VHF FIELD STRENGTH MEASUREMENTS IN MOUNTAINOUS TERRAIN-A STUDY OF REFLECTION EFFECTS

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Effects of reflection on the field strength of very high frequency radio-waves in mountainous terrain have been studied.

Experiments on diffraction paths in mountainous area were made at 126 Mc/s by varying antenna height from 1·8 m to 3·57 m for both vertically and horizontally polarised waves.

The results showed no significant reflection effects as there were no maxima and minima in received field strength with variation of antenna height.

It has been concluded that reflection effects can be neglected for many practical purposes of communication over short distances in mountainous terrain area having considerable vegetation over the path.

In very high frequency (VHF) wave propagation, the effective field strength of the radio wave at a receiving antenna due to a transmitting antenna is the vector sum of the direct and reflected waves. There may be many reflected waves due to ground and neighbouring objects, which may cause increase in or cancellation of the direct ray. When all the different rays reaching the receiving antenna add in phase, maximum field strength is obtained. The relative phases of these rays change with variation of antenna height and give rise to maxima and minima. A study of the maxima and minima of the field can give an idea of the presence or absence of reflected fields and their magnitudes. A proper understanding of these reflection for the particular terrain and surroundings is very important in field strength measurements. Foreground terrain effects are usually taken into account for diffraction paths by four-ray theory of Schelling, Burrows and Ferrel in which reflections from foreground are postulated. The interest of present study is to know how these reflections affect measurements of field strength on practical paths.

EXPERIMENTAL

Field strength measurements were made for different antenna heights on four propagation paths within a distance of 2 Km in mountainous terrain typical of Landour Cantonment area (Fig. 1). Transmissions on 126 Mc/s with horizontally and vertically polarised waves were made from field points using the SCR 522 transmitter and quarter wave ground plane antenna. The paths are the diffracted ones due to presence of intervening obstacles and are described elsewhere[1]. The paths also have vegetation predominant all over the path (Fig. 1). The diffraction field was measured at DRL (now PFRS), Landour Cantonment using a calibrated receiver which is crystal controlled and is part of the SCR 522 transreceiver[2]. The receiving antenna was a quarter wave ground plane antenna and was kept 10m

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above the ground. Three scattered transmission points within 15 to 30m of the transmitting location (denoted by A, B and C) were selected and in each case the height of transmitting antenna was varied between 1·8m and 3·57m at $\lambda/4$ intervals starting from the highest one (heights denoted by suffixes 1, 2, 3 and 4). $\lambda/4$ intervals are taken as rough guide for regular change of phases of the different rays. The field strengths measured are shown in Tables 1 to 4. The measurements are spot readings and statistical influences are negligible on such short distance paths. The results are to be mainly taken as qualitative to indicate as to how the two polarisations differ for a given type of antenna; antenna pattern differences for the two polarisations not being taken into account or neglected.

