



The Materials & Waste Management; A Main Rating Category for Sustainable New Construction in Egypt

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ملخص البحث:

إن الهدف من هذه الورقة البحثية هو توضيح للعناصر المستدامة في إستهلاك المواد وإدارة المخلفات في المنشآت ضمن نظام وطني مقترح لتقييم وتصنيف المنشآت المستدامة الجديدة في مصر، وذلك لتحقيق الأهداف الرئيسية الآتية:

- 1- تحقيق الإستدامة البيئية المطلوبة في إستهلاك المواد وإدارة المخلفات بالمنشآت الجديدة شاملاً الآتي:
 - 1-1 وجود ورقة تعريف من المصنع لكل مادة مستخدمة بالمشروع لتحديد المكونات الخضراء بها.
 - 2-1 إستخدام المواد والمنتجات المحلية، واستخدام الخرسانة الخضراء والبلوك الأخضر والمحارة الخضراء.
- 2- تحقيق الإستدامة المجتمعية المطلوبة في إستهلاك المواد وإدارة المخلفات بالمنشآت الجديدة شاملاً الآتي:
 - 1-2 إختيار المواد الخضراء لمختلف عناصر وتخصصات العمل بالمشروع بحيث لا تقوم تلك المواد بعد تركيبها وأثناء تشغيل المشروع بإصدار إنبعاثات غازية ضارة بالصحة العامة للمجتمع.
- 3- تحقيق الإستدامة الإقتصادية المطلوبة في إستهلاك المواد وإدارة المخلفات بالمنشآت الجديدة شاملاً الآتي:
 - 1-3 إختيار المواد المناسبة للمستخدمين، والمواد التي تحقق صلابة للمنشأ وتحمله للظروف المناخية والتشغيلية.
 - 2-3 إستخدام المواد الناتجة عن عملية إعادة التدوير، والمنتجات مسبقة التجهيز والتصنيع.
 - 3-3 إدارة مخلفات البناء ومخلفات التشغيل، والتخزين المؤقت لها بأماكن بالموقع، وسرعة نقلها من الموقع.

Abstract:

This paper is made for a partial fulfillment of a Ph.D. research made by the above mentioned authors to present a proposed national sustainable rating & certification system for new construction to promote the benefits of sustainable building practices, and embrace the potential of green buildings in Egypt, while the paper is describing one main category of the proposed system which is the Materials and Waste Management category, which is representing one main category among seven main categories of the proposed system.

The Materials & Waste Management category is focusing in proper sustainable measures of building materials and waste issues, under uniform & consistent Total Quality Assessment (TQA) procedures, and considering all applicable national & international codes and laws governing Materials & Waste Management-MW activities of construction projects.

The MW category, as detailed below, is having new assembly of mandatory & scoring credits complying with the sustainability three bottom lines; environmental, social, and economical aspects, to rectify the lack of important issues related to this category in new construction of Egypt, including sustainable data sheet, robust materials, green concrete, green masonry, green plastering, speculation of finishes, waste control & management.

1. Introduction:

This paper is showing an assembly of the Materials & Waste Management category along with all its relevant mandatory and scoring credits, as listed below, after a thorough study for the following three selected systems as they are currently the most popular, influential and technically advanced rating tools for the Egyptian sustainable new construction market:

- A. LEED[®]-V4 Rating & Certification System (BD+C); for New Construction and Major Renovations-2013, USGBC-USA [1].
- B. BREEAM[®]-International Rating & Certification System New Construction (NC) 2013 Scheme, BRE-UK [2].
- C. GPRS[®] Green Pyramid Rating System for New Construction, GBC-Egypt [3].

2. Components Setting of Materials & Waste Management Category:

After implementing a study for the built environment of the Egyptian construction market including laws, regulations, and difficulties\negative impacts affecting the main three bottom lines of sustainable construction, and after evaluating the above listed green rating systems w.r.t the construction criteria in Egypt, the proposed system dialogue of main categories, including the Materials & Waste Management category, along with their related credits was established in a form of a questionnaire for the purpose of validation, and it was forwarded to green professionals from the following parties in Egypt to make their evaluation & corrections for the skeleton of the proposed complete system:

- Housing and Building National Research Center (HBRC), Cairo.
- Faculty of Engineering, American University in Cairo.
- Faculty of Engineering, Cairo University.
- Faculty of Engineering, Ain-Shams University.
- Faculty of Engineering, Al-Azhar University in Cairo.
- Faculty of Engineering, Alexandria University.
- Egyptian Accredited Professionals approved by international green building councils.

