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Study of Cracks in Lecture Theatres of Obafemi Awolowo University Ile-Ife, Nigeria

[1] Musilihudeen O. A[a]., & Adeleke J. S.[b] Olawuyi S. T. & Ipaye M. A.

[a]Department of Building, Obafemi Awolowo University, Ile-Ife, Nigeria
[b]Department of Building Technology, Federal Polytechnic Ede, Osun State, Nigeria
[C]Department of Estate Management and Valuation, Federal Polytechnic Ede, Osun State, Nigeria
[d]Ministry of Water Resources, Small Towns, Water Supply and Sanitation Agency, Abere, Osun State
Corresponding author email: eeyo398@gmail.com

Abstract - *The study investigated cracks on OAU lecture theatres, identified the types of cracks on OAU lecture theatre, examined the causes and the maintenance management strategies adopted in the study area. This was with a view to reducing occurrence of cracks. Data were sourced using structured questionnaire administered to the staff of the maintenance department of OAU and the physical assessment of lecture theatres in the study area. 20 questionnaires were administered and 13 retrieved from the maintenance department. Data obtained were analysed using both descriptive and inferential statistics. The result of the study showed that maintenance on lecture theatres are done Yearly, the most occurring type of crack is the Vertical crack with a common size of 1 to 5mm and the most widely used technique of repair is Epoxy Injection. The result of the facility assessment procedure shows that Ajose, Oduduwa, 1000-seater, adminpost graduate and first bank lecture theatres had a noticeable externally located masonry crack of width 1-5mm, Agric lecture theatre had a noticeable externally located masonry crack of less than 1mm, chemical engineering, ICAN, and auditorium lecture theatre had and internally located masonry crack of width 1-5mm and Biological sciences had a noticeable externally located masonry crack of a width over 5mm. Using a mean response analysis, the result shows that bad quality material is the most responsible cause of cracks in the lecture theatres and proper placement and vibration of concrete is the most adopted strategy towards the prevention of the occurrence of cracks in the lecture theatres. Furthermore, the most occurring crack observed by the maintenance department on the lecture theatres in the last five years was hairline cracks spanning in all the directions. The study concluded that crack in buildings can be complex and unlikely to be caused by a single effect. In some situations, cracking cannot be avoided. Nevertheless, crack quantities and widths can be minimized by the careful selection of materials, proper reinforcement design details, and appropriate construction practices. The potential causes of crack can be controlled if proper consideration is given to construction material and techniques to be used. In case of existing cracks, after detail study and analysis of crack parameters, most appropriate method of correction should be adopted for effective and efficient repair of crack.*

Keyword*: Building integrity, Cracks, Deterioration, Lecture theatres, structural defects,*

1.0 Introduction

Cracks is a process whereby concrete or wall components separates into two or more parts either completely or partially. Concrete cracking is a time-dependent function that cannot be totally avoided, but can be managed and minimized. Concrete as a material with low tensile strength is usually damaged when a tensile stress is given to the structure that exceeds the tensile strength of concrete. The component will crack if the stress applied on it exceeds its strength. External forces such as dead loads, live loads, wind, and foundation subsidence can all generate compressive stress. Temperature swings, humidity changes, and chemical factors can also induce which eventually results to crack. Cracks as a defect in buildings usually appear in walls, ceilings, floors and foundations and it vary in size from thin to medium and to wider to a more alarming one. If the size of crack is ≤ 1 mm is referred to as thin crack; between 1mm –2 mm is referred to medium crack; >2 mm is referred to large crack. Cracks in buildings can have serious consequences resulting in both damaging the structural integrity and aesthetic appeal, minimized structural impact such as weakens load-bearing capacity.

Cracks in beams, columns, and foundations can reduce their strength and may lead to collapse. Similarly, foundation failure which usually results to settlement-related cracks which are caused by the instability to raise the risk of failure such as seismic vulnerability where buildings with structural cracks are more widely present are likely to suffer severe damage particularly during earthquakes. In the area of Architectural appeal and financial consequences, crack could also reduce property value resulting from lowering building market value and deter potential buyers or tenants. In addition, costly repairs ignoring cracks can lead to more extensive and expensive repairs down the line.

