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Refining The Acoustical Defects Of Assembly Buildings By Scientific Positioningof Sound Systems

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Abstract: *The public assembly buildings like outdoor and indoor stadiums are prone to acoustical defects arising out of multifold reasons observed during many stage events.This investigation was carried out with an aim todo away with the obstructions interveningduring the gala events. The factors identified to influence the acoustics of buildings are geometrical properties of the building, materials used for construction and interiors, openings in buildings, orientation and positioning of sound systems, number and capacity of sound systems and so on. Considering all these parameters into account, an investigation was made with a scientific approach of setting up of sound systems that suits well for any building geometry built with the conventional construction materials. The results of the study proposed non-linear polynomial equations for orientation and positioning of surround sound systems to generate a highly audible and ambient atmosphere.*
Keywords: *audible, ambient, assembly buildings, acoustics,orientation, positioning, sound systems.*

I. Introduction

The sound in the form of noise drags a serious attention in the modern times towards health affairs. The magnitude of sound when exceeds the hearing limits impairs our physical and mental stability and therefore it is necessary to develop technologies that stimulates noise in tolerablelimits. Acoustics is a science of sound, which deals with origin, propagation and auditory sensation of sound and also with design & construction of different building units to set optimum conditions for producing & listening speech, music, etc. Acoustics is also provided for rectifying the defects in building units and components of the structure thereof. The knowledge of this science is a prerequisite for appropriate functioning of theaters, stadiums, auditoriums, conference halls, etc. Zoontjens et. al.(2014) took survey onacoustics of Australian hospitals and found that several Australian Standards are due for an update and the recent research findings challenged the basis of existing guidelines and approaches currently recommended for the acoustical design of the healthcare facilities. Recommendations were made to suitable design positions to be used in the tendering and specification of future healthcare facilities.

Rougier et. al.(2010) studied the acoustic environmental impact of stadiums that were built in urban areas and sometimes in the proximity of city. In this study, the stadium was considered as an equivalent sound source through ray tracing simulation tool (ICARE) which takes into account the geometry of the stadium, its material properties and the sound sources of the stadium. Then the equivalent sound source was implemented into the ray-tracing code(MITHRA), which takes into account topography, buildings, roads or meteorological conditions. After the evaluation of acoustic environmental impact of stadium, it was concluded that the stadium can be used for both sports and concerts.

Deshpande et. al. discussed the acoustical issues pertaining to the public buildings. In this study, room acoustics, auditorium acoustics and architectural acoustics were reviewed with relevance to various defects and commonly used acoustical materials.

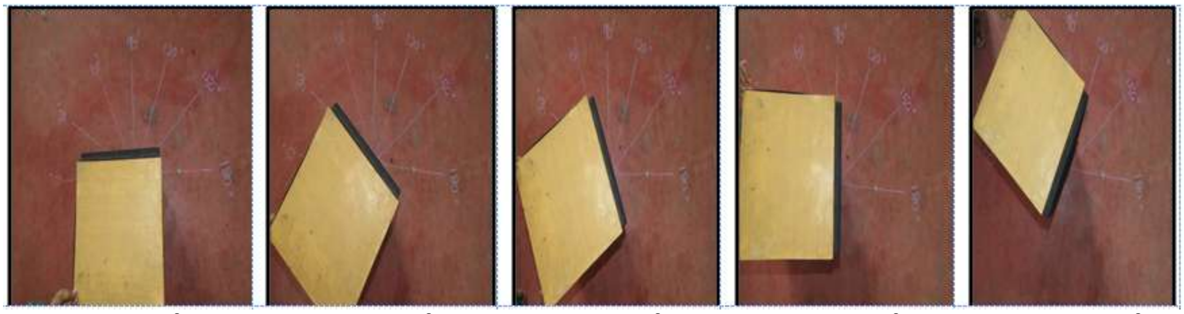
Assembly buildings are often utilized not only for sports but also for conventions, concerts etc. Such uses demand careful acoustical planning and elimination of problems caused by the reverberations produced by these buildings. The aim of this study is to propose design equations pertaining to acoustic correctionsfor a stadium building that can achieve a harmonious result without undermining its functional capacity.

II. Experimental Investigation

The sound source considered for this study was a stadium as shown in Figs.1&2. The noise levels were studied when the stadium was full with crowd.The noise expressed in terms of decibel was recorded using noise meter. The noise levels were measured in east-west direction and north-south direction at incremental distances based on their dimensional limitations. Theangle of inclination (orientation) of sound systems wasarbitrarily chosen as 0^o, 30^o, 60^o, 90^o and120^oas shown in Fig.3.

