ACOSUTICAL DESIGN CONSIDERATION FOR

AUDITORIUM LECTURE HALL RECORDING STUDIO

INTRODUCTION

The auditorium, as a place for listening developed from the classical open-air theaters.

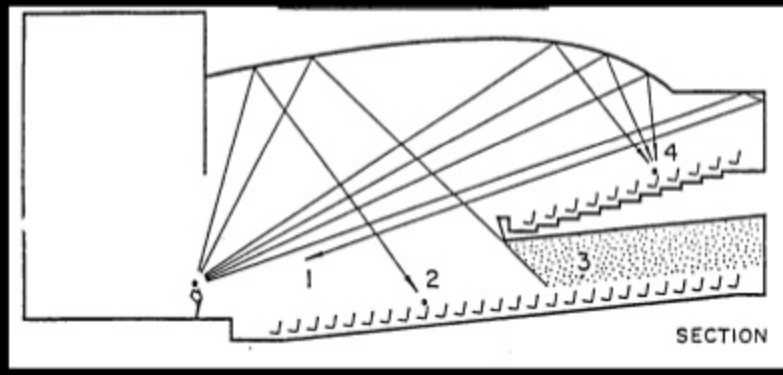
An auditorium includes any room intended for :

- listening to music including theaters
- classrooms
- churches
- meeting halls

The design of various types of auditoriums has become a complex problem, because in addition to its various, sometimes conflicting, aesthetics, functional, technical, artistic and economical requirements, an auditorium often has to accommodate an unprecedentedly large audience.

INTRODUCTION ....

- In some ways, even the **largest hall** is no different from the **smaller rooms**, the **basic acoustic criteria are the same**.
  - Must have a **low ambient noise level** from internal and external sources
  - Provide a **reasonable level of acoustic gain**
  - Provide appropriate **reverberation time**
  - **Avoid** artifacts such as **echoes**.
- Hearing conditions in any auditorium are considerably affected by purely architectural considerations like:
  - Shape
  - Dimensions
  - Volume
  - Layout of boundary surfaces
  - Seating arrangements
  - Audience capacity



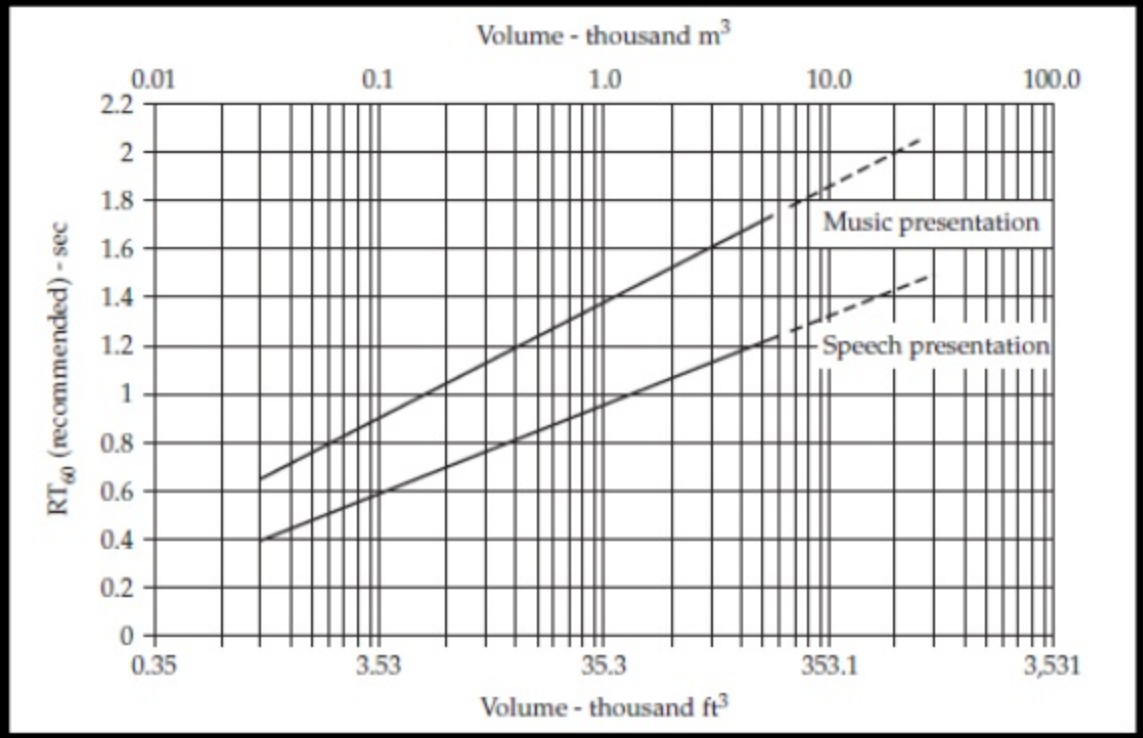
Defects:

1. **Echo**
2. **Delayed Reflection**
3. **Sound Shadow**
4. **Sound Concentration**

REVERBERATION AND ECHO

- Reverberation is an important parameter that helps define the sound quality of an acoustic space.
- This is especially true in large halls.
- Reverberation time is closely linked to the intended purpose for any room, and to room volume.