The questionnaire was mainly particular about getting the following information/results from the green professionals in Egypt:

- A- Identify the strength of total score deserved for each category.
- B- Validate the mandatory credits and segregate them from the scoring credits.
- C- Identify the degree of importance for the credit existence as per its scope summary.
- D- Identify the score strength deserved for each scoring credit.
- E- Identify the non-required credits that need to be removed from the system.

The questionnaire was validated by a group of (60) senior staff, and the results were received and analyzed, and the final assembly of the proposed system was set including all main categories along with their mandatory & scoring credits and the deserved score points for each category & for each credit, while this paper shows the resulted final assembly, scoring criteria, and score figures of the Materials & Waste Management category along with all its credits, and the validation of this category resulted with (3)

mandatory credits and (13) scoring credits with (16) available score points as shown below in figure (1).

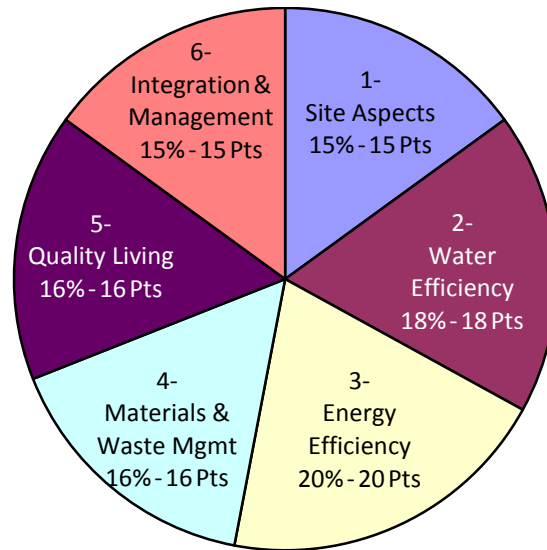


Figure 1: Category weightings of the proposed Egyptian system.

3. Final Assembly of Credits for Materials & Waste Mgmt Category:

According to the main elements of the proposed system and the results of the questionnaire made, the followings represent complete final credits assembly of the Materials and Waste Management category for the main three sustainable new construction aspects (Ecological, Social, and Economical), and the next figure (2) shows the assembly summary:

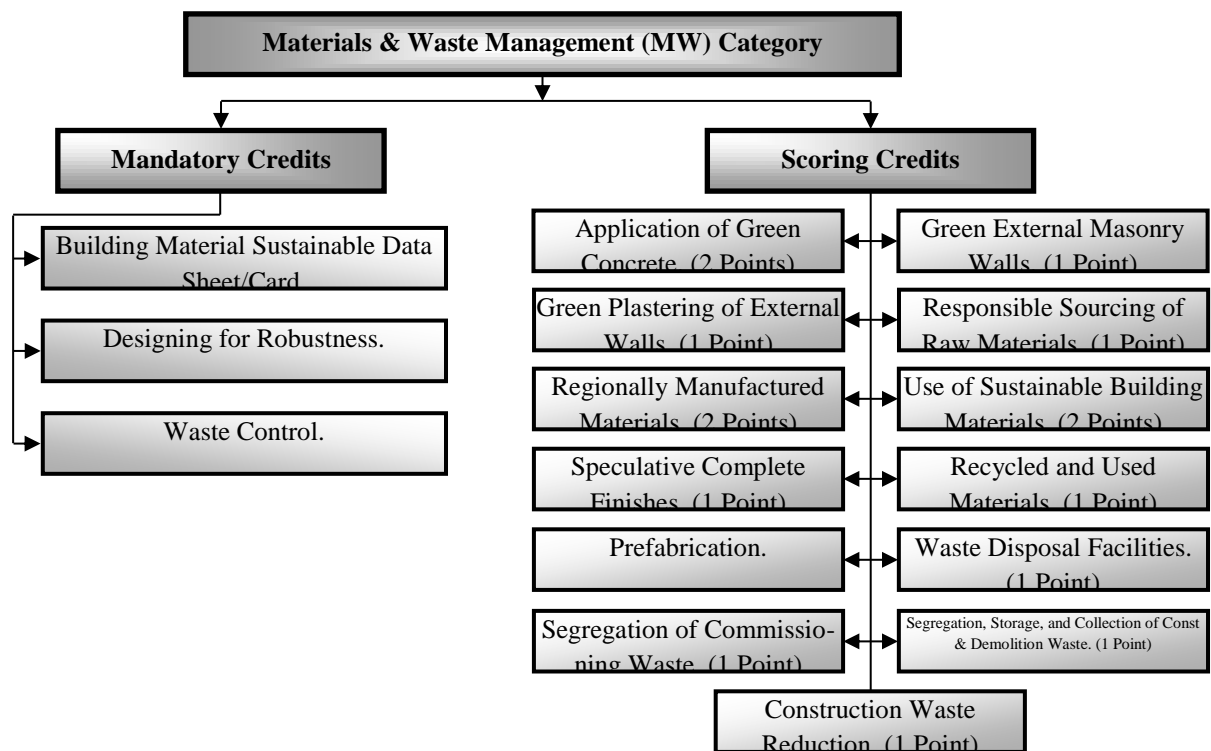


Figure 2: Components of 4th category; Materials & Waste Management (MW).

3.1 Mandatory Credits:

The followings represent mandatory credits of Materials & Waste Management category:

A. Building Material Sustainable Data Sheet/Card (Mandatory):

A.1 General Criteria:

Credit scope is to ensure using materials for which life-cycle information is available and have environmentally, economically, and socially sustainable life-cycle impacts.

A.2 Approach and Implementation:

GBC-Egypt should review that all building materials of the project are provided with the manufacturer life-cycle information, which should include the following data:

- (i) Material complete ingredients.
- (ii) Recycled components.
- (iii) All types of emissions expected to be produced out of the material.
- (iv) Precautions during and after installation.
- (v) Expiry dates (Shelf life, Life after use).

B. Designing for Robustness (Mandatory):

B.1 General Criteria:

Credit scope is to ensure high quality design & execution methods & materials, which minimize the frequency of replacement and maximize project life age.

B.2 Approach and Implementation:

GBC-Egypt should review and inspect the project design & execution works to ensure that the design procedures considered high quality design methods & practices, and also to ensure that the execution works is achieved using durable construction materials & final finishes that will resist partial or full wreckage due to severe exposure conditions or due to heavy duty commissioning activities. Refer to the following codes and standards:

- (i) GPRS[®]-2017 technical seminar [4], 4th category of Materials and Resources (MR), Credit#(MR.03)- Reduction of Overall Material Use.
- (ii) HBRC, Code#203, Egyptian Code of Concrete Structures [5].
- (iii) HBRC, Code#205, Egyptian Code of Steel Structures [6].

C. Waste Control (Mandatory):

C.1 General Criteria:

Credit scope is to avoid pollution resulting from dumping/drainage of construction or commissioning waste/discharge towards natural lands and natural water planes.

C.2 Approach and Implementation:

GBC-Egypt should ensure the followings:

- (i) The project is not dumping of construction waste or commissioning waste towards natural lands or natural water planes.
- (ii) The project is not discharging drainage to natural lands or natural water planes.

For achieving the above two conditions, refer to the following codes and laws:

- Egyptian Ministry of Environment, Law#4 at 1994 [7], Items#69&70 for Prohibiting Pollutant Drainage on Natural Water Planes.
- Egyptian Ministry of Environment, Executive Agenda of Law#4 at 1994 [8], Items#57&58.

- Egyptian Law#48 at 21/6/1982 for Protection of River Nile from Pollution [9].
- HBRC, Code#301, Egyptian Code of Plumbing & Sanitary Installations for Buildings [10].
- HBRC, Code#602, Egyptian Code of Design of Accommodation Projects [11].
- Electronic Gate of Cairo Governorate, Evaluation of the Environment in Egypt “<http://www.cairo.gov.eg/information/Disenviro.aspx?ID=11>” [12].

