Proceedings of the Institute of Acoustics

The Prediction of Clay Target Shooting Noise.

J.P. Seller

School of Engineering Systems & Design
South Bank University, London.

1. INTRODUCTION

The object is to accurately predict the shooting noise level at any location arising from a clay target shoot under various wind conditions and over real terrain.

Some of the important factors that affect the level of noise arriving at the reception point and which are included in the current procedure:

- the direction of shooting,
- the propagational distance between source and receiver,
- wind direction,
- air absorption,
- source height that is an estimation of the average muzzle height at the moment of discharge which depends on the discipline being shot,
- barriers both natural (hills and ridges) and artificial (fences and berms),
- allowance has to be made for the effect of multiple barriers

Other factors which have not yet been included are:

- air turbulence
- wind speed

2. THE MODEL

The current model gives a reasonable prediction of the noise level compared to actual measurement.

It takes some time to do a prediction and put the data in but if one wishes to model reality then detail is required. This prediction procedure can produce a reasonable result, however this may have been achieved by various errors cancelling one an other out.

THE PREDICTION OF CLAY TARGET SHOOTING NOISE

Thus the procedure needs be thoroughly tested at a number of other sites before any definite conclusion can be reached.

The direction of shooting is currently dealt with by predicting the levels forward of the guns, to the side and to the rear. The correction is currently incorporated into the basic noise levels effectively in terms of a directive index.

The wind direction correction is unsophisticated at present and allows for either a light wind or calm conditions.

The air absorption attenuation is directly proportional to the propagational distance.

Source height — the discipline being shot has to be considered. For skeet, a height of 1.75 m is used whilst 2.4 m is used for sporting.

The distance correction uses the standard inverse square law.

Mean propagational height is estimated from the ground profile. A "Pathfinder Ordnance Survey" map is enlarged see figure 1 and then a profile from source to reception point is constructed see figure 2. This is helpful in entering the basic data and the mean propagational height can be roughly estimated by eye or by measuring the height at a number of equally spaced points and then averaging them.

The spread sheet requires the actual heights of source, reception and barrier; together with the corresponding contour height obtained from the ordnance survey map. A copy of the computer spread sheet is given in table 1. The bold numbers in the tint panels were those numbers that had to be entered.

The bund or barrier attenuation is evaluated using the standard Fresnel number procedure which requires the calculation of the path difference. The path difference is that extra distance that the sound will have to take to go over/round the barrier compared to the straight through distance see figure 3. 500 Hz has been selected since shotgun has a peak in the spectrum in the range 400 to 1250 Hz.

The multiple attenuation calculation procedure is given at the end of this paper. Consider figure 4 the second barrier is relatively close to the first and at a lower height even though it is a taller barrier. It is obvious that this second barrier lies in the shadow of the first and will provide hardly any additional attenuation. Whilst in figure 5 the barriers are well separated and the combined attenuation will give an extra 3dB. (remember that 3dB corresponds to a doubling/halving of the energy - and that because noise levels are calculated logarithmically you do not add to the first reduction of 12 dB another reduction of 12 dB due to the second barrier).

3. RESULTS

In a recent case I had in my evidence predicted the shooting noise level at various locations. During the case there was a test shoot and the results from this are given.

Sporting to Wayside		
Wind direction	Predicted Level	Measured Level
	(dB)	(dB)
SW	73	
calm	68	
NE	63	63

Skeet to Wayside		
Wind direction	Predicted Level	Measured Level
	(dB)	(dB)
SW	73	
calm	68	
NE	63	61

Olympic Trap to Serge Hill		
Wind direction	Predicted Level	Measured Level
	(dB)	(dB)
SW	57	
calm	62	
NE	67	72

Sporting to Serge Hill		
Wind direction	Predicted Level	Measured Level
	(dB)	(dB)
SW	53	
calm	58	
NE	63	67

Prediction of Clay Target Shooting noise.					
Sporting to Wayside					
Along section A:B					
source ht	2.4	a1	11.11575	trig source	98
bar1 ht	2	b1	238.5541	trig bar1	100
bar2 ht	3	c1	249.4306	trig bar2	97.5
rec ht	1.75	path diff 1	.2392661	trig receiver	84
source-bar1	11				
bar1-bar2	43	a2	54.00009		
bar2-rec	195	b2	195.5571		
		c2	249.4306		
		path diff 2	.1265529		
Frequency	500	wavelenght	.686		
		Fresnel1	.698	Thus Bar1 attn	12.5
		Fresnel2	.369	Thus Bar2 attn	10.6
Multi Bar corn .6446400					
		Tot Bar Attn	13.5		
		Air Attn	1.245		
mean prop. ht	1.75	ground abs	-4.5		
		Inv sq Law	13.1		
		Total Attn	32.3		
L1	105	L'1 (forw'd)	72.7	L'1 (f+l wind)	77.7
L2	100	L'2 (side)	67.7	L'2 (s+l wind)	72.7
L3	95	L'3 (rear)	62.7	L'3 (r+l wind)	67.7
				L'1 (f-l wind)	67.7
				L'2 (s-l wind)	62.7
Assessment				L'3 (r-l wind)	57.7
with SW	***73 dB***				
calm	***68 dB***				
with NE	***63 dB***				