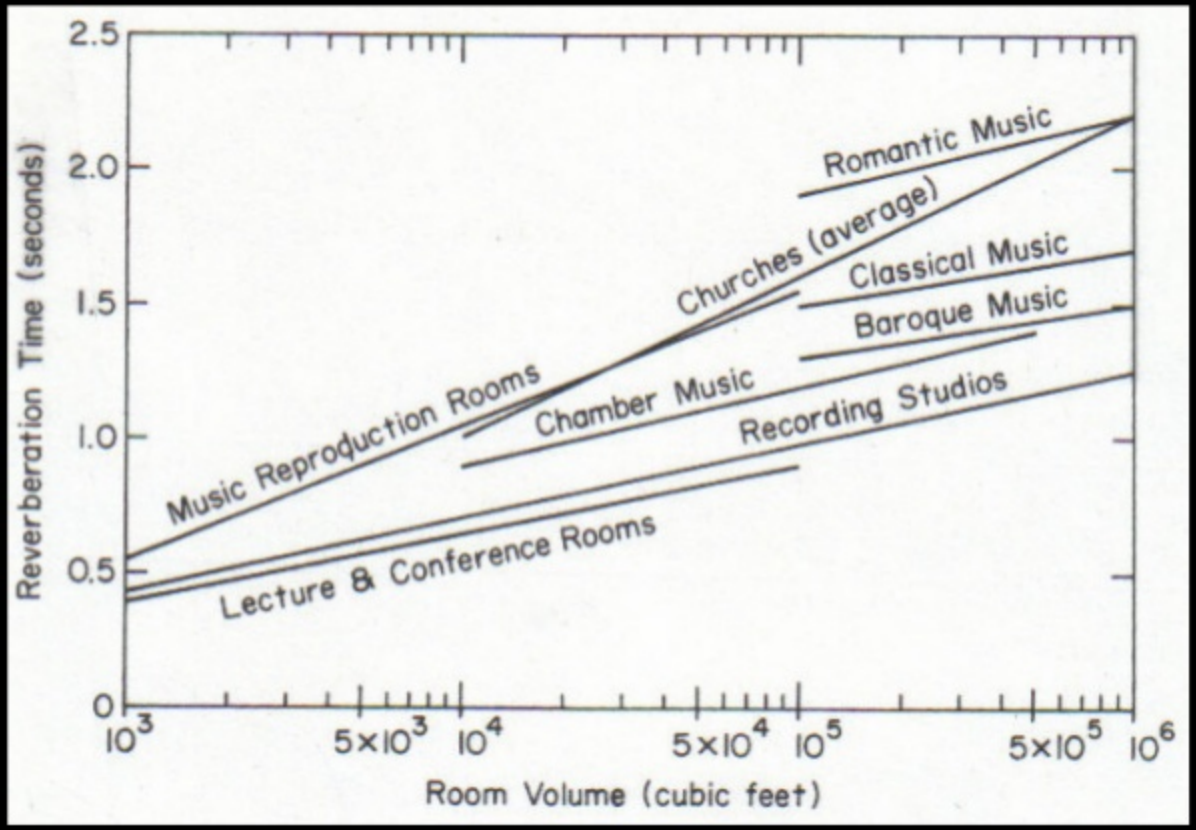
- Halls designed for speech have shorter mean reverberation times than halls designed for music performance.
- The recommended mean reverberation time increases as a function of room volume.



REVERBERATION AND ECHO ....

Large enclosed spaces are all potentially subject to the problem of discrete echoes.

The long path lengths and multiplicity of seating positions near and far from the sound source can easily create echo problems.



REINFORCEMENT BY LOUDSPEAKER

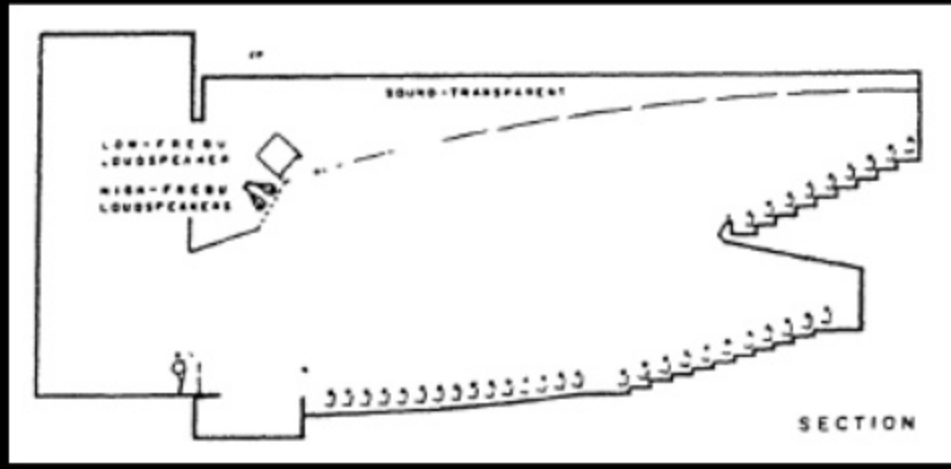
Sound amplification system are used for the following purpose:

- To reinforce the sound level when the sound source is too weak to be heard.
- To provide amplified sound for overflow audience.
- To minimize sound reverberation.
- To provide artificial reverberation in rooms which are too dead for satisfactory listening.
- To operate electronic organs, chimes etc.

TYPES OF LOUDSPEAKER SYSTEM

Three principal type of loudspeaker system are available:

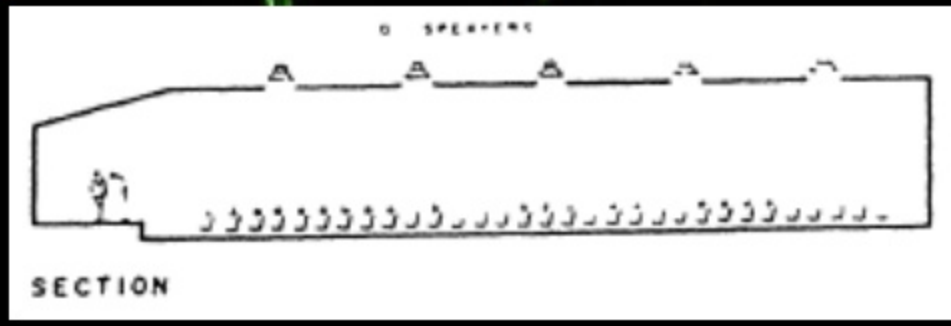
1. The centrally located system with a single cluster of loudspeakers over a sound source.



This system gives max. realism as the amplified sound comes from the same direction as original sound.

TYPES OF LOUDSPEAKER SYSTEM ....

2. The **distributed system**, using a number of overhead loudspeakers located throughout the auditorium.



This system should be used when:

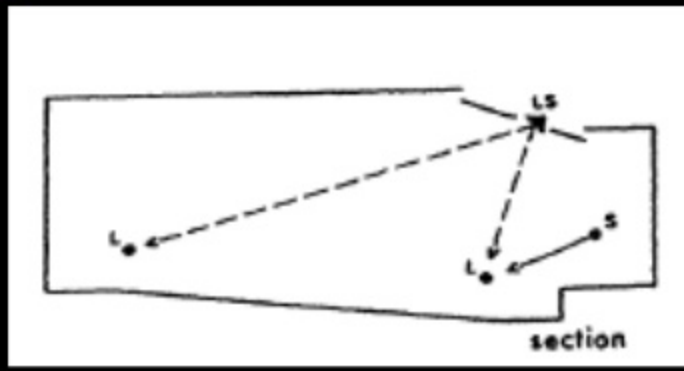
- **Auditorium height is too low** to install central system.
- When majority of **listeners** do not have an adequate **sight line of central loudspeakers**.
- When sound has to be provided **for overflow audience**.
- In **large halls**.

