Advances in Research

22(1): 38-48, 2021; Article no.AIR.65819
ISSN: 2348-0394, NLM ID: 101666096

A Condition Assessment of the Profile and Non-Structural Factors of the Buildings in the University of Eastern Philippines

Ric L. Gonzaga[1,2*]

[1]University of Eastern Philippines, University Town, 6400 Catarman, Northern Samar, Philippines.
[2]Department of Civil Engineering, College of Engineering, University of Eastern Philippines, University Town, 6400 Catarman, Northern Samar, Philippines.

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/AIR/2021/v22i130286
Editor(s):
(1) Dr. Figen Balo, Firat University, Turkey.
Reviewers:
(1) Murilo Limeira da Costa Neto, IESB, Brazil.
(2) Mahmoud Bensaibi, Algeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65819

Original Research Article

Received 30 December 2020
Accepted 04 March 2021
Published 19 March 2021

ABSTRACT

This study discusses on the condition assessment of the profile and non-structural factors of the buildings in the University of Eastern Philippines was undertaken to determine the level of functionality of the building as perceived by the end users, to find out the serviceability of the buildings structure, and to assess the profile and non-structural factors of the buildings in the University of Eastern Philippines. The study utilized ocular/visual inspection, data and documents review, applying the instrument made by Coronilli [1], survey questionnaire as perceived by the end users, and the American Concrete Institute (ACI) guidelines on the condition of the selected buildings in the University of Eastern Philippines-Main Campus. Cracking of concrete are classified into structural and non-structural cracks. Non-structural cracking was observed in the buildings inspected and the College of Nursing is the most critical building in terms of cracks of the building. Furthermore, College of Science obtained 3.07 was perceived as most functional building according to the end users. The school buildings which are in need of repair is the College of Nursing buildings.

**Corresponding author: E-mail: riclgonzaga@yahoo.com;*

Keywords: Buildings; condition assessment; level of functionality; serviceability; structural engineering.

1. INTRODUCTION

Buildings are among the important aspects in our daily lives, it is used for dwelling, establishments, and it is the art or business of assembling materials into a structure, a structure with roofs and walls, such as a house, school, store, or factory. The rapid growth and development of any institution will depend on the presence of structures or buildings which is a mere indicator that there is an improvement and development of the institution.

In some cases, the occurrence of natural calamities such as earthquake, typhoon, and many others, may cause damage and different effects to the structures. Most of the damages that are visually transpired are the presence of cracks on concrete, spalling of concrete, and many others.

Cracking in reinforced concrete structures of various types can be divided into Non-structural cracks and Structural cracks [1]. Cracks caused by the earthquake can be seen as the foundation of the dynamic deformation. Landslide and settlement cause foundation deformation, it causes cracks. According to the research data, accounts for about 80% of cracks are caused by non-load issue; other 20% are caused by load issue [2].

Furthermore, not only the occurrence of calamities and other natural phenomena may cause defects to structures but also due to aging or normal wear and tear of the structure. After the occurrence of natural phenomena particularly typhoon, earthquake and the likes, assessment, and evaluation of the building and other structures in the institution, should be carried out at reasonable time and standard.

Proper inspection procedures, based on visual inspection, can help identify deficiencies in concrete before they become critical to the overall stability of the structure [3].

The standard Guideline for Structural Condition Assessment of Existing Buildings (ASCE 11-90) was developed to provide the design community with guidelines for assessing the structural conditions of existing buildings constructed of combinations of material including concrete, masonry, metals, and wood. It consists of an overview of preliminary and detailed assessment procedures, of materials properties and test methods, and of evaluation procedures for various physical conditions of the structure [4].

Moreover, as far as the record of monitoring, assessment, and evaluation of the structures in this institution are concerned, no studies or records on condition assessment of the buildings in the University of Eastern Philippines were done yet.

Jaen et al. studied on various factors adversely affect structural condition and hence the performance of RC structures. These factors may include inadequate material selection, poor workmanship, severe environments, exposure to harmful chemicals, unexpected loadings, fatigue, and catastrophic events [5].

The problems has arise in terms of non inspection to check compliance of approved plans and specifications; illegal construction; red tape; absence of personnel tasked to process building permit and non hiring of architects and engineers to supervise construction [6].