3.2 Scoring Credits:

The followings represent scoring credits of the Materials & Waste Management category:

A. Application of Green Concrete (2 Points):

A.1 General Criteria:

Credit scope is to encourage the use of green concrete in the project by using pozzolanic cement or GGBS cement in the concrete mixes. The more execution of green concrete quantities will result in more of the following advantages – (2 Points):

- (i) Reduce the production of harmful cements which are considered among the main reasons of air pollution with greenhouse CO₂ gas emissions in Egypt.
- (ii) Reduce the use of harmful cements which are responsible for the high rates of heat transfer from outside to inside of the building.
- (iii) Increase the durability of concrete members against exposure conditions, and therefore increase the lifetime age of project buildings.

A.2 Approach and Implementation:

- (i) Green concrete is executed in the project concrete members for a minimum of 20% from the total concrete volumes executed in the project – (1 Point).
- (ii) Green concrete is executed in the project concrete members for a minimum of 30% from the total concrete volumes executed in the project – (2 Points).

For achieving the above two conditions, refer to the following codes:

- HBRC, Code#203, Egyptian code of Concrete Structures [5].
- HBRC, Code#902/7, Specification of Concrete Works [13].

B. Green External Masonry Walls (1 Point):

B.1 General Criteria:

Credit scope is to encourage the use of green masonry blocks erected with green cement/aggregate mortar mix for all external walls of the project, so as to reduce the heat transfer from outside to inside of the building – (1 Point).

B.2 Approach and Implementation:

All external masonry walls of the project are executed with Lightweight Expanded Clay Aggregate blocks-LECA, installed with cement mortar made with pozzolanic cement or GGBS cement – (1 Point). Refer to the following code:

- (i) HBRC, Code#204, Egyptian code of Masonry Works [14].

C. Green Plastering of External Walls (1 Point):

C.1 General Criteria:

Credit scope is to encourage the use of green cements for the plastering work from both sides of all external walls of the project, so as to reduce the heat transfer from outside to inside of the building – (1 Point).

C.2 Approach and Implementation:

All plastering works from both sides of external walls of the project are executed with pozzolanic cement or GGBS cement – (1 Point). Refer to the following codes:

- (i) HBRC, Code#401, Egyptian code of Plastering for buildings [15].
- (ii) HBRC, Code#902/10, Specification of Plastering Works [16].

D. Responsible Sourcing of Raw Materials (1 Point):

D.1 General Criteria:

Credit scope is to recognize and encourage the use of responsibly sourced materials for timber and all other key building elements – (1 Point).

D.2 Approach and Implementation:

GBC-Egypt should review that all project materials responsible sourcing recognition sheets should be supported with sustainability approval stamp/sheet from the Egyptian ministry of agriculture & land reclamation, and the Egyptian ministry of environment – (1 Point). Refer to the following standard:

- (i) United Nations 2015, Paris Agreement [17].

E. Regionally Manufactured Materials (2 Points):

E.1 General Criteria:

Credit scope is to encourage the use of materials manufactured locally so as to reduce the environmental impacts arising from transportation – (2 Points).

E.2 Approach and Implementation:

- (i) Materials manufactured in Egypt are installed in the project for a minimum quantity of 20% from the total quantities of project materials – (1 Point).
- (ii) Materials manufactured in Egypt are installed in the project for a minimum quantity of 30% from the total quantities of project materials – (2 Points).

For achieving the above two conditions, refer to the following system:

- GPRS[®]-2017 technical seminar [4], 4th category of Materials & Resources (MR), Credit#(MR.02)- Regionally Procured Materials and Products.

F. Use of Sustainable Building Materials (2 Points):

F.1 General Criteria:

Credit scope is to encourage the use of sustainable building materials, including natural materials and artificial materials in the key building elements of the project, with certified low harmful emissions during their lifetime age after installation/erection, so as to reduce the content of greenhouse gases emitted from building materials during project commissioning stage – (2 Points).

F.2 Approach and Implementation:

- (i) One Certified sustainable finishing material is installed for the complete quantity of this material item in the project – (1 Point).
- (ii) Two Certified sustainable finishing materials are installed for the complete quantities of these material items in the project – (2 Points).

For achieving the above two conditions, refer to the following system:

- GPRS[®]-2017 technical seminar [4], 4th category of Materials & Resources (MR), Credit#(MR.01)-Renewable Materials and Materials Manufactured Using Renewable Energy.

- GPRS[®]-2017 technical seminar [4], 4th category of Materials & Resources (MR), Credit#(MR.05)-Environment/Friendly, Sound and Thermal Insulation Materials.