3. The **stereophonic system**, with two or more clusters of loudspeakers around the proscenium opening or the sound source.

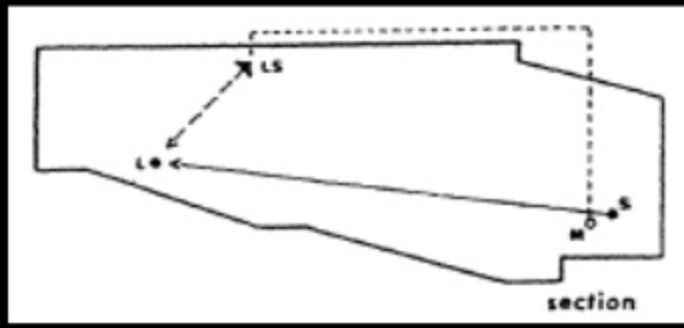
Stereophonic system preserves the illusion that, the sound is coming from the original , unamplified source.

PROBLEMS ASSOCIATED WITH LOUDSPEAKER SYSTEM

1. Audience will **hear two sounds**, arriving at two time.
   This difference should not be more than **1/30 sec**.



2. When **loudspeaker is placed halfway** down the a large auditorium.
   Audience will hear loudspeaker first and direct sound as a weak echo.



This problem can be overcome by introducing a **delayed mechanism in loudspeaker system**

- **Speech Intelligibility = Power + Clarity**

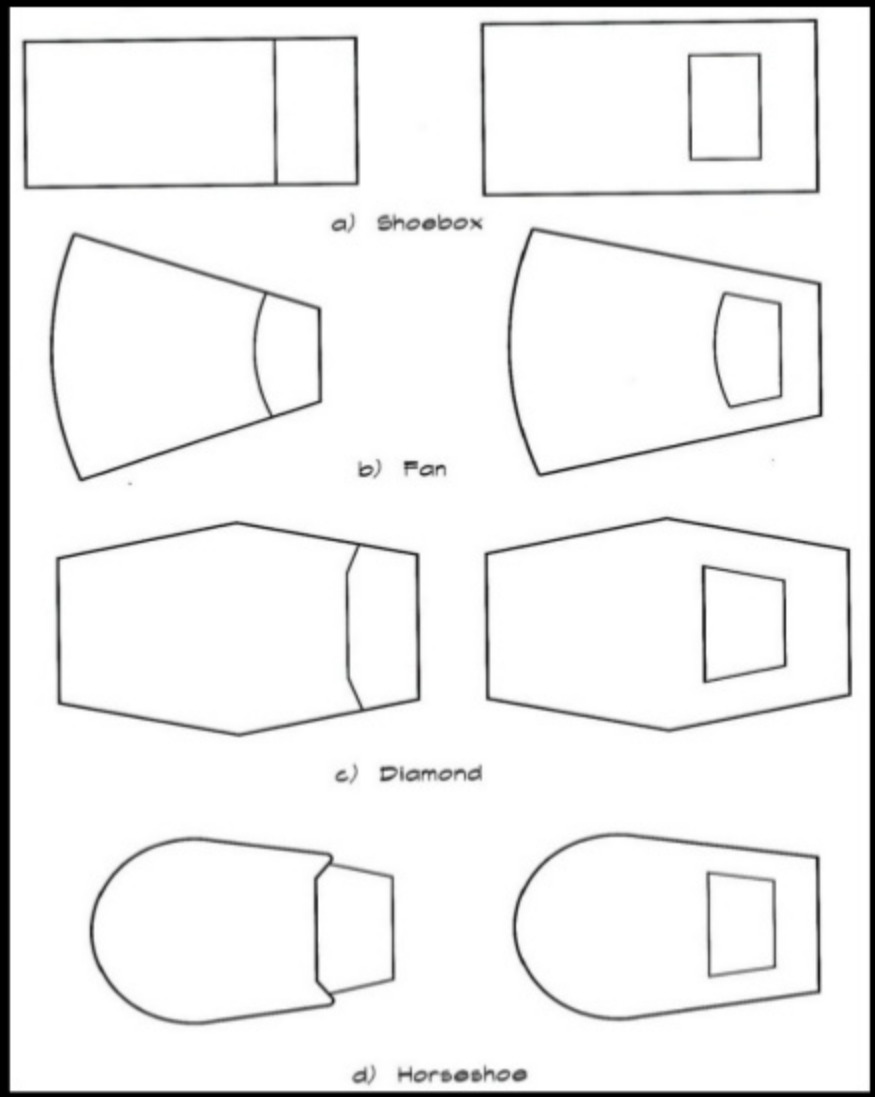
- **POWER is affected by :**
  - **Distance from speaker**
  - **Directional relationship to speaker**
  - **Audience absorption of direct sound**
  - **Reinforcement by reflectors**
  - **Reinforcement by loudspeakers**
  - **Sound shadows**
- **CLARITY is affected by :**
  - **Delayed reflections : Echos, Near Echos, Reverberation**
  - **Duplication of sound source by loudspeakers**
  - **Ambient Noise**
  - **Intrusive Noise**

VOLUME

- For unamplified speech, it is often necessary to limit the overall room volume. This is because a large volume requires more speech power than a small room.
- This volume minimization is contrary to rooms designed for music, where a relatively large volume is desirable.
- In a face-to-face conversation, an unamplified talker may generate a SPL level of about 65 dB. This level decreases 6 dB for every doubling of distance. Sound is also attenuated as it travels through the hall because of air absorption.
- To support audible levels, the audience area must be placed as close as possible to the speaker. This minimizes sound attenuation, provides a more direct sound path, and also improves visual recognition which improves intelligibility.