It is, therefore, imperative that this study was conducted. Stakeholders of UEP will benefit from this study, since information and other data pertaining to the condition of buildings in the University of Eastern Philippines will be available. The results of this Study may serve as the basis for the recommendations and suggestions for the implementation of regular monitoring of the structures, and for the assessment condition of other building structures in general. In view of this concern, this study was undertaken to find out the status, and implications of the condition of selected existing buildings in the University of Eastern Philippines.

2. METHODOLOGY

Guidelines and tools for the status of the buildings were used for assessing of the condition of the buildings. The profile data of the buildings were secured from the Program, Planning and Development Office (PPDO), the secretariat of the Bids and Awards Committee (BAC), Property Office, and the Municipal Engineering Office (MEO).

2.1 Level of Functionality

The level of functional of the building as perceived by the end-users.

The formula was used the weighted mean.

$$WM = \frac{WF}{N}$$

where:

WM – weighted mean
WF – summation of weighted frequency
N – total number of respondents

In order to determine level of functionality, the interpretation of the result was used in the scoring and for the interpretation.

The scoring and interpretation for the level of functionality of the building by the end users was based on the following categorization and quantification, to wit:

The respondents are ask to indicate as to how much or how far do they satisfied the ambiance of the building that the functionality answer the need or necessity of their lives on the extent of usage or the end user of the given building. Five (5) – point scale instrument for the functionality of the building. They are asking to evaluate and rate accordingly. The 5- point scales were the following: 5- fully functional, 4-mostly functional, 3-functional, 2-barely functional, and 1-poorly functional. Individual scores were summed up and made the basis for the range and interpretation and categorical description, to wit:

Range	Interpretation
4.2 – 5.0	Fully Functional
3.4 – 4.1	Mostly Functional
2.6 – 3.3	Functional
1.8 – 2.5	Barely Functional
1.0 – 1.7	Poorly Functional

The respondents in this study were end users of the buildings in the University of Eastern Philippines particularly the deans/head, staff, and students of which the number of samples will be pro-rated according to the number of employee of the building in the institution, using Slovin's formula.

2.1.1 Research instrument

Survey Questionnaire that elicits responses on the functionality of the buildings as perceived by the end users that the statement on the questionnaire was adopted from the instrument made by the Accrediting Agency of Chartered Colleges and Universities in the Philippines (AACCUP) particularly in Area VIII-Physical Plant and facilities letter B in the instrument which was refer to Building.

2.2 Status of the Selected Buildings in Terms Serviceability

The Rapid Condition Assessment Tool adopted from Coronelli [7] was used to assess the condition of the buildings in terms of serviceability on whether the building needs renovation, rehabilitation, and repair.

Assessment of the Selected Buildings. The Assessment of the buildings included preliminary survey and detailed investigation using the Rapid Condition Assessment Tool. The preliminary investigation dealt with the initial assessment of the concrete structure's behavior, condition and existing performance. It involved the following tasks:

a. Documents review;
b. Site inspection; and
c. Preliminary analysis

The researcher of this study conducted visual assessment of the selected buildings, through photographic recordings of images on distress areas that are visible with the naked eye. Photographic images of the distress areas within the selected buildings were captured using digital cameras during the in-site assessment to gather information needed for this study.

Detailed specification focused on specific building elements for condition evaluation. The elements primarily include columns, slab, and beams. Walls were also included even if it is non-load bearing in nature because it is involved in the overall rating of the structure. The component tools of the detailed investigation were divided into six aspects: plan frame, critical areas, visible deterioration, building component, condition rating, and the recommendation part.

The buildings and other vertical structures in UEP-Main Campus were based on the structures which has merely two-storey buildings beyond 15 years of age from the date of acquisition/completion were all included for sampling procedure corresponding to the condition of the buildings.

Rapid Tool Assessment Instrument of the buildings was used to assess the status of the selected building in the University of Eastern

Philippine in terms of serviceability. Serviceability. The structural factor, as adopted for the study of Coronelli, gives the relative importance of each structural element, is shown below. After examining the structural component, damage of each individual element will be rated.