Fig.1 Stadium in East-West Direction

Fig.2 Stadium in North-South Direction



a. At 0^o **b. At 30^o** **c. At 60^o** **d. At 90^o** **e. At 120^o**

Fig.3 Orientation of Sound Systems inside the Stadium

III. Experimental Results & Discussion

The results of the tests conducted on various criteria mentioned earlier are discussedin detail under this section. The results of noise levels measured with respect to direction, distance (position) and angle of inclination (orientation) of sound systems are furnished in the following Tables and Figures.

3.1. Acoustics In East-West Direction

Table 1 presents the results of the noise levels travelling from east to west direction with respect to different angle of inclination of sound systems ranging from 0^o to 120^{o}and at every incremental distance of 5m.

Table 1 Noise Level in East-West Direction

Distance (m)	At 0^o	At 30^o	At 60^o	At 90^o	At 120^o
0	95.3	100.7	100.5	101.8	101.5
5	101.6	91.4	101.6	96.8	97.5
10	97.6	102.3	100	95.3	102.5
15	93.7	102.2	102.5	97	93.6
20	90.2	98.9	99.7	96.5	101.5
25	100.5	101.4	95.6	98.2	99
30	102.7	98.8	94.2	99.5	98.3
35	90.6	103	93.6	101.5	97.5
40	92	95.4	90.8	96.2	100.3

Fig.3 shows the graphical trajectory of noise levels travelling from east-to-west direction at 0^o inclination of sound systems placed at an incremental distance of every 5m. From the graph, it was observed that the noise level ranged from 92 to 97db. The governing non-linear polynomial regression equation for this case is expressed as

$y = - 0.005x^2+0.107x+96.77$

where,

y = noise level in decibels and

x = distance travelled by sound in m

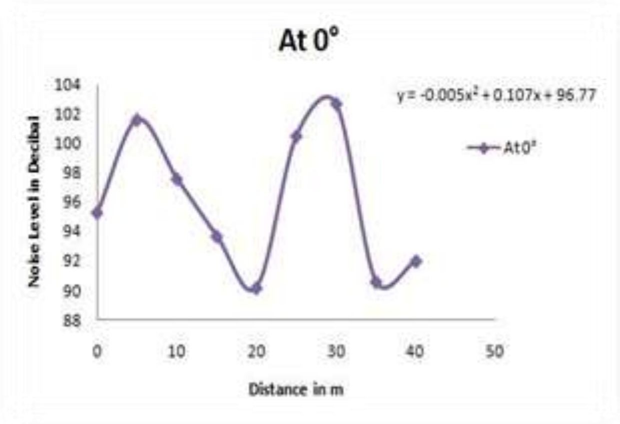


Fig. 3 Noise Level in E-W direction at 0^o

Fig.4shows the graphical trajectory of noise levels travelling from east-to-west direction at 30^o inclination of sound systems placed at an incremental distance of every 5m. From the graph, it was observed that the noise level ranged from 97 to 100db. The governing non-linear polynomial regression equation for this case is expressed as

$y = - 0.008x^2+0.359x+96.97$

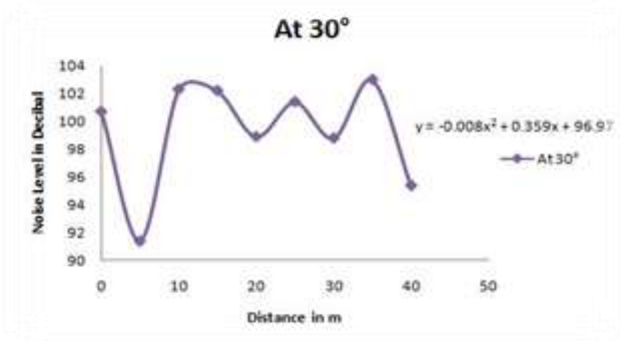


Fig. 4 Noise Level in E-W direction at 30^o

Fig.5shows the graphical trajectory of noise levels travelling from east-to-west direction at 60^o inclination of sound systems placed at an incremental distance of every 5m. From the graph, it was observed that the noise level ranged from 90 to 101db. The governing non-linear polynomial regression equation for this case is expressed as