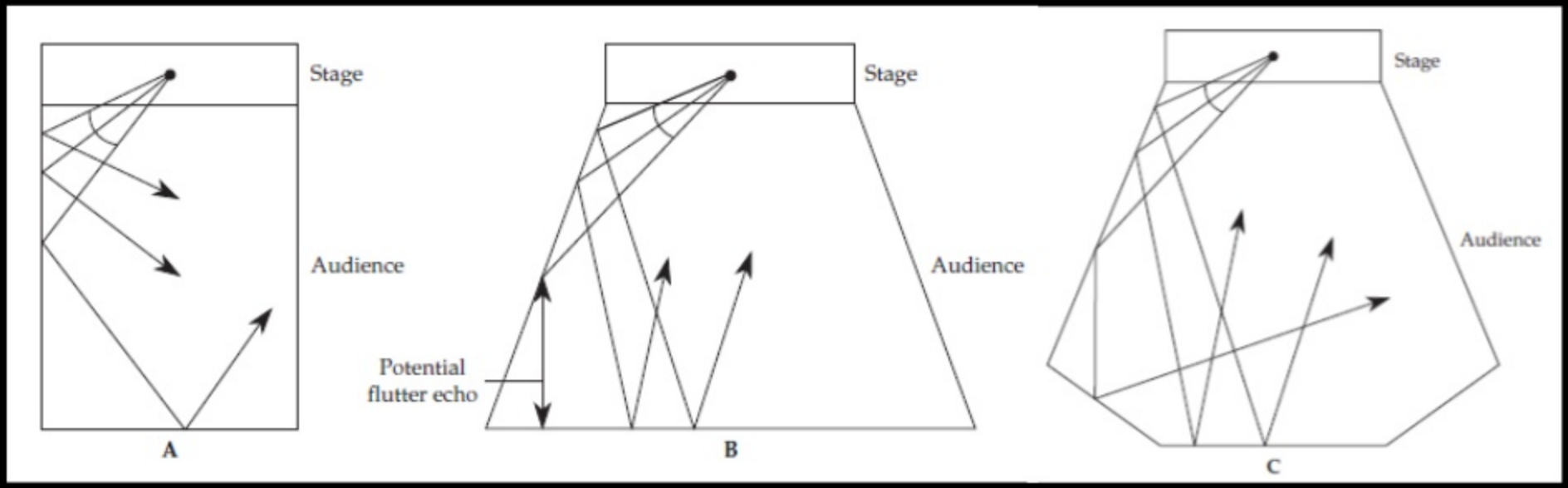
ROOM SHAPE

- The talker-to-audience distance can be minimized by carefully considering the room geometry.
- A **rectangular shoebox-type hall**, with the stage across one narrow end, may be **excellent for music** where an audience can be seated farther away and a **greater ratio of reverberant sound is desirable**.
- However, a **rectangular geometry** is only **suitable for a relatively small speech hall.**



ROOM SHAPE

- For **greater seating capacity**, the **side walls should be splayed** from the stage.
- Splayed side walls **allow greater seating area** that is relatively **close to the stage**.
- The splayed walls can usefully reflect sound energy to the rear of the hall.
- A side-wall splay may range from 30° to 60°, the latter is considered a maximum angle, given the directionality of speech. **Generally, fan-shaped halls are not used for music performance**.



ABSORPTION

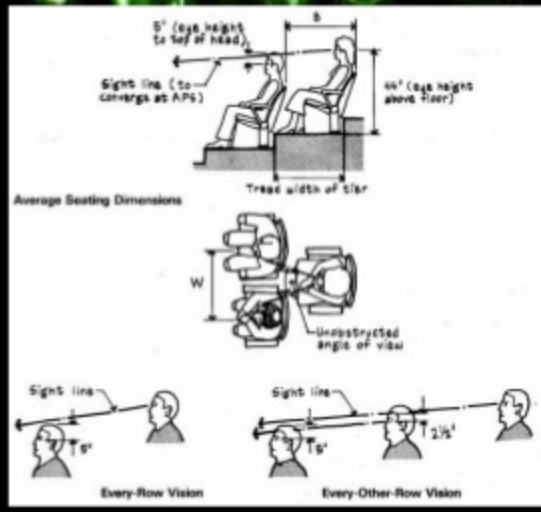
- In small speech halls, the majority of absorption is provided by the audience, therefore, the room surfaces can be relatively reflective. In larger halls, where there is greater room volume per seat, relatively greater room absorption is needed.
- Beneficially, a reflective front stage area provides strong early reflections that are integrated with the direct sound and enhance it. On the contrary, strong late reflections and reverberation, such as from rear walls, would not be integrated and may produce echoes.
- To accommodate this, the stage area and front of the hall are made reflective and absorption is placed in the seating area and rear of the hall.

CEILING

- In many large halls, ceiling reflectors, sometimes called clouds, are used to direct sound energy from the stage to the seating area.
- Both dimensions of a square reflecting panel should be at least five times the wavelength of the lowest frequency to be reflected.
- When ceilings are high, care must be taken to ensure that path-length differences between direct and reflected sound are not too great, and particularly should not exceed 20 msec.
- In some cases, clouds are made absorptive, to avoid late reflections.

FLOORS

- A sloping (raked) floor allows a more direct angle of incidence which in turn allows less absorption. Generally, the slope of an auditorium floor should not be less than 8°.
- The floor of a lecture-demonstration hall might have a 15° angle of inclination.
- Staggering of seats is also recommended.



WALLS

- Because of its potential to create undesirable late reflections, the rear wall of a large hall requires special attention.
- Reflections from the rear wall would create a long path-length difference to a listener at the front of the hall. This can result in audible echoes, particularly because of the otherwise low reverberation level.
- A reflective concave rear wall would also undesirably focus sound.
- For these reasons, the rear wall of a large hall is usually absorptive.
- In some cases, when added absorption is undesirable because of decreased reverberation time, reflective diffusers can be placed on the rear wall.

TYPES OF AUDITORIUM

1. **FOR SPEECH**
   - Conference Hall
   - Lecture Theatre
   - Law Court
2. **FOR MUSIC**
   - Concert Hall
   - Music Practice Room
3. **MULTI-PURPOSE**
   - School Assembly Hall
   - Town Hall

RULE of THUMB for SEATING AREA:

Allow 7½ sq. ft per Seat, including Aisles and Cross-overs.

This is sufficiently accurate for preliminary planning.