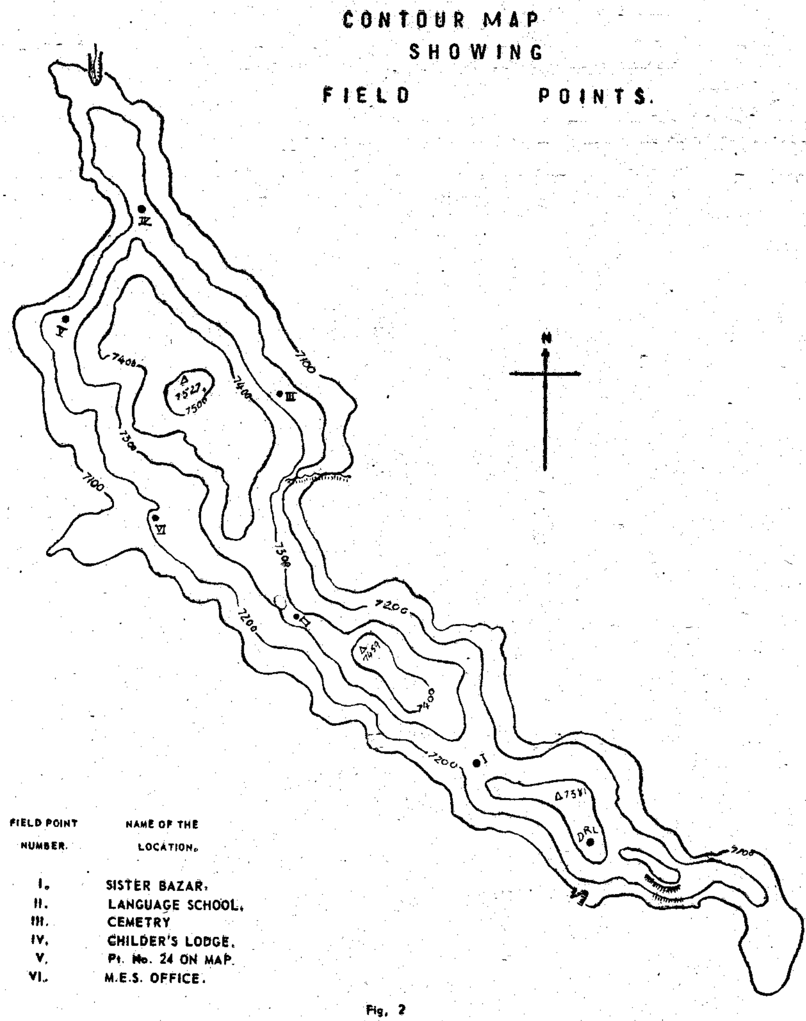

Fig. 1

TABLE 1

MEASURED FIELD STRENGTH FOR 765m DISTANCE BETWEEN TRANSMITTER AND RECEIVER

Communication path	DRL to Language School, Landour Cantonment.
Distance between transmitter and receiver	765 m.
Distance between transmitter and obstacle	605 m.
Distance between receiver and obstacle	160 m.
Height of the obstacle above T-R line	34·5 m.

Transmitting point		Received field in DBU	
Pt. No.	Height of the antenna from ground	Vertical Polarisation	Horizontal Polarisation
A1	3·57 m.	66·0	74·0
A2	2·98 m.	68·0	75·5
A3	2·39 m.	58·0	80·0
A4	1·80 m.	40·0	78·0
B1	3·57 m.	66·0	75·5
B2	2·98 m.	61·5	75·5
B3	2·39 m.	66·0	70·0
B4	1·80 m.	66·0	74·0

DISCUSSIONS

It can be seen from the tabulated results that there are no significant maxima and minima with changes in antenna height for both vertically as well as horizontally polarised waves indicating no significant reflections. In both the cases, propagation is governed by space waves as the transmitting and the receiving antennas are sufficiently high from the ground in comparison with wave length and ground waves do not have any contributing effect[3]. The observations also indicate that higher the receiving antenna from the ground, more is the received field and the figures give an approximate idea of the height gain factors. This can be explained as partly due to the fact that the effective height of the obstacle becomes less as the antenna is raised giving more diffracted field and partly because of less influence of surroundings with increase in height.

TABLE 2

MEASURED FIELD STRENGTH FOR 1560m DISTANCE BETWEEN TRANSMITTER AND RECEIVER

Communication path	DRL to Pt. 24 on Landour Cantonment Map.
Distance between transmitter and receiver	1560 m.
Distance between transmitter and obstacle	1400 m.
Distance between receiver and obstacle	160 m.
Height of the obstacle above T — R line	63 m.