$y = - 0.008x^2+0.062x+101$

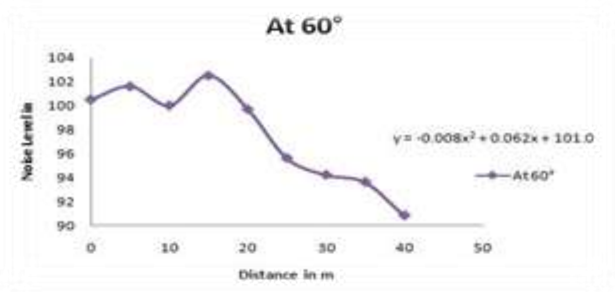


Fig. 5 Noise Level in E-W direction at 60^o

Fig.6shows the graphical trajectory of noise levels travelling from east-to-west direction at 90^o inclination of sound systems placed at an incremental distance of every 5m. From the graph, it was observed that the noise level ranged from 97 to 99db. The governing non-linear polynomial regression equation for this case is expressed as

$y = 0.005x^2-0.212x+99.26$

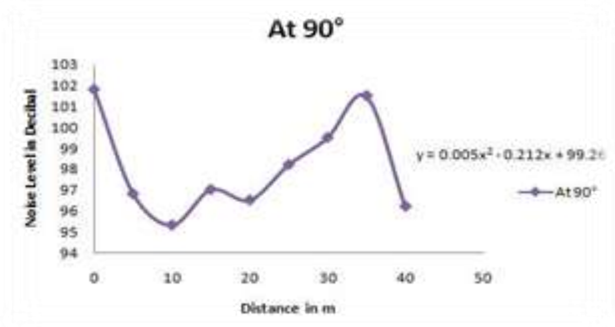


Fig. 6 Noise Level in E-W direction at 90^o

Fig.7shows the graphical trajectory of noise levels travelling from east-to-west direction at 120^o inclination of sound systems placed at an incremental distance of every 5m. From the graph, it was observed that the noise level ranged from 98 to 101db. The governing non-linear polynomial regression equation for this case is expressed as
$y = 0.004x^2 - 0.207x+100.6$

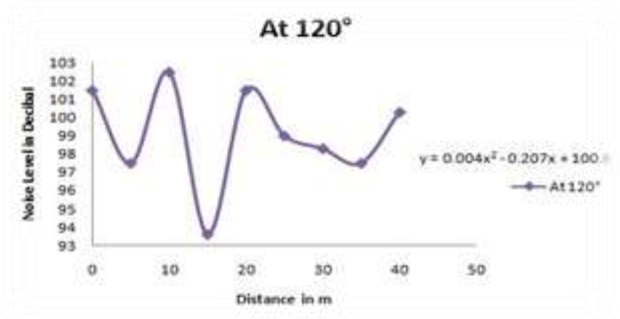


Fig. 7 Noise Level in E-W direction at 120^o

Fig.7shows the noise level enveloped in east-west direction with a variation in angle of inclination of sound systems ranging from 0^o to 180^o. From the graph, it was observed that the surround noise level at threshold level was85 db and at peak level it wasmore than 105 db. The contour profile of the surround noise level was not of a regular circle rather it varied randomly with respect to the angle of inclination of the sound systems. This non-circular noise pattern caused by the improper propagation of sound waves may develop an acoustic defect for the audience in the stadium.

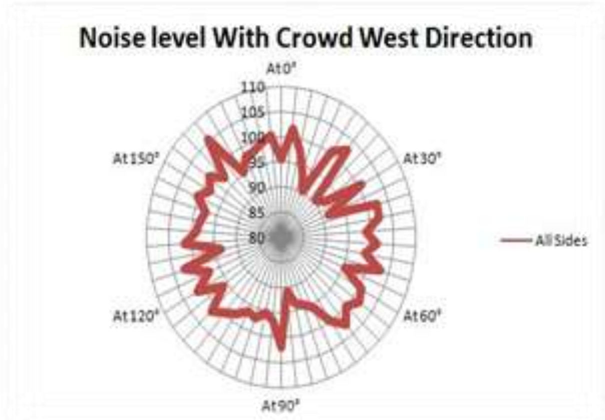


Fig. 8 Surround Noise Level in E-W direction

3.2 Acoustics In North-South Direction

Table 2 presents the results of the noise levels travelling from north to south direction with respect to different angle of inclination of sound systems ranging from 0^o to 120^o and at every incremental distance of 8.25m.