Condition Rating. The condition rating is a numerical score given to the structure relative to its most deteriorated case. The score can range from 0 to 100% with 100% representing the worst case scenario or the case in which all members are deteriorated. A brief description of each of the deterioration case is shown.

The form included two condition ratings as follows:

2.2.1 Local condition rating (LCR)

The local condition rating or LCR was the rating for each of the building component.

This included individual ratings for beams, columns, floor slabs and walls.

The LCR was computed as:

$$LCR = \frac{\sum B_1 K_2 K_3 K_4}{72} \times 100\%$$

where:

B1 is the basic value of ith damage type, expressing its potential effect on the safety and durability of the structural component under observation; values range 1–4;
K1 is the structural element factor characterizing its importance for the safety of the whole structure or one of its parts;
K2 is the intensity factor for the ith damage, determined by qualitative visual criteria and experimental measurements in a scale of four degrees, with the corresponding numerical values K2 = 0.5, 1, 1.5, 2;
K3 is the extension factor for the ith damage within the elements under consideration, defined uniquely by descriptive criteria and applied in a scale of K3 = 0.5–1.0–1.5–2;
K4 is the urgency of intervention factor for the ith damage, with values varying from 1 to 5, grouped into four classes on the basis of direct consequences of the deterioration type on the safety of the structure and the users, and related to an indication of time for intervention.

Table 1. Structural element factor values for framed buildings (adopted from coronelli, 2007 [1])

Structural element factor	
Columns	1.2
Beams	1.1
Slabs	0.3
Walls	0.0

Table 2. Condition rating and corresponding deterioration class with description

Deterioration class	Description of the condition	Rating
I	No defect, Only construction deficiencies	0-5
II	Low degree deterioration, which only after a long period of time might be the cause for reduced serviceability or durability of the affected structural component, if not repaired in proper time	6 – 10
III	Medium degree deterioration, which can be the cause for reduced serviceability and durability of the affected structural component, but still not requiring any limitation of use of the structure	11 – 15
IV	High degree deterioration, reducing the serviceability and durability of the structure, but still not requiring serious limitation of use	16 – 25
V	Very heavy deterioration, requiring limitation of use, propping of most critical components, or other protective measures	26 - 35
VI	Critical deterioration, requiring immediate propping of the structure and strong limitation of use, for example, closing	> 36

2.2.2 Global condition rating (GCR)

The global condition rating gave the condition index of the structure as a whole considering all the structural components. It was the condition rating for the whole building. It was computed as:

$$GCR = \frac{(1.2 * \text{LCR Column} + 1z.1 \text{ LCR Beams} + 0.3 \text{ LCR Slabs})}{2.6}$$

Cut-off score and making recommendations.

Three recommendations were made upon computation of the condition rating of the building such as:

a. No further investigation required;
b. Detailed local investigation; and
c. Overall detailed investigation or Level 2 assessment

This recommendation was based on the computation of local and global condition rating. If the condition rating was greater than 15%, a detailed investigation is recommended. This value was based on the fact that at 15% deterioration condition, a building is already considered medium to high degree deteriorated [7].

3. RESULTS AND DISCUSSION

3.1 Level of Functionality of the Building as Perceived by the End Users

Many failures have taken place in rehabilitation projects due to erroneous procedure and improper judgment. It should be recognized that there is no absolute measurement of structural safety in an existing structure, particularly in structures that have deteriorated due to prolonged exposure to the environment, or that have been damaged by a physical event. Similarly, there are no generally recognized criteria for evaluating serviceability of an existing structure [8].

The most important measure in any evaluation of a building's design quality is whether it satisfies user requirements and what users think and feel about it. However, understanding the views of users is not easy: there might be many different and conflicting views held by individuals and groups. Facilities managers, clients, occupants, visitors, cleaners, repair staff, etc. might all have different perspectives on the same facility [9].

The respondents under surveyed emphasized that almost all the sources of the distress area of the buildings was the effect of the natural calamities, then followed the non-periodic regular maintenance of the buildings, improper implementation of the designed engineering plan and specification, change of uses/functions of the building, and man-made calamities.