Table I - Depth Dimensions (Ft.-In.) for Various Spacings

No. Rows	Overall Depth for Seat Spacing (Back-to-back) of:										
	32"	33"	34"	35"	36"	37"	38"	39"	40"	41"	42"
1	2-8	2-9	2-10	2-11	3-0	3-1	3-2	3-3	3-4	3-5	3-6
2	5-4	5-6	5-8	5-10	6-0	6-2	6-4	6-6	6-8	6-10	7-0
3	8-0	8-3	8-6	8-9	9-0	9-3	9-6	9-9	10-0	10-3	10-6
4	10-8	11-0	11-4	11-8	12-0	12-4	12-8	13-0	13-4	13-8	14-0
5	13-4	13-9	14-2	14-7	15-0	15-5	15-10	16-3	16-8	17-1	17-6
6	16-0	16-6	17-0	17-6	18-0	18-6	19-0	19-6	20-0	20-6	21-0
7	18-8	19-3	19-10	20-5	21-0	21-7	22-2	22-9	23-4	23-11	24-6
8	21-4	22-0	22-8	23-4	24-0	24-8	25-4	26-0	26-8	27-4	28-0
9	24-0	24-9	25-6	26-3	27-0	27-9	28-6	29-3	30-0	30-9	31-6
10	26-8	27-6	28-4	29-2	30-0	30-10	31-8	32-6	33-4	34-2	35-0
11	29-4	30-3	31-2	32-1	33-0	33-11	34-10	35-9	36-8	37-7	38-6
12	32-0	33-0	34-0	35-0	36-0	37-0	38-0	39-0	40-0	41-0	42-0
13	34-8	35-9	36-10	37-11	39-0	40-1	41-2	42-3	43-4	44-5	45-6
14	37-4	38-6	39-8	40-10	42-0	43-2	44-4	45-6	46-8	47-10	49-0
15	40-0	41-3	42-6	43-9	45-0	46-3	47-6	48-9	50-0	51-3	52-6
16	42-8	44-0	45-4	46-8	48-0	49-4	50-8	52-0	53-4	54-8	56-0
17	45-4	46-9	48-2	49-7	51-0	52-5	53-10	55-3	56-8	58-1	59-6
18	48-0	49-6	51-0	52-6	54-0	55-6	57-0	58-6	60-0	61-6	63-0
19	50-8	52-3	53-10	55-5	57-0	58-7	60-2	61-9	63-4	64-11	66-6
20	53-4	55-0	56-8	58-4	60-0	61-8	63-4	65-0	66-8	68-4	70-0
21	56-0	57-9	59-6	61-3	63-0	64-9	66-6	68-3	70-0	71-9	73-6
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24	64-0	66-0	68-0	70-0	72-0	74-0	76-0	78-0	80-0	82-0	84-0
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26	69-4	71-6	73-8	75-10	78-0	80-2	82-4	84-6	86-8	88-10	91-0
27	72-0	74-3	76-6	78-9	81-0	83-3	85-6	87-9	90-0	92-3	94-6
28	74-8	77-0	79-4	81-8	84-0	86-4	88-8	91-0	93-4	95-8	98-0
29	77-4	79-9	82-2	84-7	87-0	89-5	91-10	94-3	96-8	99-1	101-6
30	80-0	82-6	85-0	87-6	90-0	92-6	95-0	97-6	100-0	102-6	105-0
31	82-8	85-3	87-10	90-5	93-0	95-7	98-2	100-9	103-4	105-11	108-6
32	85-4	88-0	90-8	93-4	96-0	98-8	101-4	104-0	106-8	109-4	112-0

Table III - Seating Capacities, 1-32 Rows

No. of Rows	7 Seats	14 Seats	28 Seats	No. of Rows	7 Seats	14 Seats	28 Seats
1	7	14	28	17	119	238	476
2	14	28	56	18	126	252	504
3	21	42	84	19	133	266	532
4	28	56	112	20	140	280	560
5	35	70	140	21	147	294	588
6	42	84	168	22	154	308	616
7	49	98	196	23	161	322	644
8	56	112	224	24	168	336	672
9	63	126	252	25	175	350	700
10	70	140	280	26	182	364	728
11	77	154	308	27	189	378	756
12	84	168	336	28	196	392	784
13	91	182	364	29	203	406	812
14	98	196	392	30	210	420	840
15	105	210	420	31	217	434	868
16	112	224	448	32	224	448	896

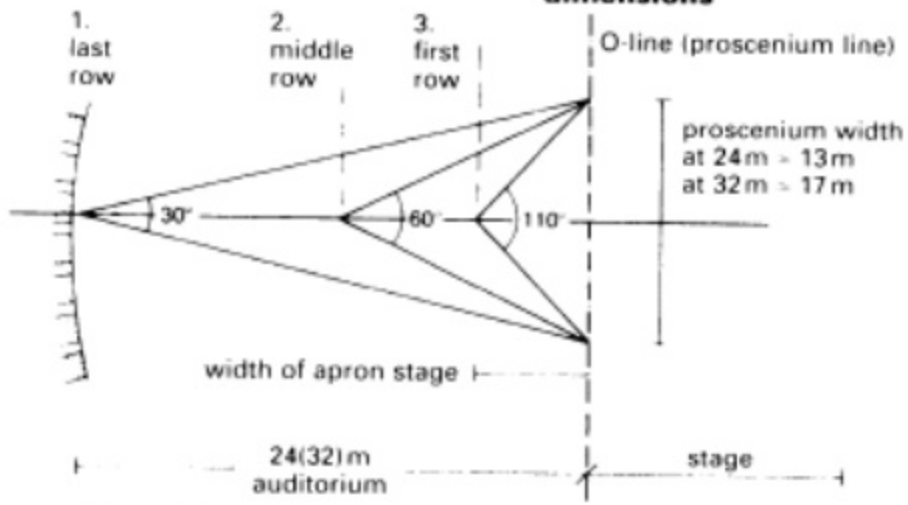
Table II - Aisle Width Increase (in inches) Per Row of Length

Seat Spacing Back-to-Back	Fire Underwriters Code: 3'-0" plus ⅛" per 1'-0"	N.Y. City Code: 3'-0" plus 1½" per 5'-0"
32"	0.67	0.80
33"	0.69	0.83
34"	0.71	0.86
35"	0.73	0.88
36"	0.75	0.90
37"	0.77	0.93
38"	0.79	0.95
39"	0.81	0.98
40"	0.83	1.00
41"	0.85	1.03
42"	0.88	1.05