G. Speculative Complete Finishes (1 Point):

G.1 General Criteria:

Credit scope is to encourage the specification and fitting of proper complete final finishes, hardware, fixtures, and installations, suitable for building occupants and therefore avoid unnecessary waste of materials due to future alterations – (1 Point).

G.2 Approach and Implementation:

GBC-Egypt should review that the project finishing materials and interior space allocation are satisfactory for the occupants and there are no noticeable numbers of alteration demands/works for these elements in the project – (1 Point). Refer to the following system:

- (i) GPRS[®]-2017 technical seminar [4], 4th category of Materials & Resources (MR), Credit#(MR.03)-Reduction of Overall Material Use.

H. Recycled & Used Materials (1 Point):

H.1 General Criteria:

Credit scope is to recognize and encourage the use of recycled and used materials, thereby reducing the demand for new materials & resources and optimizing material efficiency in construction – (1 Point).

H.2 Approach and Implementation:

Install one recycled/used material representing a key building element for a minimum of 20% of the complete quantity of this material item in the project – (1 Point). Refer to the following codes and standards:

- (i) HBRC, Code#203, Egyptian code of Concrete Structures [5].
- (ii) HBRC Journal (2013) 9, 193–200, Recycled construction and demolition concrete waste as aggregate for structural concrete, Ashraf M. Wagih, Hossam Z. El-Karmoty, Magda Ebid, Samir H. Okba [18].
- (iii) Egyptian Environmental Affair Agency-EEAA, Egypt state of environment report-2015 [19].
- (iv) Samir Okba et al., Applying sustainability approach for demolition waste management in Egypt. J. Environ. Sci. in press [20].
- (v) HBRC, Code#902/3, Specification of Wood Works [21].

I. Prefabrication (1 Point):

I.1 General Criteria:

Credit scope is to encourage the use of prefabricated building elements in order to increase quality of executed works and reduce wastage of materials – (1 Point).

I.2 Approach and Implementation:

Install one prefabricated key building element/material to the full quantity of this element/material item in the project, to replace the in-situ fabrication of the same element/material – (1 Point). Refer to the following system:

- (i) GPRS[®]-2017 technical seminar [4], 4th category of Materials & Resources (MR), Credit#(MR.04)-Alternative Building Prefabricated Elements.

J. Waste Disposal Facilities (1 Point):

J.1 General Criteria:

Credit scope is to encourage the design and installation of waste disposal facilities in the project to avoid the negative impacts of waste accumulations inside the project indoor and outdoor premises – (1 Point).

J.2 Approach and Implementation:

The project should be provided with the following waste disposal facilities– (1 Point):

- (i) Buildings are provided with garbage chutes and enough dumping/collection rooms with special and proper treatment to waste odors and disintegrations.
- (ii) Fast disposal of waste outside the project premises towards the associated dumping yards.

For achieving the above two conditions, refer to the following system:

- GPRS®-2017 technical seminar [4], 6th category of Management Protocols (MP), Credit#(MP.04)-Solid Waste Management.

K. Segregation and Collection of Commissioning Waste (1 Point):

K.1 General Criteria:

Credit scope is to segregate and collect the commissioning waste that is generated by the project occupants – (1 Point).

K.2 Approach and Implementation:

The project should be provided with a continuously working system to segregate and collect the commissioning waste generated from project occupants into the following elements – (1 Point):

- (i) Solid waste including cans, bottles, Plastics, cloth, textiles, leather, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, tires, and household hazardous wastes).
- (ii) Liquid waste including oils, nontoxic inorganic substances, toxic organic substances.
- (iii) Organic waste including cooked foods, kitchen debris, paper products, human waste, and garden waste.

For achieving the above two conditions, refer to the following codes and standards:

- GPRS®-2017 technical seminar [4], 6th category of Management Protocols (MP), Credit#(MP.04)-Solid Waste Management.
- Egyptian Ministry of Environment, Egyptian Environmental Affairs Agency, National Solid Waste Management Program-NSWMP, Annual Report of Solid Waste Management in Egypt, 2013 [22].
- Egyptian Environmental Affairs Agency-EEAA, Egypt state of environment report-2015 [19].
- HBRC, Code#602, Egyptian Code of Design of Accommodation Projects [11].
- Electronic Gate of Cairo Governorate, Evaluation of the Environment in Egypt “<http://www.cairo.gov.eg/information/Disenviro.aspx?ID=11>” [12].

