551·591 : 551·577 (547·1)

ON VISIBILITY AT BOMBAY AIRPORT UNDER DIFFERENT PRECIPITATION CONDITIONS

The advent of air navigation has given special importance to visibility as a weather element. Visibility is the greatest distance towards the horizon at which prominent objects such as mountains, buildings, towers etc can be seen and identified by unaided eyes. This distance depends upon the clearness of the air and is modified by the presence of haze, dust, smoke, fog, rain and snow. The changes due to rain are quite common over most parts of the country during the monsoon season. The observatories which are not provided with suitable visibility meters usually report visibility in rain on the basis of intensity of the rain. According to the India Meteorological Department instructions issued to such observatories, visibility should be reported as 200 or 500 metres in very heavy rain, 1000 metres in heavy rain, 2000 metres in moderate to heavy rain, 4000 metres in moderate rain and as 10,000 metres in light rain. The terms "very heavy", "heavy" etc have not, however, been quantitatively defined. With a view to finding out approximately the intensity of rain that reduces visibility at Bombay airport to the above limits, the authors arranged to record visibility observations at this station under different precipitation intensities during the monsoon season of 1961. The results of analysis of the data are presented and discussed. The various practical difficulties experienced in recording the observations have also been briefly mentioned and these may be of some interest to other workers who may like to undertake a similar study in future.

Rainfall and Visibility observations—There is a Bibby type rainfall intensity recorder at the meteorological office at Bombay airport and this instrument registers rainfall intensity averaged over three minutes. Arrangements were made to record visibility observations with the help of the available landmarks when the above instrument recorded rainfall intensity of 0·5 inch per hour or more. The deterioration in visibility caused by lighter rain is small and, therefore, not so significant from the aviation point of view. In all, about 160 observations were taken for this study.

Analysis and discussion of the data—The analysed data are shown in Table 1. It will be seen from this table that for the same rainfall intensity range, the visibility data sometimes varied appreciably particularly when the rainfall was light. For instance, when the rainfall intensity range was 0·50—0·75 inch/hr, the maximum visibility was 5 km while the minimum visibility was only 1·2 km. For the higher range of 1·76—2·00 inches/hr, the maximum and minimum values of visibility were 2·0 and 0·5 km respectively. It is well known that the monsoon showers along the west coast are often of localised nature. If this fact is taken into account, the large variability of the visibility observations can be partly explained. The spatial variation in the rainfall intensity is also another contributory factor. Instances of occurrence of a shower at a particular locality with little or no rain in the immediate neighbouring areas are quite

common in Bombay in the monsoon season. Visibility in such showers is not likely to be so poor as on occasions when the showers are simultaneous and distributed over a wide area. According to Rai Sircar and Hariharan (1954), the area coverage of heavier rainfall is ordinarily larger. This perhaps partly accounts for the less scatteredness of the visibility data in precipitation of higher intensity.

The duration of a shower also gives some rough indication about its spatial coverage. The showers from Cumulus cells ordinarily last for a short period whereas those from Cumulonimbus clouds may continue for an hour or even more. The area receiving precipitation is much larger in the second case. It is also well-known that rain from Altostratus and Nimbostratus clouds is usually of persisting type and covers a large area; therefore, for the same precipitation intensity, visibility is expected to be poorer in rain or showers of larger duration. This aspect also appears to be supported by this study. The durations of showers or rain in which the visibility observations were taken were determined from the charts of the rainfall recorder used. Table 2 contains the mean durations of showers corresponding to visibility values greater or less than the mean visibility value in each row of Table 1. For instance, the mean of all the visibility data considered in the second row of Table 1 is 2·3 km. All showers considered in this row were divided into two categories on the basis of visibility taken in them being $>$ or $\leqslant$ 2·3 km. It is seen that the mean duration of the showers of the first category was only 10 minutes whereas that of the second category was much longer, namely, 37 minutes. The same feature is also generally noticed in respect of the showers considered in the other rows of Table 1. The durations of 160 and 47 minutes in the last column of Table 2 are based on a few observations only and, therefore, may not be quite representative.

In order to make a rough estimate of the precipitation intensity that reduces visibility

TABLE 1

Visibility values under different precipitation intensities

Intensity of ppt/hr (inches)	No. of obsn.	Mean visibility (km)	Mean deviation (km)	Max. visibility (km)	Min. visibility (km)
0·50—0·75	69	2·8	0·7	5·0	1·2
0·76—1·00	21	2·3	0·7	4·0	0·8
1·01—1·25	14	2·1	0·3	3·5	1·0
1·26—1·50	20	2·0	0·8	3·0	0·7
1·51—1·75	11	1·7	0·6	2·5	0·5
1·76—2·00	11	1·1	0·3	2·0	0·5
2·01—2·25	6	1·2	0·2	1·6	0·8
2·26—2·50	6	1·0	0·4	2·0	0·5

TABLE 2

Mean duration of precipitation corresponding to visibility values $>$ or $\leqslant$ the mean visibility values as shown in Table 1

Row No. in Table 1	1	2	3	4
Visibility (km)	$>2·8$ $\leqslant 2·8$	$>2·3$ $\leqslant 2·3$	$>2·1$ $\leqslant 2·1$	$>2·0$ $\leqslant 2·0$
Duration of precipitation (min.)	12 15	10 37	20 23	31 42
Row No. in Table 1	5	6	7	8
Visibility (km)	$>1·7$ $\leqslant 1·7$	$>1·1$ $\leqslant 1·1$	$>1·2$ $\leqslant 1·2$	$>1·0$ $\leqslant 1·0$
Duration of precipitation (min.)	30 67	40 77	54 80	160 47

TABLE 3

Visibility and corresponding precipitation intensity

Visibility (km)	Precipitation (inch/hr)
0·2	4·1
0·5	3·2
1·0	2·3
2·0	1·25
3·0	0·6
4·0	0·25

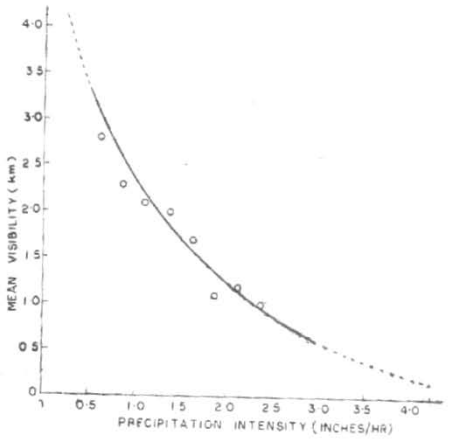

Fig. 1

to 0·2, 0·5, 1·0, 2·0, 3·0 and 4·0 km as mentioned earlier, the mean visibility values in Table 1 were plotted against the corresponding precipitation intensities and the curve is shown in Fig. 1. From this curve, the precipitation intensities corresponding to the above visibility limits have been picked up and shown in Table 3. The values may, however, somewhat differ from place to place depending on the local peculiarities.

In some cases considerable practical difficulty was experienced in recording the visibility observations properly due to quick variation in the precipitation intensity. As mentioned before, the instrument used records precipitation intensity averaged over three minutes. Even during this short period, visibility sometimes changed appreciably due to change in the precipitation intensity. In such cases, mean of the highest and lowest visibility during the three-minute interval was taken as far as possible. For a study of this kind it is also desirable to have more visibility landmarks at shorter intervals in all the different directions so that the visibility observations could always be taken in the direction of the approaching or receding showers. The error arising from spatial variation in the precipitation intensity will, however, continue and at times this may be appreciable.

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