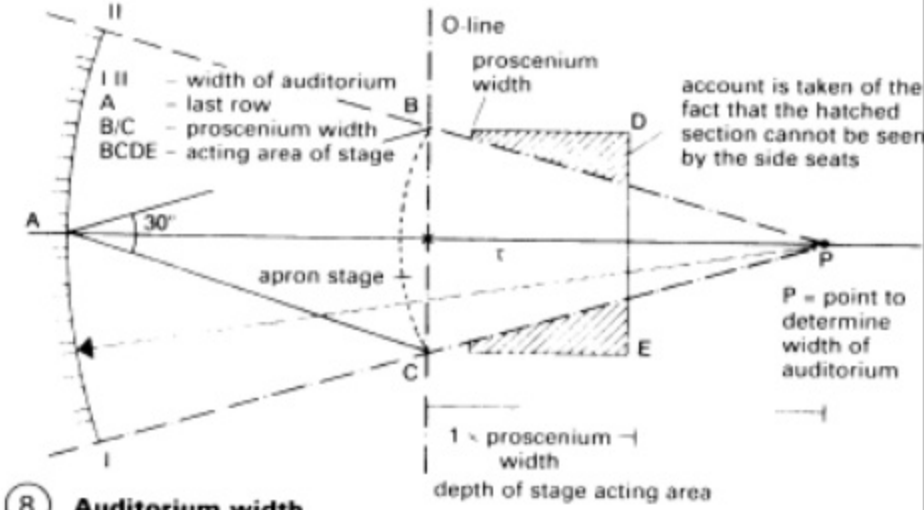
Proper factor x no. of rows = total increase in inches, Add to 3'-0" minimum aisle width

DESIGN DATA

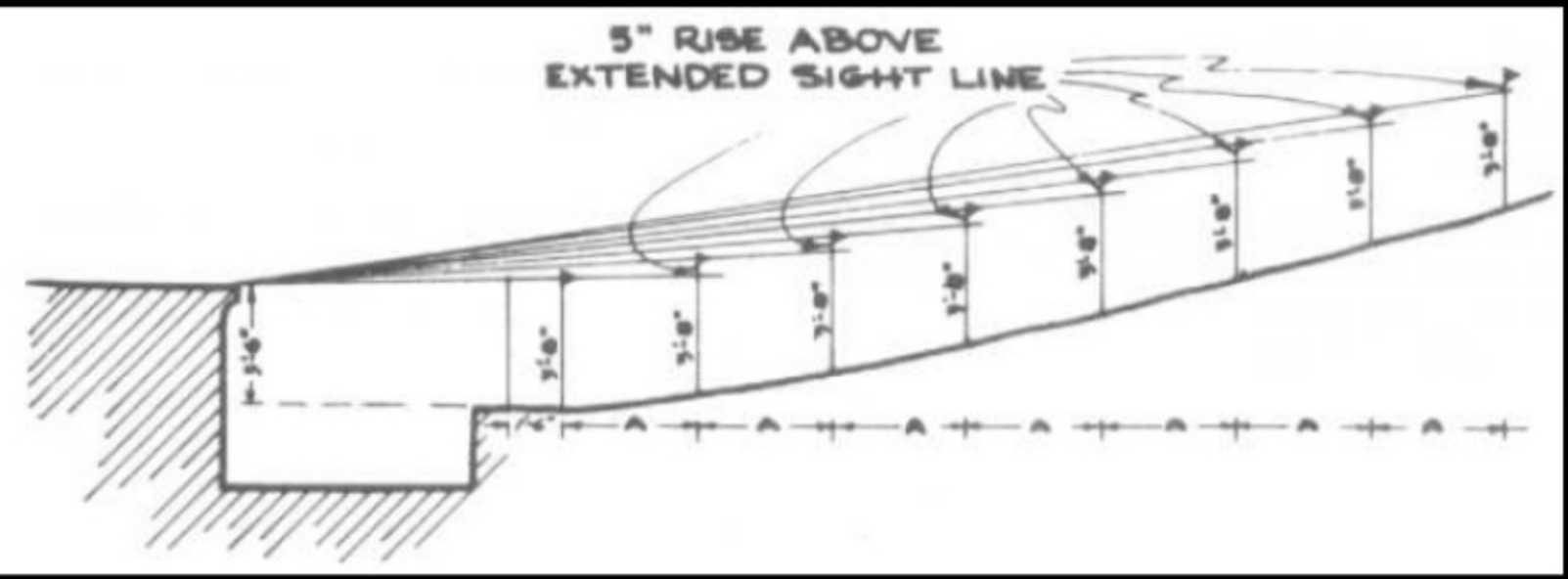
dimensions



(7) **Proportions of the traditional auditorium (view)**



(8) **Auditorium width**



Developed Floor Slope For Unobstructed View

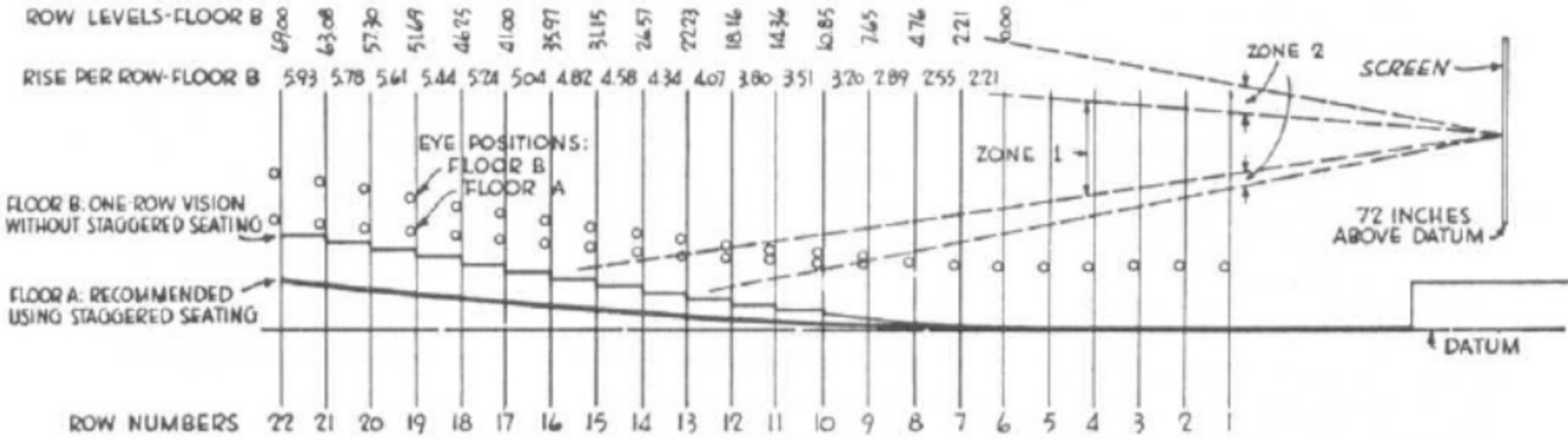


Fig. 6 Single-slope auditorium. On ground sloping 3 ft or more downward toward screen. Without staggered seats, risers required starting tenth row.