Currently, OAU lecture theatres in Obafemi Awolowo University have many theatres that have been constructed in the past and recent. But looking at all these buildings constructed, lecture theatres have been seen to have a lot of cracks despite the maintenance practices on some of the lecture theatres. Most of the newly constructed structures still develop major cracks

that are visible on Lecture Theaters: majority of these structural cracks occurs due to faulty design, construction, and overloading, endangering the safety of the building. Furthermore, vertical cracks which type of cracks travel from DPC (Damp Proof Course) level upward. They are more or less straight and pass through masonry units which are caused by thermal expansion and contraction, or by moisture expansion of blocks or bricks. Similarly, horizontal cracks; occurs due to pull exerted by flat walls because of drying shrinkage and thermal contraction. This results in bending of the wall, causing cracks across the section; Again, the also exist diagonal cracks which are caused by drying shrinkage at the foundation. Uneven moisture movement (especially in clay soil). Trees planted near the building, which accelerates dehydration of soil and contributes to foundation movement.

Approaches to mitigate cracks on OAU Lecture Theatres requires proper curing by implementing moisture curing methods such as water spraying or curing with wet burlap to maintain adequate moisture levels and reduce shrinkage. The temperature control also assists in monitoring and controlling temperature fluctuations during curing to prevent thermal cracking. Surface sealants also apply surface sealants to prevent moisture ingress and protect the concrete from damage. Material selection during construction with suitable properties such as proper aggregate gradation and cement types to reduce shrinkage and cracking risk. Similarly, plan load management distribution carefully to minimize stress concentration points and prevent cracking. Conduct regular inspections to identify and address cracks promptly. The problem of cracks in lecture theatres can pose a serious threat to the life of students and lecturers who use these lecture theatres. This is why this study identify the various categories, types, causes, and maintenance management strategies to prevent the occurrence of cracks in lecture theatres of Obafemi Awolowo University. Through this approach, it is believed that the maintenance staff of OAU will have a better understanding of the problems. This will enable them to formulate policies that guide their operations from both safety and operational performance perspectives.

2.0 Methodology

The research methods adopted for this study involves identifying the population, data requirements, sample frame, sampling techniques, sample size, the study population is primarily the maintenance staff of Obafemi Awolowo University, Ile-Ife and the physical assessment of lecture theatres in the study area. Data collected for this study were primary qualitative in nature. Data collected also included the type, causes and maintenance strategies adopted for the lecture theatres. The data were collected in two sections. The primary section consisted of those that was collected through questionnaires administered to the maintenance staff of Obafemi Awolowo University, Ile-Ife. While the secondary section consisted of personal observation on the identification of cracks on the lecture theatres. The sample frame covered Twelve (12) selected lecture theatre buildings in Obafemi Awolowo University, campus. Table 1 shows the list of selected lecture theatre in OAU.A total of 12 lecture theatres were identified based on information from the institution's website and a total number of 20 questionnaires was administered to the maintenance staff of OAU as the technical and administrative staffs that were on ground are 20 staffs. The data obtained from the study was analysed, summarized and presented with reference to both descriptive and inferential statistical technique such as frequency distribution, mean response analysis and percentages were used on the physical condition of the lecture theatres and maintenance strategies in the form of tables. The data obtained from the study was analysed, summarized and presented with reference to both descriptive and inferential statistical technique such as frequency distribution, mean response analysis and percentages was used on the physical condition of the lecture theatres and maintenance strategies in the form of tables. The field data collected was analysed and the results discussed in line with the methodology laid down in the preceding chapter. The analysis is focused on the types of cracks, causes of the cracks and maintenance strategies adopted in the study area. Questionnaires were distributed to maintenance staff unit of OAU. A total of twenty questionnaires (20) were administered and thirteen (13) were returned and found useful. For any research to be meaningful the target population must among other requirements, be of direct relevance to the research (Oseghale, 2012). To ensure that these requirements are achieved. The department of physical planning was visited to collect the year of construction of the selected lecture theatres, and maintenance department of the university, general information concerning the maintenance staff in charge of lecture theatre on OAU were collected.