Care has to be exercised in not double counting both the barrier and the ground . For instance if the source, barrier and reception are on different contour lines and each has a different height.

It is **completely incorrect** to calculate a path difference for the barrier (assuming horizontal ground) and hence an attenuation for the barrier), then to calculate a path difference for the contours and its corresponding attenuation and simply add the two together to obtain the combined attenuation.

I calculate only one path difference for the actuality and subsequently one attenuation for the complete situation.

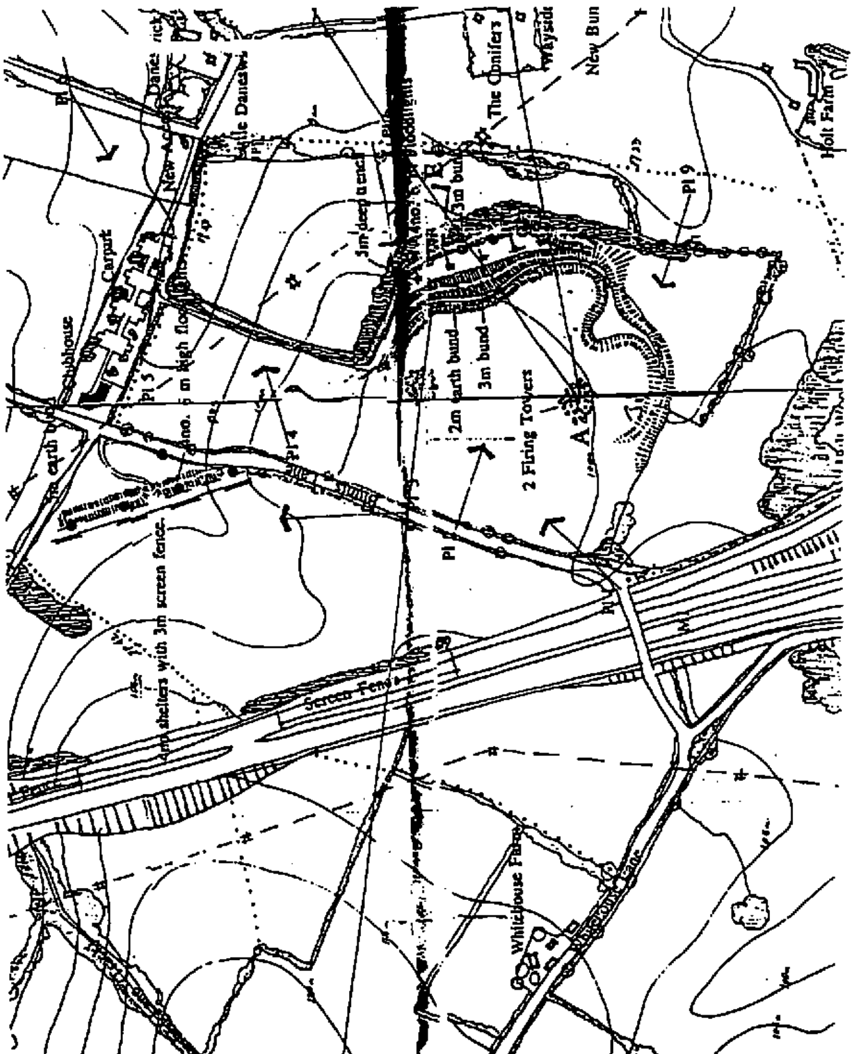

Carpark
2 Firing Towers
2m earth bund
3m bund
4m shelters with 3m screen fence.
Screen Fence
The Conifers
Holt Farm
Wellfield Spring
Pl 9