Furthermore, the functionality condition of the building encountered in the present condition were absence of equipment for an assessment of the building, failure of immediate conduct of distress area for proper and security measures of the building, lack of funds for the maintenance of the condition of the building, and inadequacy of dissemination and information of the construction worker in relation to the assigned work.

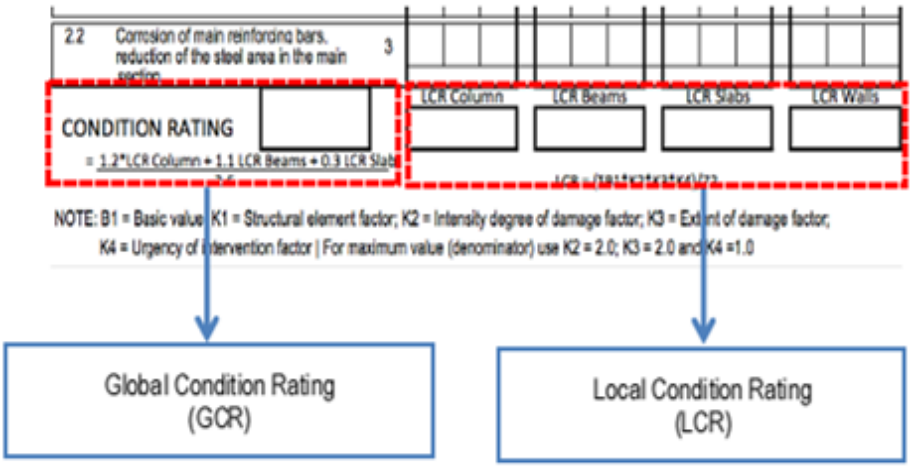


Fig. 1. Global and local condition ratings

However, half of the 180 respondents indicated "mostly functional" on the following statements: the building meets all requirement of the Building Code; the Building is properly constructed and well-planned; the building is safe for the end user; structural elements of the buildings are designed for excessive calamities; and the buildings are constructed according to their uses. While the respondents responded "functional" on the statements: the building has a Certificate of Occupancy; the building is fully equipped and functional. Furthermore, "barely functional" were indicted by the end users on: the buildings are periodically checked by the competent authority/local building official; the rooms are properly lighted, well-ventilated/ air-conditioned and conducive to the end-user; and the buildings undergo proper periodic maintenance.

This implies that the school buildings in the institution were constructed according to their respective uses, the building meets all requirement of the Building Code, and structural elements of the buildings were designed for excessive calamities which greatly contributed to the quality of condition of the buildings.

Furthermore, the table below with the indicator for the building is periodically checked by the competetnt authority/Local Building Official, which was 1.32% of the level of functionality as perceived by the end-users which implies that implementation for the monitoring and maintenance of the building has been done properly. Moreover, 23.66% for the indicator of the Building is safe for the end user which implies that the building is fully functional.

Table exemplifies the summary of the frequency distribution regarding of the end users perceptions on the level of functionality of the building.

Legend:

FF	- Fully Functional	(4.2 - 5.0 pts)
MF	- Mostly Functional	(3.4 - 4.1 pts)
F	- Functional	(2.6 - 3.3 pts)
BF	- Barely Functional	(1.8 - 2.5 pts)
NF	- Not Functional	(1.0 - 1.7 pts)

3.2 Serviceability

The status of building in terms of serviceability was assessed using Coronelli's [1] instrument or the Rapid Condition Assessments Tool, in which, the College of Nursing Building was found to be the most critical. Based on the Coronelli's instrument it is recommended that detailed local investigation is required for the areas such columns, beams, slabs, and walls, if the computed global condition rating is beyond 15%.

The Colleges such as the College of Agriculture, Fisheries, and Natural Resources; College of Business Administration; College of Education; College of Law; and College of Science, the global condition rating attained were below the recommendations based on the computation of local and global condition rating, thus, no further action required.

The result is in conformity with the study of Becker (1999) which concluded that with the increase in standards of living most new building are expected not only meet safety requirements, but also to provide adequate serviceability [10].

