of industries and in varied sectors. It is crucial for product development, green building, energy systems, transportation, waste management, agriculture, and corporate sustainability initiatives due to its capacity to offer thorough insights into environmental implications from cradle to grave. Organizations can make better informed decisions that lead to a more sustainable future by incorporating LCA into their operations.

Basic steps of life cycle analysis :

Building construction with timber or bamboo and bamboo composites and its long-term use have a lasting effect on both the environment and human health. The quickly developing science of shedding light on these effects in terms of their nature, intensity, and duration is called life cycle assessment. A building generates environmental impacts throughout its life cycle. A typical life cycle has the following stages:

A. *Production and construction*
   The energy and resources required to extract raw materials, move those elements to product manufacturing facilities, and create the finished building products are all included in the production stage. The energy needed to power construction equipment, provide auxiliary building supplies, and remove any waste produced during the building process can all be included in the construction stage, along with the transportation of goods to the construction site.

B. *Use stage*

The effects of occupying a building over its lifetime, including lighting, heating, water use, and any materials necessary for upkeep, replacement, and repairs, are all included in the use stage.

C. *End-of-life*
At the end when the timber or bamboo structure reaches the end of its useful life, it must be demolished, disposed of, and processed into waste.

D. *Externalized impacts beyond the system boundary*
The last phase collects all of the incidental impacts of recycling, reusing, and or recovering water, energy, or materials from the project. Since these effects appear outside of the system boundary which is defined as the actual boundaries of the LCA study which are referred to as externalized impacts.

Environmental Impact Categories:

Emissions and other pollutants are created and discharged into the surrounding environment during the course of a building's life cycle stages. CA assesses a number of environmental impact categories, which are broad measures of environmental change, encompassing the effects of many types of emissions. The five most prominent environmental impact categories that are commonly used and the LCA tools are

a) Global Warming Potential
b) Acidification Potential
c) Eutrophication Potential
d) Ozone Depletion Potential
e) Smog Formation Potential

All of the material and process quantities are combined into an information body called the inventory for an LCA of a structure, and then multiplied by the relevant impacts for each item or process. The total outcomes are added up to determine a building's overall environmental effects.

Requirement of Life Cycle Assessment :

In the building sector, Life Cycle Assessment is commonly used for

1. Assisting building owners in making well-informed decisions about resilience and or sustainability
2. Assessing design possibilities by offering information on material selections and their effects on the environment
3. Obtaining certification for green buildings
4. Declaring that a system or product is environmentally superior to another
5. Assisting in evaluating the environmental benefits of new products and or policies
6. Assessing a building's performance by comparing it to certain benchmarks

Method of Life Cycle Assessment

Even though there are phases involved in doing an LCA, the process is frequently iterative. An LCA can be carried out at various phases of building's design or construction. There will be more clarity and ability to define the building with ever-higher levels of accuracy and precision as the design develops or as construction gets underway. The start of the life cycle is also called the "cradle," the production facility's exit point is called the "gate," and the life cycle's conclusion is called the "grave." Because of this, phrases like "cradle-to-grave" and "cradle-to-gate" are used to describe various stages of the life cycle assessment.

The LCA is conducted in various steps as given below

1. **Define Goal and Scope**

   Setting out the purpose and parameters of the assessment is the first stage in carrying out an LCA. This is a crucial phase because it will helps focus your efforts and make sure your work is accomplishing your objectives by helping you understand why and how you are performing an LCA

2. **Collect Inventory**

   It's critical to identify the kinds of products or components that go into your construction. One should sure to record anything uncommon about the products or materials that are used, especially if they differ greatly from the industry average, as LCA programs frequently employ data that is average for the industry. One must, at the very least, gather the following material information:
   - a) Material names or types
   - b) material quantities (and units),
   - c) material lifespans (if appropriate),
   - d) Stage of the material's life cycle.

   Always remember to include materials and products that will appear in the use stage, which encompasses usage, maintenance, repair, replacement, and refurbishment. As majority of the material quantities generally will appear in the production stage with scenario definitions.

3. **Perform Impact Assessment**

   After establishing the assessment purpose and scope and gathering building data, it is time to determine the building's environmental effect. For the most part, this is done by different software tools (Matlab programming, SimaPro). The tools can arrange the results by building component and life cycle stage and keep track of materials, situations, and impacts easily since these are complex data. In building and construction projects where wood and bamboo based products are used, there will probably need to address the biogenic carbon problem. Carbon that is "produced in natural processes by living organisms but not fossilized or derived from fossil resources" is referred to as "biogenic carbon". Within the construction sector, timber goods are most frequently affected by this. Additional biogenic building materials could be cork, bamboo, and straw. Use of wood products is thought to assist the environment because wood is a byproduct of carbon removal from the atmosphere. But estimating the impact of biogenic carbon is a difficult and divisive topic that involves burning biomass, carbon neutrality, certification for sustainable forestry, and carbon accounting of every part of a forest, including the soil.

4. **Interpretation of results**

   Interpreting the results of LCA is done in 3 steps which are
   - a) Checking for errors in the analysis,
   - b) Understanding the results and

c) Developing conclusions.

Sorting the environmental impacts by building component, material type, and life cycle stage is an excellent place to start after getting a general overview of the LCA results after which results can be visualized. Using the results, which construction elements, materials, and life cycle stages significantly contribute to the overall impact of the building can be understood.

5. **Reporting Results**

Results to be published with all the assumptions, methodology, observations, and conclusions in order to disseminate the study's findings. Project reports and summaries are provided from the majority of LCA tools used.

Reference

ISO, "ISO 21930: Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services." International Organization for Standardization, Geneva, Switzerland, 2017.

ISO, "ISO 14040: Environmental management — Life cycle assessment — Principles and framework." International Organization for Standardization, Geneva, Switzerland, 2006.

ISO, "ISO 14044 Environmental management — Life cycle assessment — Requirements and guidelines." International Organization for Standardization, Geneva, Switzerland, 2006.

IPCC, Policymakers' Summary. Cambridge University Press, 2014; Cambridge, UK; New York, NY, USA.

Architecture 2030, "Architecture 2030: Why The Building Sector?" (2017). [Online]. http://architecture2030.org/buildings_problem_why/ is accessible. [Accessed: June 18, 2024].

K. Simonen, Life cycle assessment, First. New York: Routledge, 2014.

C. Chen, F. Pierobon, S. Jones, I. Maples, Y. Gong, I. Ganguly: Comparative life cycle assessment of mass timber and concrete residential buildings: a case study in China , Sustainability, 14 (2022), 10.3390/su14010144.

A.F. Abd Rashid et al. A review of life cycle assessment method for building industry Renew. Sustain. Energy Rev. (2015).