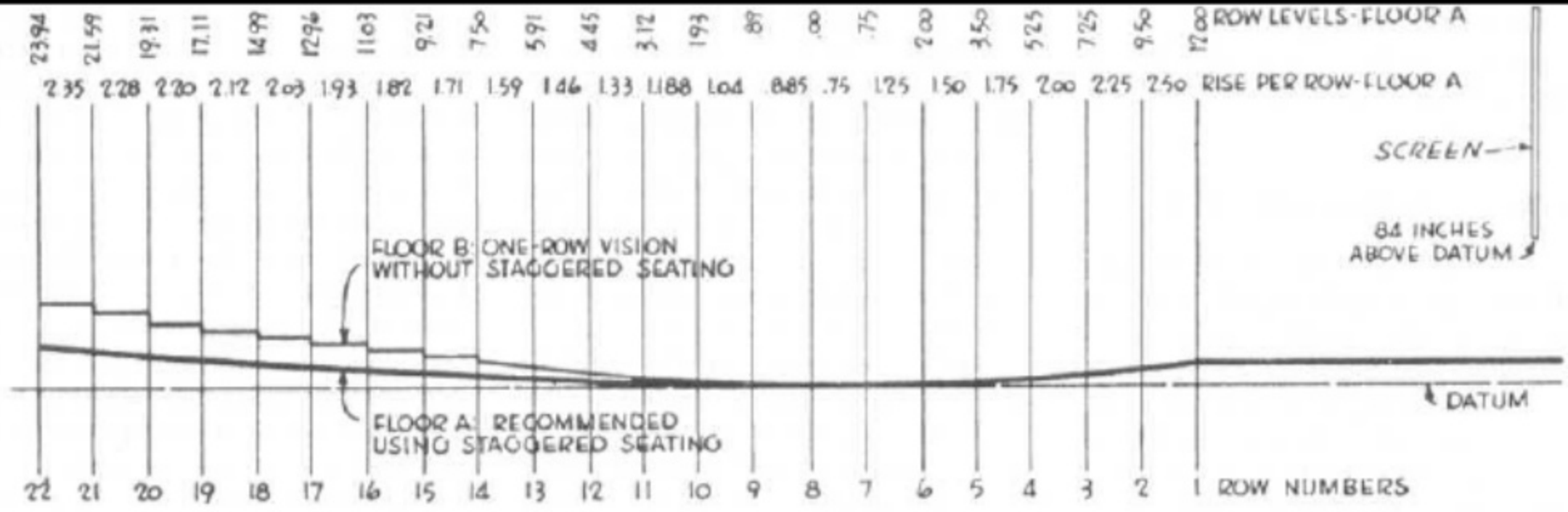


Fig. 7 Double-slope auditorium. On level ground, or on ground sloping less than 3 ft in any direction. First six rows aligned to allow view of entire screen.

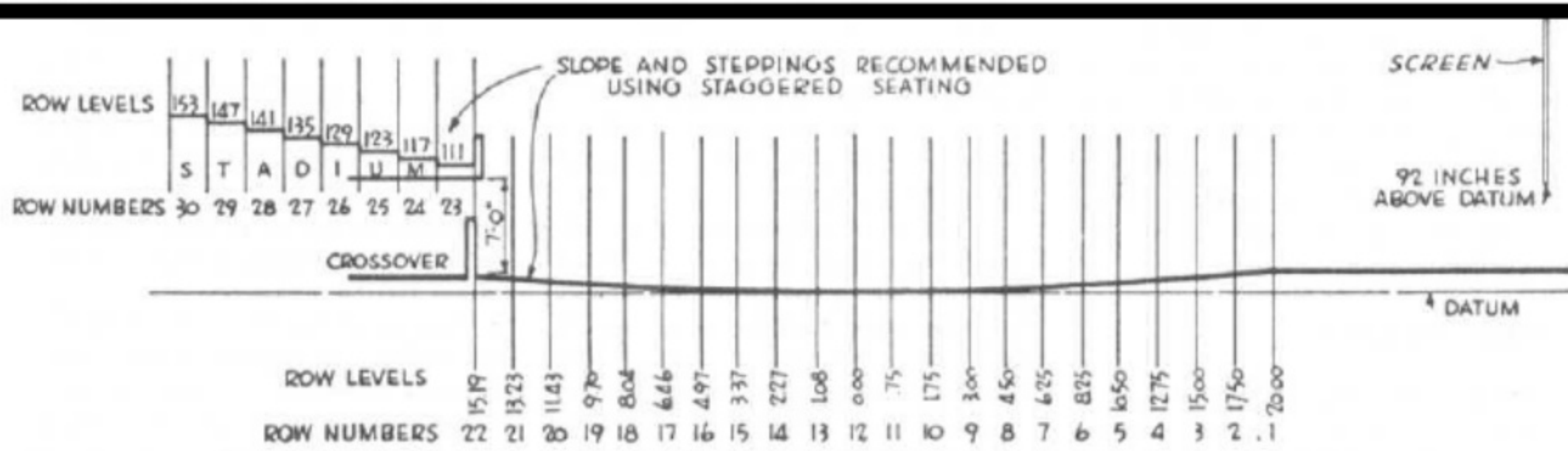


Fig. 8 Double-slope auditorium with stadium. On level ground or on ground sloping less than 3 ft in any direction. Seats in at least first six rows aligned. Crossover under first few rows of stadium saves seating area. Staggered seating and minimum clearance in crossover prevent intermediate steps.