Table 2 Noise Level in North-South Direction

Distance (m)	At 0^o	At 30^o	At 60^o	At 90^o	At 120^o
0	90.1	102.2	103.8	97.3	97.8
8.25	93.7	95.6	101.6	104.5	96.3
16.5	103.2	104.8	105.7	105	95.4
24.75	105.4	101.5	101.2	97	97.8
33	95.3	103.3	98.6	96.8	94.3

Fig.9shows the graphical trajectory of noise levels travelling from north-to-south direction at 0^o inclination of sound systems placed at an incremental distance of every 8.25m. From the graph, it was observed that the noise level ranged from 90 to 100db. The governing non-linear polynomial regression equation for this case is expressed as
$y = -0.036x^2+1.469x+88.16$

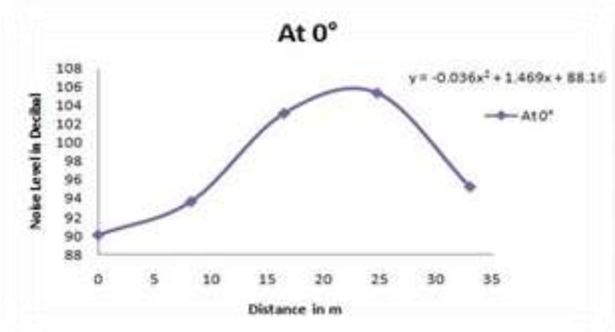


Fig. 9 Noise Level in N-S direction at 0^o

Fig.10shows the graphical trajectory of noise levels travelling from north-to-south direction at 30^o inclination of sound systems placed at an incremental distance of every 8.25m. From the graph, it was observed that the noise level ranged from 100 to 102db. The governing non-linear polynomial regression equation for this case is expressed as

$y = 0.004x^2 - 0.050x + 100.4$

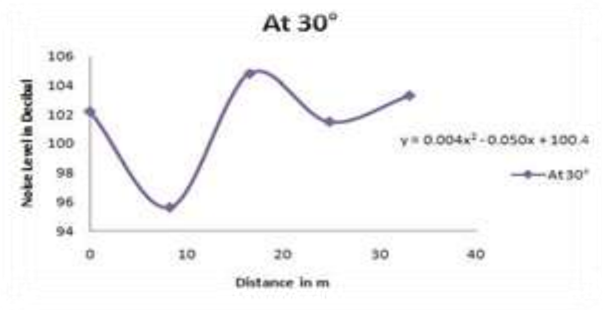


Fig. 10 Noise Level in N-S direction at 30^o

Fig.11shows the graphical trajectory of noise levels travelling from north-to-south direction at 60^o inclination of sound systems placed at an incremental distance of every 8.25m. From the graph, it was observed that the noise level ranged from 99 to 103db. The governing non-linear polynomial regression equation for this case is expressed as

$y = -0.009x^2 + 0.194x + 103$

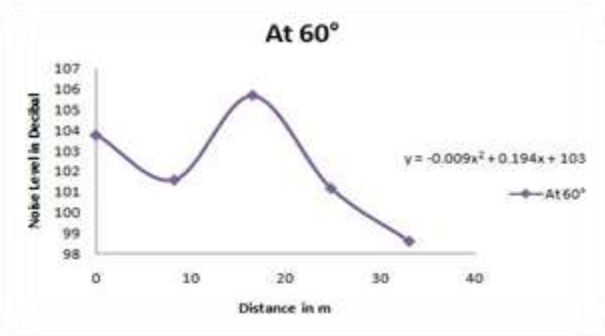


Fig. 11 Noise Level in N-S direction at 60^o

Fig.12shows the graphical trajectory of noise levels travelling from north-to-south direction at 90^o inclination of sound systems placed at an incremental distance of every 8.25m. From the graph, it was observed that the noise level ranged from 96 to 99db. The governing non-linear polynomial regression equation for this case is expressed as

$y = -0.024x^2 + 0.703x + 78.49$

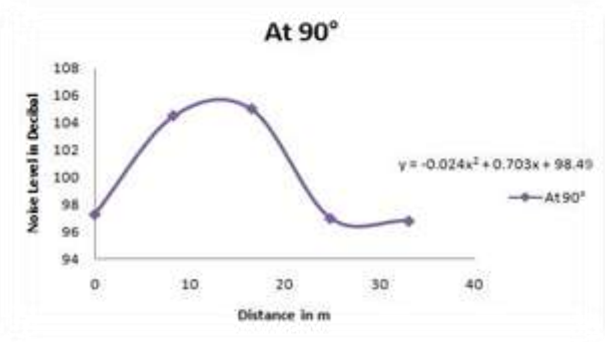


Fig. 12 Noise Level in N-S direction at 90^o

Fig.13shows the graphical trajectory of noise levels travelling from north-to-south direction at 120^o inclination of sound systems placed at an incremental distance of every 8.25m. From the graph, it was observed that the noise level ranged from 95 to 97db. The governing non-linear polynomial regression equation for this case is expressed as