Transmitting point		Received field in DBU	
Pt. No.	Height of the antenna from ground	Vertical Polarisation	Horizontal Polarisation
A1	3·57 m.	28·5	42·0
A2	2·98 m.	28·5	42·0
A3	2·39 m.	28·5	41·0
A4	1·80 m.	29·5	40.0
B1	3·57 m.	33·5	34·5
B2	2·98 m.	29·5	32·5
B3	2·39 m.	28·0	32·5
B4	1·80 m.	26·5	32·0
C1	3·57 m.	38·5	52·0
C2	2·98 m.	39·0	42·5
C3	2·39 m.	39·5	42·5
C4	1·80 m.	40·0	42·0

It can also be seen that certain cases are exceptions, such as point A (Table 1) and point C (Table 4), where higher fields are obtained for lower heights. These are probably explained by interference effects. Also at point B (Table 1) and point A (Table 4) we find that higher the antenna, less is the field and this effect can be caused by metal tops of nearby buildings and trees coming closer as the antenna is raised. Considerable absorption due to buildings and trees is reported in literature, however quantitative figures are either not readily available or are vague[4,5] for the present application.

TABLE 3

MEASURED FIELD STRENGTH FOR 280 m DISTANCE BETWEEN TRANSMITTER AND RECEIVER

Communication path	DRL to Sister Bazar, Landour Cantonment.
Distance between transmitter and receiver	280 m.
Distance between transmitter and obstacle	198 m.
Distance between receiver and obstacle	82 m.
Height of the obstacle above T-R line	0 m.

Transmitting point		Received field in DBU	
Pt. No.	Height of the antenna from ground	Vertical Polarisation	Horizontal Polarisation
A1	3·57 m.	87·5	83·5
A2	2·98 m.	87·5	82·5
A3	2·39 m.	86·0	80·0
A4	1·80 m.	84·5	75·5
B1	3·57 m.	89·0	84·5
B2	2·99 m.	86·0	82·5
B3	2·39 m.	82·5	80·0
B4	1·80 m.	78·0	82·5
C1	3·57 m.	84·5	80·0
C2	2·98 m.	84·5	80·0
C3	2·39 m.	82·5	80·0
C4	1·80 m.	82·5	82·5

It is also observed that horizontally polarised waves are less sensitive to height variations in as much as they provide almost the same signal strength even at the lowest height. At low antenna heights, horizontally polarized waves provide considerably stronger field than vertically polarised ones, the reasons for which have been discussed by the authors elsewhere[1]. DRL-Sister Bazar path (Table 3) is an exception where the vertically polarised waves provide higher field strengths. This point falls just into the shadow zone and also has less vegetation over the path. Under such cases it can be said that there is not much difference between the two polarisations except that vertically polarised waves give slightly better field strengths.

TABLE 4

MEASURED FIELD STRENGTH FOR 1170 m. DISTANCE BETWEEN TRANSMITTER AND RECEIVER

Communication path	DRL to MES office; Landour Cantonment
Distance between transmitter and receiver	1170 m.
Distance between transmitter and obstacle	542 m.
Distance between receiver and obstacle	628 m.
Height of the obstacle above T.R. line	14·3 m.

Transmitting point		Received field in DBU	
Pt. No	Height of the antenna from ground	Vertical Polarisation	Horizontal Polarisation
A1	3·57 m.	40·0	42·0
A2	2·98 m.	40·0	43·5
A3	2·39 m.	40·0	55·5
A4	1·80 m.	54·5	74·5
B1	3·57 m.	70·0	74·0
B2	2·98 m.	70·0	74·0
B3	2·39 m.	63·5	74·0
B4	1·80 m.	54·5	74·0
C1	3·57 m.	60·0	78·0
C2	2·98 m.	69·0	80·0
C3	2·39 m.	63·5	80·0
C4	1·80 m.	41·0	78·0

CONCLUSIONS

From the discussions, it suggests that the reflected rays usually contribute very little to the resultant field strength and can be neglected for many practical purposes for communication work on diffraction paths in mountainous areas typical of Landour Cantonment area with predominant vegetation over the path. However foreg round terrain effects are still taken into account by considering reflections from the terrain[6].

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