The College of Nursing Building reached a global rating of 20.66%. This implies that the College of Nursing needs detailed local investigation required particularly the beams which are very much affected by the corrosion of reinforcing steel bars or the corrosion of embedded metals. Other school buildings did not exceed 15% global condition rating. This findings is in agreement with the study of Neville that concrete structures can deteriorate prematurely, giving rise to poor durability performance. Reasons include poor understanding of deterioration processes, inadequate acceptance criteria of site concrete, and changes in cement properties and construction practices with time [11].

The photos shown below was the status of the building that needs detailed local investigation. The College of Nursing buiding needs attention for repair of the different distress areas that appears in the building, and to have proper periodic monitoring and evaluation of the building due to the global conditioning rating which is above 15%.

3.3 Building or Structure in the University of Eastern Philippines which Needs Renovation, Rehabilitation, and Repair

Based on the results of the visual assessment, description from the distress area of the selected buildings, functionality of the building as perceived by the end users, and other factors affecting the condition of the building in terms of

Table 3. Frequency distribution on the level of functionality of the building asperceived by the end users

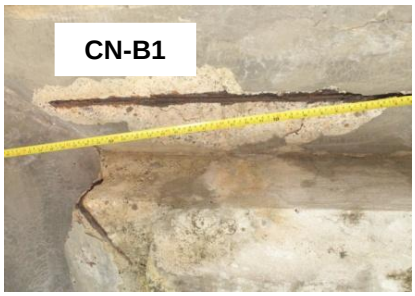
Statement		FF		MF		F		BF		PF		Weighted Mean	Interpretation
		f	%	f	%	f	%	f	%	f	%		
1.	The Building meets all requirement of the Building Code	25	13.89	57	31.67	75	41.67	18	10.00	5	2.78	3.54	Mostly Functional
2	The Building has a Certificate of Occupancy.	3	1.67	22	12.22	50	27.78	69	38.33	36	20.00	2.76	Functional
3	The Building is properly constructed and well-planned	36	20.00	61	33.89	52	28.89	17	9.44	14	7.78	3.49	Mostly Functional
4	The building is periodically checked by the competent authority/Local Building Official.	3	1.67	5	2.78	25	13.89	76	42.22	71	39.44	1.85	Barely Functional
5	The Building is safe for the end user	53	29.44	49	27.22	63	35.00	11	6.11	5	2.78	3.76	Mostly Functional
6	The Building is fully equipped and functional.	22	12.22	54	30.00	73	40.56	18	10.00	13	7.22	3.30	Functional
7	The rooms are properly lighted, well-ventilated/ air-conditioned and conducive to the end-user.	8	4.44	27	15.00	56	31.11	61	33.89	28	15.56	2.59	Barely Functional
8	Buildings are undergo proper periodic maintenance	3	1.67	7	3.89	46	25.56	70	38.89	54	30.00	2.08	Barely Functional
9	Structural elements of the buildings are designed for an excessive calamities.	33	18.33	48	26.67	63	35.00	31	17.22	5	2.78	3.41	Mostly Functional

Statement		FF		MF		F		BF		PF		Weighted Mean	Interpretation
		f	%	f	%	f	%	f	%	f	%		
10	The Buildings are constructed according to their respective uses.	38	21.11	69	38.33	56	31.11	12	6.67	5	2.78	3.68	Mostly Functional
				Grand mean								3.05	Functional

Table 4. Status of building in terms of serviceability

Category (name of the buildings)	Local condition rating				Global condition rating	Remarks
	C	B	S	W		
School Buildings						
CAFNR	4.17	24.06	9.32	13.02	13.18	No further action required
CBA	4.17	24.06	10.34	13.02	10.08	No further action required
COED	4.17	24.06	12.23	18.02	14.12	No further action required
CL	4.17	24.06	11.36	13.02	11.15	No further action required
CN	4.17	40.64	13.33	13.02	20.66	Detailed local investigation required for the following areas
CS	4.17	24.06	9.87	13.03	11.59	No further action required