Table 1: Lecture Theatres in OAU

S/N	Lecture theatre
1	Oduduwa Lecture Theatre (ODLT)
2	Agric Lecture Theatre (AGLT)
3	Ajose Lecture Theatre
4	ICAN Lecture Theatre
5	Chemical Lecture Theatre
6	Biological Sciences Lecture Theatre (BOOA, B and C)
7	Humanities Lecture Theatre (AUD I and II)
8	Postgraduate Lecture Theatres (PGLT)
9	First Bank Lecture Theatre
10	1000 Seaters Lecture Theatre
11	Duduyemi Lecture Theatre
12	Admin Extension Lecture Theatre

Source: OAU Official Website

3.0 Discussion of Results and Findings

3.1 Types, Causes and Prevention of Cracks Identified at the Lecture Theatre in Obafemi Awolowo University

The condition assessment of the cracks on the lecture theatre found round the university was conducted. The assessment was done by visiting and visually inspecting each of the selected locations in the case study. In reconnaissance survey, the building inspection was carried out to diagnose the cracks in the building, by looking at the whole building from a distance, walking round the building, and observation of each room to locate the cracks, and detail measurement of each crack, and their location in the building. Other areas of investigation include critical visual observation of key areas of the building such as; the pattern of cracks' defects on load bearing/shear walls, floor slab, beams, columns, examination of floor finishes and walls, the examination of column interface with ground floor slab to establish possible foundation settlement, Survey/Investigation of the cracks was done to investigate on what might have caused the occurrence of each crack in the building. The cracks were grouped based on the findings, which are drying shrinkage, architectural design fault, foundation settlement, and movement due to creep.

Table 2 shows how the staff of maintenance department identify the various type of cracks they have frequently noticed on the lecture theatres in the last five years of inspection. 22 (twenty-two) types of cracks were identified and respondents were asked to indicate their observation on a 5-point scale ranging from Most frequent, More frequent, frequent, never, unknown. The result is being analysed using mean response analysis and presented in Table 2. Mean response analysis were calculated in order to know the most occurring type of crack in lecture theatres in ObafemiAwolowo University. The result shows that hairline cracks spanning in all directions ranked 1, 2=Horizontal crack at the topmost corner of a building, 3= Vertical cracks at the topmost corner of a building having RCC roof, and Diagonal cracks accompanied by outward tilting of walls ranked least in the table.

Table 2: Types of Cracks in Lecture Theatres of OAU (Maintenance Staff) in the Past Five Years

Types of cracks	**Mean**	**Rank**
Hairline crack spanning in all directions	4.73	1
Horizontal crack at the topmost corner of a building	3.85	2
Vertical cracks at the topmost corner of a building having RCC roof	3.77	3
Vertical crack at the junction of RCC column and masonry	3.44	4
Horizontal crack in column	3.20	5
Horizontal crack in mortar joint	3.20	5
Vertical cracks in the sidewalls at the corner of the building	2.92	6
Vertical cracks below the opening in line with window joints	2.78	7
Horizontal cracks at the top most story above slab level	2.64	8
Horizontal cracks at the eaves level in building having pitch roof	2.64	8
Horizontal cracks at the top most story below slab level	2.43	9
Horizontal cracks at window lintel at the topmost stories	2.22	10
Diagonal cracks across the corner of a building affecting two adjacent walls	1.93	11
Vertical crack in column	1.84	12
Horizontal crack at the bottom of beam	1.84	12
Horizontal crack at the middle of a beam	1.76	13

Diagonal cracks over RCC lintels spanning over large openings	1.54	14
Diagonal crack near beam support	1.29	15
Vertical cracks at the centre span of beam	1.03	16
Vertical crack from the top to bottom of beam	1.03	16
Diagonal cracks accompanied by outward tilting of walls	0.95	17

Table 3 shows the causes of cracks observed on the lecture theatres of OAU as perceived by the maintenance department. The staff of the maintenance department were asked to identify the causes of cracks they have frequently noticed on the lecture theatres in the last five years of inspection. 14 (fourteen) causes of cracks were identified and respondents were asked to indicate their observation on a 5-point scale ranging from very much, much, moderate, low and very low. The result analyzed using mean response presented in table 3 shows that bad quality materials ranked=1, wear and tear of building=2, shrinkage=3 are the most responsible cause of cracks and corrosion of reinforcement steel=11, chemical reaction=12, foundation movement=13 are the least responsible cause of cracks in the lecture theatres in Obafemi Awolowo University.