Figure 1

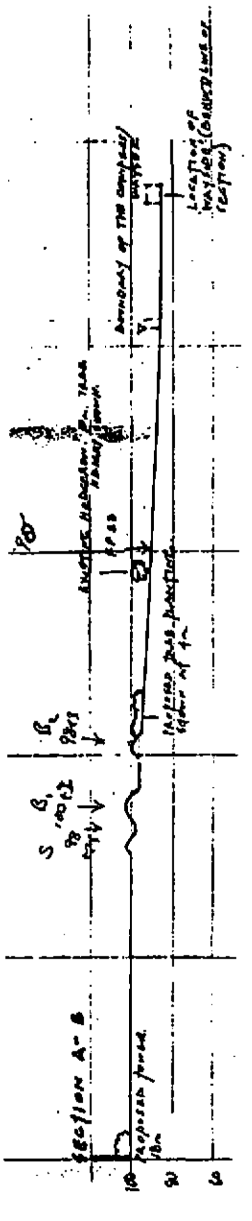


Figure 2

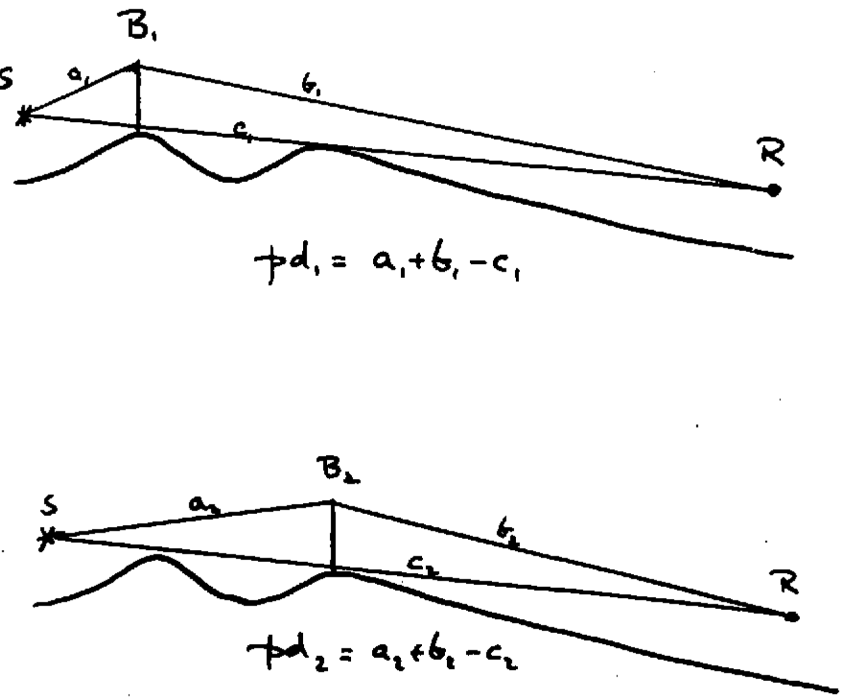


Figure 3

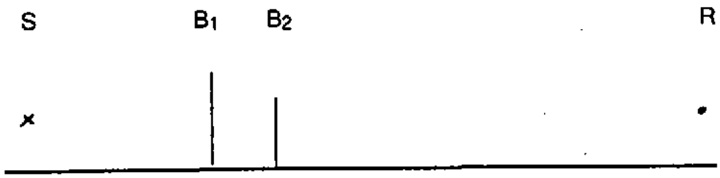
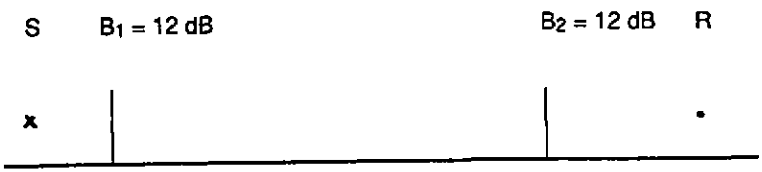


Figure 4



Total attenuation = 15 dB

Figure 5

BARRIER

The Fresnel Number is given by:

$$N = \frac{2\,(a+b-c)}{\lambda}$$

where a + b - c is the path difference and λ is the wavelength.

Multiple Barrier

Procedure for calculating the combined effect of two barriers

1) Calculate the attenuation of each barrier separately.

2) The barrier that affords the greater attenuation shall be designated A_1, the other A_2

3) Evaluate the correction d

$$d = \left(\frac{x_2}{x_1 + x_2 + x_3}\right)^{0.25}$$

where x_1 is the distance from source to barrier 1

x_2 is the distance from first to second barrier

x_3 is the distance from second barrier to receiver.

The combined attenuation A_t is given by

$$A_t = 10\,lg\left(10^{A_1/10} + 10^{d.A_2/10}\right) \quad dB$$