L. Segregation, Storage, and Collection of Construction & Demolition Waste (1 Point):

L.1 General Criteria:

Credit scope is to segregate, store, and collect the construction & demolition waste that is generated during construction of the project – (1 Point).

L.2 Approach and Implementation:

The project, during construction stage, should be provided with a continuously working system for the following activities – (1 Point):

- (i) To receive the construction & demolition waste that is generated by project segregated into the following elements:
 - Insulation and asbestos materials.
 - Concrete, aggregates, stones, boulders, and soils.
 - Bricks, tiles and ceramics.
 - Wood, glass and plastic.
 - Bituminous mixtures, coal tar and tarred products.
 - Metallic waste, including cables.
 - Gypsum elements.
 - Cement.
 - Paints, varnishes, adhesives, and sealants.
 - Sanitary fixtures.
- (ii) Provide dedicated areas accessible to waste haulers and construction team for the collection and storage of segregated construction & demolition waste materials.

For achieving the above two conditions, refer to the following codes and standards:

- Egyptian Ministry of Environment, Egyptian Environmental Affairs Agency, National Solid Waste Management Program-NSWMP, Annual Report of Solid Waste Management in Egypt, 2013 [22].
- Egyptian Environmental Affairs Agency-EEAA, Egypt state of environment report-2015 [19].
- HBRC, Code#203, Egyptian code of Concrete Structures [5].
- HBRC Journal (2013) 9, 193–200, Recycled construction and demolition concrete waste as aggregate for structural concrete, Ashraf M. Wagih, Hossam Z. El-Karmoty, Magda Ebid, Samir H. Okba [18].
- Samir Okba et al., Applying sustainability approach for demolition waste management in Egypt. J. Environ. Sci. in press [20].
- HBRC, Code#902/3, Specification of Wood Works [21].

M. Construction Waste Reduction (1 Point):

M.1 General Criteria:

Credit scope is to encourage best execution practices in the reduction of construction materials waste, to reduce the project cost and reduce the production demands of building materials – (1 Point).

M.2 Approach and Implementation:

The quantity of generated waste for each building material in the project should not exceed 5% from the installed quantity of the same material – (1 Point). Refer to the following system:

- (i) GPRS[®]-2017 technical seminar [4], 4th category of Materials & Resources (MR), Credit#(MR.03)-Reduction of Overall Material Use.

4. Score Validation Results:

The score validation of the above mentioned questionnaire came with the following results:

- 4.1 The maximum total score points given to the Materials & Waste Management category is 16 points out of 100 total available points for all the system categories plus 6 bonus score points for approved innovation and creation issues.
- 4.2 The deserved score points for each credit in this category is shown below in table (1):

Credit Code	Credit Title	Awarding Criteria	
		Mandatory	Scoring
MW-01	Building Material Sustainable Data Sheet/Card	✓	
MW-02	Designing for Robustness	✓	
MW-03	Waste Control	✓	
MW-04	Application of Green Concrete		2 Pts
MW-05	Green External Masonry Walls		1 Pt
MW-06	Green Plastering of External Walls		1 Pt
MW-07	Responsible Sourcing of Raw Materials		1 Pt
MW-08	Regionally Manufactured Materials		2 Pts
MW-09	Use of Sustainable Building Materials		2 Pts
MW-10	Speculative Complete Finishes		1 Pt
MW-11	Recycled & Used Materials		1 Pt
MW-12	Prefabrication		1 Pt
MW-13	Waste Disposal Facilities		1 Pt
MW-14	Segregation, Storage, and Collection of Commissioning Waste		1 Pt
MW-15	Segregation, Storage, and Collection of Construction & Demolition Waste		1 Pt
MW-16	Construction Waste Reduction		1 Pt
Total Figures		3 Credits	13Cr, 16Pts

Table 1: Validation Results for credits of the Materials & Waste Mgmt (MW) category.

