# How can a hall have a short EDT and a long RT60?

Hello,

I just finished going through M. Barron's book Auditorium Acoustics & Architectural Design, apart from the usual famous halls, Marshall's Christ Church, and Segerstrom Hall perked my curiousity (appendix C). It seems like the trend in all new high-end concert halls is an occuppied midband RT of 2-2.2 sec and an EDT of 1.2-1.4 sec. While there seems to be lots of books on how to get a room with RT60 time of 2 secs to sound good, I can't find any literature on how to get that elusive double slope curve with a EDT of almost half the RT60!

Anyone know the secret?

Tony

"Tony" <ton...@canada.com> wrote in message news:<k0169.138082$Ag2.7112216@news2.calgary.shaw.ca>...
- show quoted text -

Dear Tony,
The EDT is a consequence of the existence of a non-sound diffuse field. It is dependance of an asymmetrical absorption distribution on the room.
None reverberation time theoty treat this subject to exception of An improved reverberation formula (H.Arau-Puchades. Acustica (1988) Vol 65. p.163- 180).
And by other hand only we have the experiments realised by O'Keefe ( The influence of heigth/width ratio and side wall boxes on room. Acoustics measurements. Inst. of Acoustics, Manchester, October 1999.), who derived that EDT/RT ratio decrease as a function of the height to width ratio. For heigth to width ratios greater than 1.0, the EDT/RT ratio is perfectly efficient, or similars. If the height to width ratios les than 1 there is a degradation of the early decay time being possible in ahall with a RT = 2s to obatin an EDT 0.4 s shorter that RT in a low ceiling concert hall.To summarise, in a wide, flat room one can expected the EDT to be much shorter than the RT, EDT/RT ratios could be in the range of 70 to 80%. Also he investigated the effect of the absorption above EDT. As final conclusion obtained the EDT/RT ratio is shown to be proportional to the Height to width ratio and inversely proportional to average room absorption.
Now we will analyse it from the view point of the H.Arau (1988).
In this theory we have: EDT = RT/d, being d the factor dispersion, given in equation (34). Therefore: EDT/RT = 1/d. If d=1 then EDT = RT and therefore we have sound diffuse field.
The d factor was improved in equation (15) in the paper "General Theory of the Energy Relations in Halls with Asymmetrical Absorption.(1998) Higini Arau. Building Acoustics, Vol 5 number 3, p.163-183).
According to theory of H.Arau we have the EDT (there indicated Ti)is dependent in main proportion to the absorption distribution on the several surfaces and second therm to the geometrical relations, specially to the heigth/widht ratio.

We assume we have the following cases:
Hall 1: Long 40 m, Witdh = 20 m, Height = 12.5 m

Hall 2: Long 32 m, Witdh = 25 m, Height = 12.5 m
Hall 3: Long 25 m, Witdh = 15 m, Height = 26.66 m
Hall 4: Long 53.33 m, Witdh = 15 m, Height = 12.5 m
Hall 5: Long 50 m, Witdh = 50 m, Height = 8 m.
Hall 6: Long 24.3 m, Witdh = 15 m, Height = 24.3 m.
Hall 7: Long 24.3 m, Witdh = 24.3 m, Height = 15 m.
In all these cases the absorption are: Alfa foor: 0.8, Alfa ceiling: 0.09
alfa walls: 0.09. In these cases we have tried to obtain a mean free path lm similar.
The values calculated, for beta= -2, are:

| Case | H/W | L/W | RTSabine | RTArau | d | EDT/RT | lm | alfa mean |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.625 | 2 | 1.913 | 2.153 | 1.257 | 0.795 | 12.903 | 0.273 |
| 2 | 0.5 | 1.28 | 1.91 | 2.12 | 1.253 | 0.798 | 13.22 | 0.278 |
| 3 | 1.77 | 1.666 | 2.939 | 3.493 | 1.214 | 0.823 | 12.976 | 0.176 |
| 4 | 0.833 | 3.555 | 1.854 | 2.109 | 1.254 | 0.797 | 12.09 | 0.262 |
| 5 | 0.16 | 1 | 1.358 | 1.288 | 1.214 | 0.823 | 12.12 | 0.359 |
| 6 | 1.62 | 1.62 | 2.85 | 3.401 | 1.224 | 0.817 | 13.425 | 0.188 |
| 7 | 0.6173 | 1 | 2.161 | 2.49 | 1.252 | 0.794 | 13.425 | 0.249 |

Analysing these cases we have that:
When the EDT/RT ratio are increasing for high H/W ratio (case 3) or also for very smaller W/H ratio (case 5). In specially the case 6 have a golden proportion related by the fibonacci number. This case is good the EDT/RT ratio is higher. Many old churches of the temple have these proportions. And also is observed that when be greatest the area of maximum absorption (in thess cases the floor) will be shorter EDT/RT ratio.
What happens when the absorption is varied?
Analyse first the case 6 puting alfa walls = 0.20, alfa ceiling= 0.09, alfa floor= 0.80,(called case 66) and second changing again puting: alfa walls = 0.45, alfa ceiling= 0.09, alfa floor= 0.80 (called case 666).
And also the case 7 puting:alfa walls = 0.20, alfa ceiling= 0.09, alfa floor= 0.80 (called case 77) and second puting: alfa walls = 0.45, alfa ceiling= 0.09, alfa floor= 0.80 (called case 777)

| Case | H/W | L/W | RTSabine | RTArau | d | EDT/RT | lm | alfa mean |
|---|---|---|---|---|---|---|---|---|
| 6 | 1.62 | 1.62 | 2.85 | 3.401 | 1.224 | 0.817 | 13.425 | 0.188 |
| 66 | 1.62 | 1.62 | 2.011 | 1.845 | 1.114 | 0.817 | 13.425 | 0.188 |
| 666 | 1.62 | 1.62 | 1.205 | 0.909 | 1.007 | 0.993 | 13.425 | 0.449 |
| 7 | 0.6173 | 1 | 2.161 | 2.49 | 1.252 | 0.897 | 13.425 | 0.268 |
| 77 | 0.6173 | 1 | 1.741 | 1.565 | 1.127 | 0.887 | 13.425 | 0.310 |
| 777 | 0.6173 | 1 | 1.207 | 0.912 | 1.002 | 0.998 | 13.425 | 0.448 |