$y = -0.000x^2 - 0.042x + 97.32$

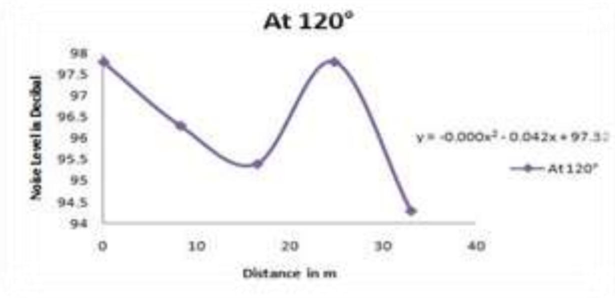


Fig. 13 Noise Level in N-S direction at 120^o

Fig.14shows the noise level enveloped in north-to-south direction with a variation in angle of inclination of sound systems ranging from 0^o to 180^o. From the graph, it was observed that the surround noise level at threshold level was90 db and at peak level, it wasmore than 105 db. The contour profile of the surround noise level was not of a regular circle rather it was a skewed circular shapewith respect to the angle of inclination of the sound systems. This non-circular noise pattern caused by the improper propagation of sound waves may develop an acoustic defect for the audience in the stadium.

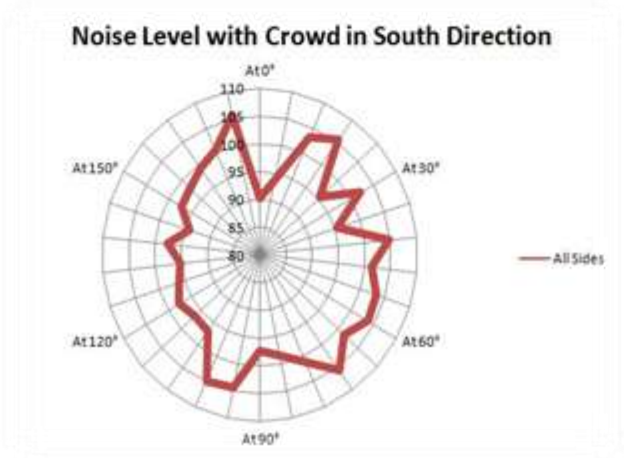


Fig. 14 Surround Noise Level in N-S direction

IV. Conclusions

The acoustics of the stadium building was investigated with respect to direction, distance (position) and angle of inclination (orientation) of the sound systems. Based on this experimental investigation, it was observed that the surround noise levels varied from 85 to 105 db in east-west direction and 90 to 105 db in north-south direction. The surround noise levels proved that the distribution of sound wavesresulted in a non-uniform pattern over the entire stadium creating a hearing imbalance. In order to overcome the pitfall, non-linear polynomial regression equations were developed from this study with a purpose of refining the sound waves by scientific installation of sound systems. Careful application of these equations with suitable modifications in the parameters of equations enables us to achieve a smooth circular curve for the surround noise levels. Once the targeted smooth circular curve was obtained, the requirement for an ambient and harmonious atmosphere inside the public assembly buildings like stadiums is fulfilled when engaged for situational purposes.

References

[1] Subash S. Deshpande, Sanjay N. Patil and Anil K. Gupta, “Acoustics-Essential Requirement for Public Buildings”, IOSR Journal of Mechanical and Civil Engineering, pp 25-28.

[2] C. Rougier, J. Defrance, N. Noe, J. Maillard and M. Baulac, “Acoustic Environmental Impact of Stadiums”, Internoise, 13-16 June 2010, Lisbon-Portugal.

[3] Luke Zoontjens and Tom Cockings, “Review of Design Approaches to Acoustics in Australian Hospitals”, Internoise, 16-19 November 2014, Melbourne-Australia.

[4] M. Azimi, “Noise Reduction in Buildings using Sound Absorbing Materials”, Journal of Architectural Engineering Technology, Vol.6, Issue 2, 2017.

[5] Chan-Ki Jeon, Jae-Seong Lee, Hoon Chung, Ju-Ho Kim and Jong-Pil Park, “A Study on Insulation Characteristics of Glass Wool and Mineral Wool Coated with a Polysiloxane Agent”, Advances in Materials Science and Engineering, Vol.2017.

[6] Limin Peng, Boqi Song, Junfeng Wang and Dong Wang, “ Mechanic and Acoustic Properties of the Sound-Absorbing Material made from Natural Fiber and Polyster”, Advances in Materials Science and Engineering, Vol.2015.