Table 3: Causes of Cracks Observed on the Lecture Theatres in OAU

Causes of Cracks	**Mean**	**Rank**
Bad quality materials	4.32	1
Wear and tear of buildings	4.26	2
Shrinkage	3.92	3
Poor construction practise	3.84	4
Poor workmanship	3.72	5
Poor maintenance	3.98	6
Poor specification	3.42	7
Thermal movement	3.36	8
Elastic deformation	3.36	9
Faulty design	3.20	10
Overloading	2.88	11
Corrosion of reinforcement steel	2.88	11
Chemical reaction	2.65	12
Foundation movement	2.47	13

Table 4 shows the strategies for minimize the occurrence of cracks in lecture theatres. In order to examine the strategies adopted to prevent the occurrence of cracks in the lecture theatres study questions were asked on the frequency of use on a 5-point scale ranging from most often, more often, often, less often and not often. 9 (nine) strategies were identified. The result is being analysed using mean response analysis. The result showed that Proper placement and vibration of concrete ranked=1, Proper compaction of soil to prevent settlement=2, Proper curing of concrete=3, Proper concrete mix design and use of quality materials=4, Proper finishing of concrete surface=5, Reduction in water content in concrete=6, Provision of control joints in concrete=7 and Use of shrinkage reducing mixture, Use of synthetic fibres to help control plastic shrinkage cracks= 8 (least).

Table 4. Strategies for Minimizing the Occurrence of Cracks in OAU Lecture Theatres

Strategies	**Mean**	**Rank**
Proper placement and vibration of concrete	3.62	1
Proper compaction of soil to prevent settlement	3.59	2
Proper curing of concrete	3.43	3
Proper concrete mix design and use of quality materials	3.33	4
Proper finishing of concrete surface	3.01	5

Reduction in water content in concrete	2.87	6
Provision of control joints in concrete	2.61	7
Use of shrinkage reducing mixture	2.41	8
Use of synthetic fibres to help control plastic shrinkage cracks	2.41	8

4.0 Conclusion and Recommendation

The study concluded that, though it is impossible to guarantee against cracking yet attempts can be made to minimize development of cracks. Also, not all type of crack requires same level of attention. The potential causes of crack can be controlled if proper consideration is given to construction material and technique to be used. In case of existing cracks, after detail study and analysis of crack parameters, most appropriate method of correction should be adopted for effective and efficient repair of crack. The study concluded that cracking in buildings can be complex and unlikely to be caused by a single effect. In some situations, cracking cannot be avoided. Nevertheless, crack quantities and widths can be minimized by the careful selection of materials, proper reinforcement design details, and appropriate construction practices.

The study however, recommended the followings:

(i) Avoid cracks in block work on account of initial expansion, a minimum period varying from 1 week to 2 weeks is recommended by authorities for curing of blocks after the day of production.

(ii) Shrinkage cracks in masonry could be minimized by avoiding use of rich cement mortar in masonry and by delaying plaster work till masonry has dried after proper curing and has undergone most of its initial shrinkage.

(iii) Use of precast tiles in case of terrazzo flooring is an example of this measure. In case of in-situ/terrazzo flooring, cracks are controlled by laying the floor in small alternate panels or by introducing strips of glass, aluminium or some plastic material at close intervals in a grid pattern, so as to render the shrinkage cracks imperceptibly small

(iv) Wherever feasible, provision should be made in the design and construction of structures for unrestrained movement of parts, by introducing movement joints of various types, namely, expansion joints, control joints and slip joints.

(v) Even when joints for movement are provided in various parts of a structure, some amount of restraint to movement due to bond, friction and shear is unavoidable. Concrete, being strong in compression, can stand expansion but, being weak in tension, it tends to develop cracks due to contraction and shrinkage, unless it is provided with adequate reinforcement for this purpose. Members in question could thus develop cracks on account of contraction and shrinkage in the latter direction. It is, therefore, necessary to provide some reinforcement called 'temperature reinforcement" in that direction.

(vi) Over flat roof slabs, a layer of some insulating material or some other material having good heat insulation capacity, preferably along with a high reflectivity finish, should be provided so as to reduce heat load on the roof slab.

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