AIIMS LIKE APEX HEALTHCARE INSTITUTE AT BHUBANESHWAR

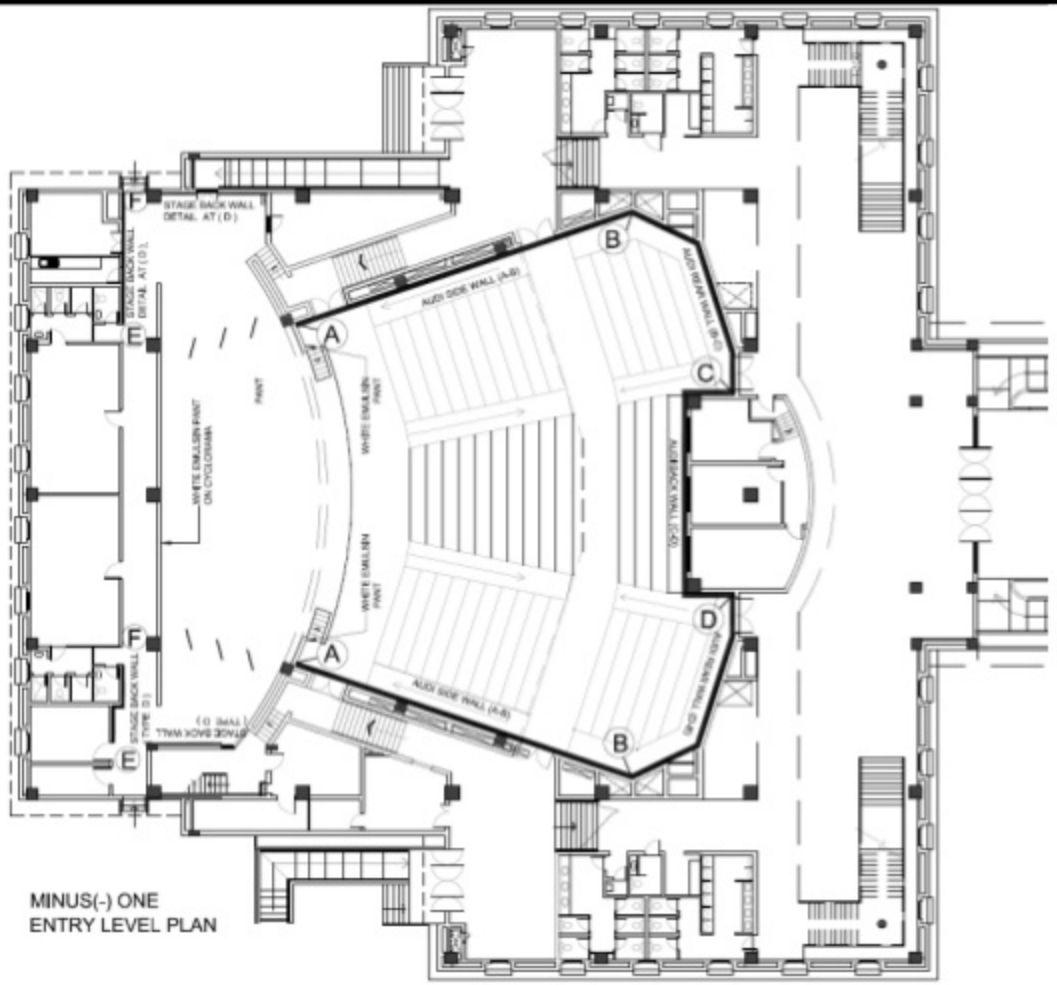
SCHEDULE OF COVERED AREAS

	DESCRIPTION		TOTAL BUILT UP AREA (IN SQM.)
3.0	**AUDITORIUM**		
3.1	MINUS (-) ONE ENTRY LEVEL FLOOR PLAN		2399.35
3.2	BALCONY LEVEL FLOOR PLAN		1081.20
	TOTAL AREA OF AUDITORIUM		**3480.55**

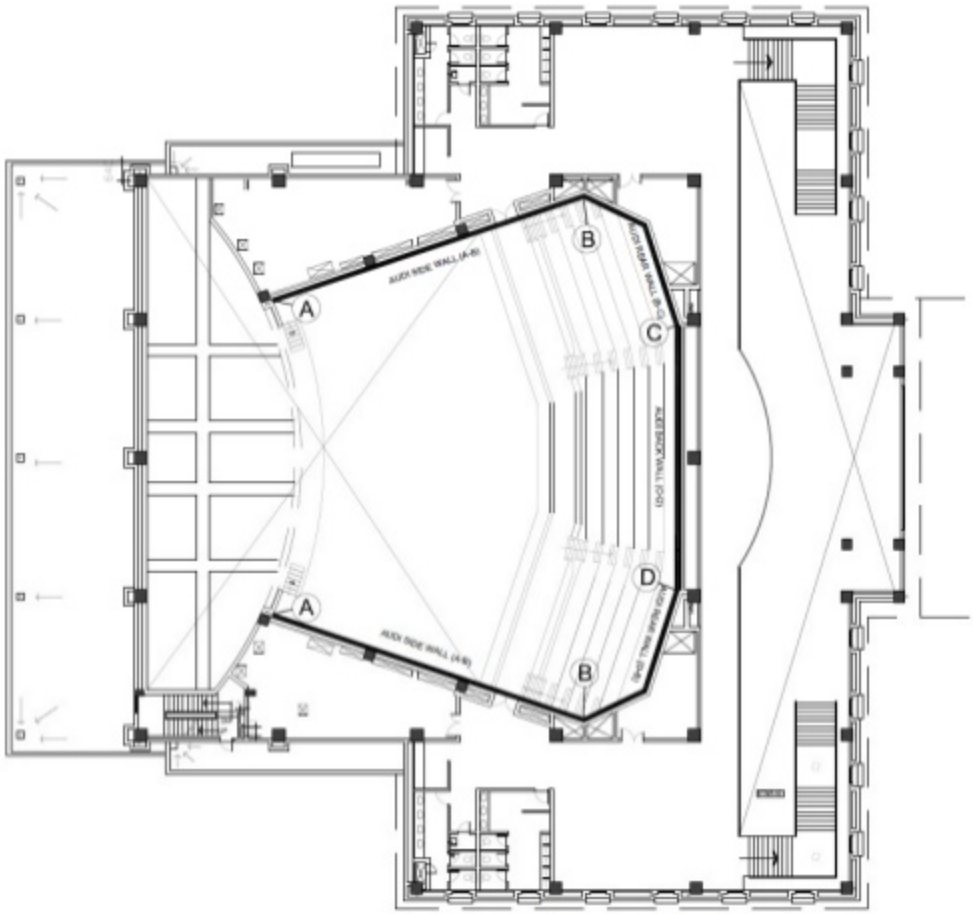
NOTE:-

A TO B – AUDI SIDE WALL (TYPE A)
B TO C – AUDI REAR WALL (TYPE B)
C TO D – AUDI BACK WALL (TYPE C)
E TO F – STAGE BACK WALL (TYPE D)

(A TO F) DETAILS REFERENCE DRAWING NO.– 2007132/AR(SB)/C/AD/A–9



MINUS(-) ONE ENTRY LEVEL PLAN



BALCONY LEVEL PLAN
SCALE:-1:200

AUDITORIUM