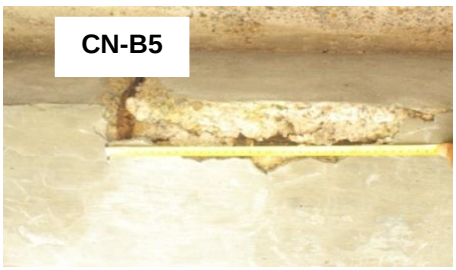
A-College of nursing building



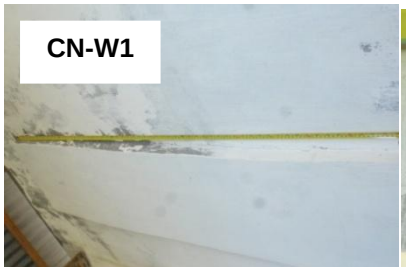
CN Extension building

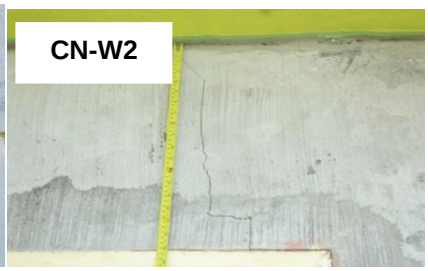
CN extension building in the 2nd floor of the beam

