

# A Technical Visit to the Meteorological Station at Bayan Lepas Penang Airport

TECHNICAL COMMITTEE ON WIND LOADING, IEM



by Ir. Prof. Dr. Jeffrey Chiang Choong Luin

A team of four members of the IEM Technical Committee on Wind Loading, namely Ir. Prof. Dr. Jeffrey Chiang, Ir. Tu Yong Eng, Engr. Prof. Dr. Azmi Ibrahim and Mr. Kang Thean Shong, recently participated in a technical visit to the Meteorological Office and Station at Bayan Lepas, Penang Airport. The Technical Committee (TC) members boarded the 50-minute domestic flight at the old Subang Airport at 10.30 a.m. The visit was made possible through the kind arrangement of Mr. Kang, the Director of the Malaysian Meteorological Department (MMD) who is based in the Headquarters of MMD located in Petaling Jaya, and who is in charge of Commercial operations, Climatology and Hydrology.

The TC members arrived at the Bayan Lepas Airport and were brought to the MMD station which was adjacent to the new wing of the refurbished airport. Interestingly, the MMD office is only 50 metres away from the tarmac, where the TC members had disembarked from the Firefly propeller-driven airplane. Theoretically, the TC members could just walk over to the station from the airplane. However, in order to adhere to the security clearance procedure, all passengers were directed to go into the terminal, and exit via the designated checkpoints.

The delegation was welcomed into the MMD station by the Office Director, Mr. Loh Eng Kee. Both Mr. Loh and Mr. Kang are experienced MMD officers and were able to give an overall briefing on the operations of the station, in terms of its functions and its role in providing up-to-date and reliable weather forecast to the aviation sector, media and government agencies, and as and when required for public knowledge. The department also plays a role in providing an early detection and warning system for tsunamis originating from the northern part of Sumatra and the Andaman Sea.

Consequently, the discussion revolved around wind directions, and the typical movement of typhoons which develop off the South China Sea or Pacific Ocean and which normally move up northwards towards the southern China coast, Hong Kong and Taiwan. In one of the rare cases which occurred at the end of 2001, a tropical storm, Vamei, formed over the South China Sea east of the Johor coastline, and moved westwards over the southern peninsula of Malaysia to the Straits of Malacca, causing fairly widespread damage along its track.

After the welcoming lunch, Mr. Loh proceeded to offer a first-hand tour of the station facility, in particular the measuring anemometer instruments within the vicinity of

the station. In addition to that, the visitors were also taken on a tour of the single-storey annex, where the computerised instruments to record measured wind speeds were installed. The measurement of wind speeds would all be automatically captured and then sent electronically to the main MMD Headquarters in Petaling Jaya. As in most parts of Malaysia, excessive wind speeds could cause damage to weak structures, while thunderstorm downbursts could uproot trees. However, it is most difficult to obtain accurate wind speed profiling in a thunderstorm condition.

This visit aims to provide the TC members a first-hand look of the layout of typical wind speed measuring instruments in MMD stations located along the coastal zone in Peninsular Malaysia. The two previously organised visits to MMD were inland visits, namely to the old Subang Airport and Cameron Highlands.

Following are some of the common definitions related to the measurement of wind speed:

Basic wind speed is defined as the mean hourly wind speed with an annual risk of exceedance of 0.02, or having an annual return period of  $1/0.02 = 50$  years irrespective of wind direction, at 10m above flat open terrain at sea level which extends at least 100km in all directions. There are a number of equivalent ways to interpret this value of risk. It could be interpreted as:

- i. A 1 in 50 chance of exceedance in any one year;
- ii. A mean recurrence interval of 50 years; or
- iii. A 63% chance of exceedance in any 50-year period.

The above risk caters for normal building structures, whereas critical structures such as nuclear plants are designed to a much smaller risk, i.e.  $10^{-4}$ , or a mean recurrence interval of 10,000 years.

The other measured wind speed is the site's wind speed, which is an intermediate value of wind speed that was introduced to separate the factors dependent on local climate from other factors. It represents the mean hourly wind speed 10m above ground level at the site with the desired annual risk of exceedance.