We see that when the absorption is adequatetely distributed on the surfaces of the hall the the EDT/RT ratio is noticieably improved.
Sincerely yours

Higini

For those who might be interested, here is a link to my paper quoted below:
http://www.aercoustics.com/papers/ioa99/ioa99.htm
I might also note that, although I have chosen to make the correlation between Height/Width Ratio and the EDT/RT ratio, that was only done so the concept could be easily understood by the rest of the world. For

those of us who understand how sound behaves in a room, I could have just as easily chosen a correlation between the ratio of Seat Absorption/Total Absorption vs EDT/RT ratio. My guess is that the latter of these two alternatives (i.e Sabs/Tabs vs EDT/RT ratio) is
**Higini arau Puchades**

John O'Keefe wrote:
> I might also note that, although I have chosen to make the correlation
> between Height/Width Ratio and the EDT/RT ratio, that was only done so
> the concept could be easily understood by the rest of the world. For
> those of us who understand how sound behaves in a room, I could have
> just as easily chosen a correlation between the ratio of Seat
> Absorption/Total Absorption vs EDT/RT ratio. My guess is that the
> latter of these two alternatives (i.e Sabs/Tabs vs EDT/RT ratio) is
> probably the more physically robust. This concept was part of the
> presentation in Manchester but I have not written anything about it yet.
>
> ... consider it an alt.sci.physics.acoustics scoop ;-)
>
> John O'Keefe

Hello John:

From my table of the six cases presented the other day, grouping only H/W ratio and EDT /RT ratio, in were the main absorption in all cases were concentrated in the floor, alfa = 0.8, and the mean chord of the halls are similars, we had:

| Case | H/W | EDT/RT |
|---|---|---|
| 1 | 0.625 | 0.795 |
| 2 | 0.5 | 0.798 |
| 3 | 1.77 | 0.823 |
| 4 | 0.833 | 0.797 |
| 5 | 0.16 | 0.823 |
| 6 | 1.62 | 0.817 |
| 7 | 0.6173 | 0.794 |

Now writing the same H/W ratio from less to higher values of H/W, we obtain:

| Case | H/W | EDT/RT |
|---|---|---|
| 5 | 0.16 | 0.823 |
| 2 | 0.5 | 0.798 |
| 7 | 0.6173 | 0.794 |
| 1 | 0.625 | 0.795 |
| 4 | 0.833 | 0.797 |
| 6 | 1.62 | 0.817 |
| 3 | 1.77 | 0.823 |

If were posible to draw it, puting H/W ratio in abscises and EDT/RT ratio in ordinates,we would look a curve, that for very low values of H/W we obtain a high value of EDT/RT ratio, increasing the value of H/W then the EDT/RT values are decreasing until a minimum value, after of this minimum, increasing H/W the EDT/RT values obtained are increased.
What physical explanation have it? I will try say something about it:
I believe that the EDT is strong dependent with existance of early reflections.
In the case 5 I have a room where the fraction of the walls with relation to the total area surfaces is very small, being in this case

the ceiling fraction is very important. In this case the main early reflections only are given by the ceiling because the wall reflections produced are very weak due that the walls are very few influence. When the H/W is increased then the early reflections due to the presence of the walls are increased looking for a equilibrim with the early reflections produced by ceiling. When the early reflections produced by walls are similar to the ceiling reflections produced, or that the area fractions are similars, then we obtain the mínimum of EDT/RT. Following if the fraction area ceiling is disminished in proportion to the walls fraction, then the early reflections of the walls are very important, more than those produced by ceiling, and in consequence the EDT/RT ratio is increased.

Now I will realise other correlation, you say "a correlation between the ratio of Seat Absorption/Total Absorption vs EDT/RT ratio". In my cases the area seats is the floor. Now I realise the following ratio: (SA / TA), where are,
Seat absorption (SA) = Floor area x alfa floor, being Total Absorption (TA) = Overall Area surfaces x alfa mean. In the next table I write (SA / TA) related with the EDT /RT values is obtained:

| Case | (SA/TA) | EDT/RT |
|---|---|---|
| 1 | 0.756 | 0.795 |
| 2 | 0.761 | 0.798 |
| 3 | 0.553 | 0.823 |
| 4 | 0.738 | 0.797 |
| 5 | 0.960 | 0.823 |
| 6 | 0.587 | 0.817 |
| 7 | 0.718 | 0.794 |

Now writing the same (SA/TA) ratio from less to higher values, we obtain:

| Case | (SA/TA) | EDT/RT |
|---|---|---|
| 3 | 0.553 | 0.823 |
| 6 | 0.587 | 0.817 |
| 7 | 0.718 | 0.794 |
| 4 | 0.738 | 0.797 |
| 1 | 0.756 | 0.795 |
| 2 | 0.761 | 0.798 |
| 5 | 0.960 | 0.823 |

Now, I do not know what conclusion I must to obtain with these values.

Regards

Higini