5. Conclusion:

Based on the above constituents of the Materials & Waste Management-MW category of the proposed Egyptian sustainable rating system, the following conclusion can be drawn:

- 5.1 The MW category is part of a complete proposed national new sustainable rating & certification system for new construction, while the category credits can be easily applicable for new construction activities in Egypt to strengthen the integrative work activities and implement the modern regulations to enhance the sustainability deliverables from the Egyptian new construction market.
- 5.2 The questionnaire survey made to validate the proposed national sustainable rating system came out with the above listed mandatory and scoring credits, while the resulted total available score points for the MW category is 16 points representing 16% of the total system score which is 100 points for all categories plus 6 bonus score points for approved innovation and creation issues, and that shows the

importance and professional appreciation of the MW category among other system categories.

- 5.3 The MW category as it is thoroughly studied and validated to cover the three bottom lines of sustainability, it is also containing the following new rating credits which are appearing for the first time among all other national and international sustainable rating systems:
- A. Application of Green Concrete.
 - B. Green External Masonry Walls.
 - C. Green Plastering of External Walls.
- 5.4 The above detailed proposal for The MW category as part of a proposed Egyptian green/sustainable rating and certification system for new construction should strongly be taken into consideration during the release of periodical updates of the Egyptian national green rating & certification system; namely GPRS[®].

Acknowledgement:

The authors of this paper are directly sponsoring that the results of the survey made in a form of a questionnaire are honestly transferred and analyzed as received from the Egyptian green professionals related to the agencies/firms listed above in this paper.

Notations:

Ph.D.	: Philosophy and Directorate degree.
TQA	: Total Quality Assessment.
MW	: Materials and Waste Management.
LEED [®]	: Leadership in Energy and Environmental Design, USA.
BD+C	: Building Design and Construction.
USGBC	: United States Green Building Council.
BREEAM [®]	: Building Research Establishment's Environmental Assessment Method, UK.
NC	: New Construction.
BRE	: Building Research Establishment.
GPRS [®]	: Green Pyramid Rating System, GBC-Egypt.
GBC-Egypt	: Green Building Council-Egypt.
w.r.t	: with respect to.
HBRC	: Housing and Building National Research Center.
MR	: Materials & Resources.
GGBS	: Ground-Granulated Blast-furnace Slag cement.
CO ₂	: Carbon Dioxide.
LECA	: Lightweight Expanded Clay Aggregate blocks.
EEAA	: Egyptian Environmental Affair Agency.
MP	: Management Protocols.
e.g.	: example.
NSWMP	: National Solid Waste Management Program,
Pt/Pts	: Point/Points.
Cr	: Credits.

References:

1. Technical Manual of LEED[®]-V4 Rating & Certification System (BD+C); for New Construction and Major Renovations, 2013, USGBC-USA.
2. Technical Manual of BREEAM[®]-International Rating & Certification System New Construction (NC), 2013 Scheme, BRE-UK.
3. Technical Manual of GPRS[®] Green Pyramid Rating System for New Construction, HBRC, GBC-Egypt.
4. The HBRC technical seminar dated in 2/6/2016 for the new edition of GPRS[®]-2017.
5. The Egyptian code of practice for Concrete Structures (HBRC, Code#203).
6. The Egyptian code of practice for Steel Structures (HBRC, Code#205).
7. The Egyptian Ministry of Environment, Law#4 at 1994.
8. The Egyptian Ministry of Environment, Executive Agenda of Law#4 at 1994.
9. The Egyptian Law#48 at 21/6/1982, for Protection of River Nile from Pollution.
10. The Egyptian code of Plumbing & Sanitary Installations for Buildings (HBRC, Code#301).
11. The Egyptian code for Design of Accommodation Projects (HBRC, Code#602).
12. Electronic Gate of Cairo Governorate, Evaluation of the Environment in Egypt “<http://www.cairo.gov.eg/information/Disenviro.aspx?ID=11>”.
13. The Egyptian Specification of Concrete Works (HBRC, Code#902/7).
14. The Egyptian code of practice for Masonry Works (HBRC, Code#204).
15. The Egyptian code of practice for Plastering of buildings (HBRC, Code#401).
16. The Egyptian Specification of Plastering Works (HBRC, Code#902/10).
17. United Nations 2015, Paris Agreement.
18. HBRC Journal (2013) 9, 193–200, Recycled construction and demolition concrete waste as aggregate for structural concrete, Ashraf M. Wagih, Hossam Z. El-Karmoty, Magda Ebid, Samir H. Okba.
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