The current MS1553:2002 prescribed the 3-second gust wind speeds, which is suitable for Malaysia due to its frequent thunderstorm winds. Wind is measured in both sustained wind speeds, and 3-second gusts. When an announced weather report states, "Winds out of the southwest at 40 km/h with gusts of up to 64 km/h", the 40 km/h is the sustained wind speed, and the 64 km/h velocity is a measured 3-second gust. Both 3-second gust wind

speeds and sustained wind speeds are used as input variables for building construction codes, especially in areas where buildings have to withstand strong winds such as hurricanes.

Structural engineers in Malaysia are expected to refer to MS1553:2002 to ascertain the design wind speed which in turn will lead to a design wind pressure to be applied as wind loading or actions against the building structure being designed. This standard is an adoption of the Australian and New Zealand Standard AS1170.2 – 2002 on wind loads.

In the Malaysian Standard for wind loads, basic wind speeds for selected stations in Peninsular Malaysia are provided as a reference. Besides this, a geographic map of Peninsular Malaysia is also included, in which two reference wind speed zones are identified. The surrounding coastal areas (up to 50km inland) are accorded a zonal wind speed of 32 m/s (or 115 km/h), while the inland areas, consisting of mountain ranges are tagged with a wind speed of 33 m/s (or 119 km/h). The reference wind speed in the geographic map is used in the simplified method in determining the wind loads.

At the moment, the standard is up for a review, and changes are expected, not only in putting in the necessary amendments, in line with various changes made to the latest revision of AS1170.2, but also the basic wind speeds as presented for the various wind speed stations.

In MS1553:2002, the design wind pressure,  $p$  (measured in  $N/m^2$ ), is determined for structures and parts of structures using the following equation:

$$p = (0.5 \rho_{air}) [V_{des}^*]^2 C_{fig} C_{dyn}$$

where

- $V_{des}$  = building design wind speed, which takes into account importance factor
- $C_{fig}$  = aerodynamic shape factor
- $C_{dyn}$  = dynamic response factor
- $\rho_{air}$  = density of air which can be taken as  $1.225 \text{ kg/m}^3$

The problem faced by the TC on Wind Loading is the determination of wind speed profiles from wind speed measuring stations. It was fortunate that the MMD station in Bayan Lepas on the day of the visit was able to demonstrate the release of a wind station balloon at 2.00 p.m. A fixed theodolite at the designated position was used to pinpoint the exact location of the released balloon at time intervals. The following table offers an indication of the measured wind speed at increasing heights from the time the balloon was released:

Table 1: Measured wind speed profile

Height of released balloon, ft (m)	Measured wind speed, knots (m/s)
1000 (303)	4 (2)
2000 (606)	7 (3.5)
3000 (909)	5 (2.5)
4000 (1333)	8 (4)

The results from Table 1 show that the profile is quite haphazard and irregular.



*A theodolite equipment (in front) was on standby to record positions of a released balloon filled with helium, which was released to measure wind speed. In the background, a plane can be seen landing on the runway of Bayan Lepas Airport*

*Table 2: Typical wind speeds [Source: MS1553:2002]*

Town	Wind speed (m/s) at 50-year return period
Alor Setar	29.9
Bayan Lepas	27.5
Cameron Highland	26.8
Ipoh	33.5
Kuantan	29.8
Kota Bahru	32.4



*Ir. Prof. Dr J Chiang presenting a token of appreciation to the MMD station Director, Mr. Loh Eng Kee, on behalf of the IEM delegation (From left to right: Assoc. Prof. Dr Azmi Ibrahim, Ir. Tu Yong Eng, Ir. Prof. Dr J Chiang, Mr. Loh Eng Kee and Mr. Kang Thean Shong)*

The published typical wind speeds for selected stations at Bayan Lepas and other northern stations are indicated in Table 2.

Towards the end of the on-site briefing and tour, Mr. Loh Eng Kee treated the visitors to a sumptuous dinner at a nearby famous Penang nasi kandar restaurant. At the end of the visit, the head of the delegation, Ir. Prof. Dr Jeffrey Chiang thanked the gracious host for the kind hospitality extended to the IEM delegation, and presented a souvenir to Mr. Loh for his detailed briefing and explanation to the visitors. Finally, the delegation departed from the station just in time to catch the last flight back to Subang Airport at 9:30 p.m. ■