Parapet wall at the 2nd floor

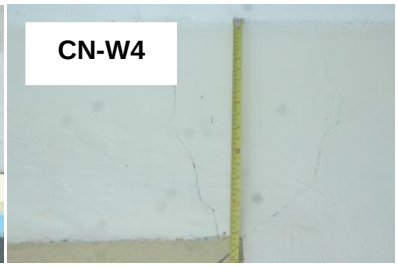


CN extension building in the 2nd floor of the beam

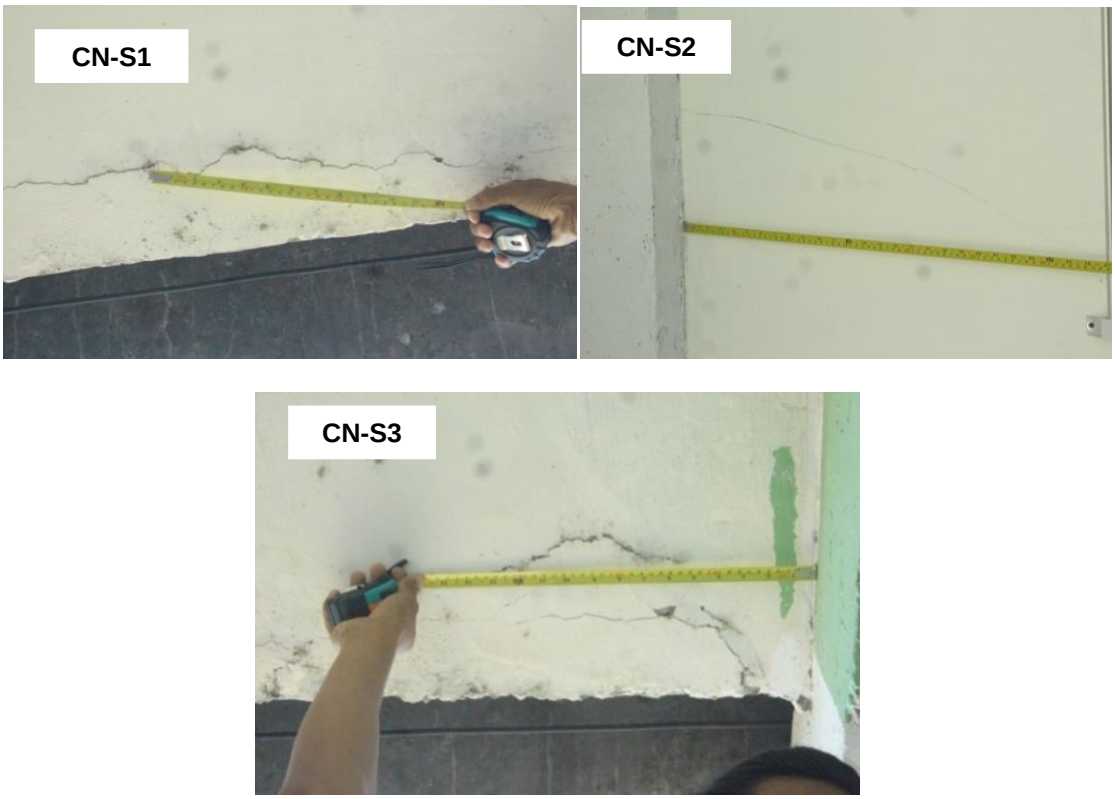




Front Elevation of the 2nd floor college of nursing



Front Elevation of the 2nd floor college of nursing



2nd floor bottom slab of the lobby near dean's office

Fig. 2. Photos of distress area in the college of nursing (CN) building

the number of times that building/s have survived calamities, the building that needs immediate action for repair is the College of Nursing. This finding is in agreement with study of Lattef, 2011 that buildings deteriorate over time, resulting in a reduced capacity to meet the functions for which they were designed and built. The physical condition of buildings affects the quality of the services provided and buildings require maintenance to create a suitable environment that supports andstimulates learning, teaching and innovation [12].

4. CONCLUSIONS

The following conclusions and implication are drawn on the basis of the findings of the study, to with:

1. The buildings that are exposed to more calamities are buildings which suffered and were recorded to have more distress areas. It entails that the institution particularly the concerned department/unit must undergo proper periodic monitoring of the buildings.
2. The College of Nursing and College of Education buildings have more distress areas compared to the other buildings. This implies that these buildings need immediate action repair for it to be safe for use.
3. The findings of the study revealed that the majority of the selected buildings has no building permit, no data en banc for the profile of the buildings, and no proper periodic monitoring and assessment. Nevertheless, the physical appearance of the selected buildings of this study found out that most of the distress areas in terms of concrete cracks were classified as non structural cracks which are the early thermal contraction.
4. The serviceability of the selected buildings revealed that only the College of Nursing needs detailed local investigation for the slab, column, beam, and wall. The findings revealed that the selected school buildings, administration buildings, landmarks/his torical landmarks, and other two-story buildings were functional to the end users.

5. It was also found out that the College of nursing that there is a dire need for immediate repair.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ACKNOWLEDGEMENT

This piece of work is not my heritage. Many persons have contributed to the completion of this work.

- Prof. Ray D. Ramilo, the Faculty of the Graduate Studies, my thesis adviser.
- Dr. Rem N. Laodeño, Prof. Noriel S. Getalado and Dr. Benjamin D. Varela, my panel of examiners.
- Dr. Virginia G. Balanon, the Dean of the Graduate Studies, University of Eastern Philippines.
- Dr. Karina Milagros C. Lim, the Vice President for Research, Development and Extension.
- The University of Eastern Philippines through its Faculty Development Program.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Kazem Reza Kashyzadeh, et. al. Study type of Cracks in construction and its controlling, International Journal of Emerging Technology and Advanced Engineering; 2012.
2. Longhu Li, Cracks in Different Types of Concrete Construction and Renovation, VIA University College, Horsens, Denmark; 2012.
3. Orosco E, et al. Study on development of a rapid condition assessment tool for reinforce concrete moment-resisting in the Philippines: Materials component; 2013.
4. Structural Engineering Institute American Society of Civil Engineers Guideline for Structural Condition Assessment of Existing Buildings. ascelibrary.org by 125.212.120.246 on 02/22/15. Copyright ASCE. Library of Congress Control Number: 00-132816
5. Jaen KE, et al. Application of fuzzy concepts to the visual assessment of deteriorating reinforced concrete structures. ASCE Journal of Construction Engineering and Management; 2012.
6. Ducisin, Preciosa T. The National Building Code in Baguio City. Unpublished Master Thesis, Baguio City; 2001.
7. Coronilli D. Condition rating of RC structures: A case study. Journal Building Appraisal; 2007.
8. ACI 364.1 Guides for Evaluation of Concrete Structures before Rehabilitation.
9. Gann, D. et.al. Design Quality Indicator as a tool for thinking. Building Research & Information; 2003.
10. Becker, R. Ensuring Building Serviceability at the Design Stage; 1999.
11. Neville AM. "Why we have concrete durability problems", ACI SP-100, Katherine and Bryant Mather International Conference on Concrete Durability, American Concrete Institute, Detroit, USA. 1987;21-48.
12. Lattef OAA, et al. Behavioural issues in maintenance of university buil din gs. Journal of Retail and Leisure Property. 2011;9;5:415-428.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/65819