

# The collapse of table formworks at a construction site - a case study

by Dr Goh Yang Miang, Yee Yew Seng, Er. Liau Wai Kun and Jonathan Tan, Health and Safety Engineering Technical Committee, IES

Twenty-four table formworks collapsed at a construction worksite in a coastal area in Singapore, on 3 August 2016. Fortunately, no one was injured as a result of the collapse. The Ministry of Manpower was notified of the incident.

One of the parties involved in the project felt the need to share the lessons learned, so as to prevent similar incidents in the future. Accordingly, they invited members of the Health and Safety Engineering Technical Committee of IES to visit the site and learn about the incident.

This article highlights the risk of table formwork collapsing, especially in windy areas. If applicable, designers and contractors should identify this hazard in their design risk review and risk assessment, and implement the relevant risk controls to prevent such incidents from happening in their projects.

## Background

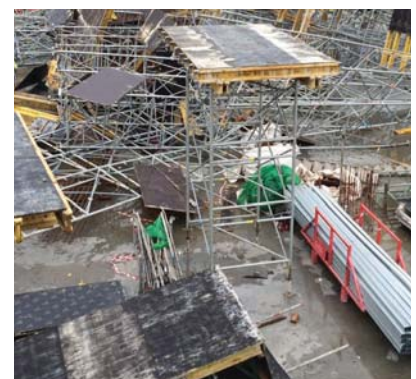
The building under construction was more than 40 m tall at the point of the incident. On the night of 2 August 2016, a total of 27 formworks were lifted and stored on the top level of the building, to facilitate dismantling during the following day shift.

According to site personnel, the table formworks could not be stored on the lower levels, due to site constraints. Each of the table formworks was about 10.2 m tall. The lifting was completed at about 5 am on 3 August 2016, the day of the incident, after which, the night shift workers ended their shift. At about 5.50 am, the workers found that 24 of the formworks had collapsed. Workers reported strong winds, prior to the collapse. This was corroborated by the meteorological report on wind speeds in the vicinity, between 5 am and 6 am on 3 August 2016.

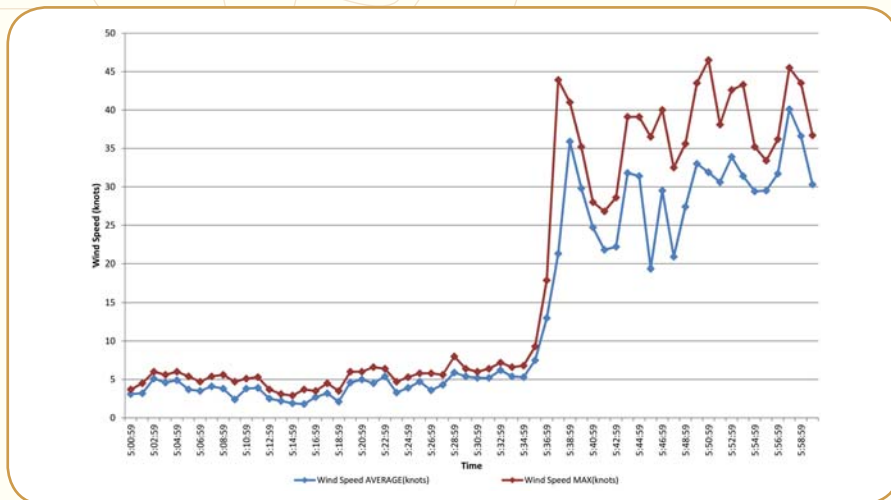
## The cause of the incident

Based on observations from the site visit and the photos provided, the formworks seemed to have collapsed in the same direction. At the same time, the formwork bracings and base plates seemed to have remained largely intact and damage was probably due to the collapse.

Based on the information supplied by the site personnel, strong winds appeared to be the most likely direct



The scene of the incident on the morning of 3 August 2016



Wind speeds between 5 am and 6 am

cause of the collapse. The meteorological report showed that the maximum wind speed near the worksite, between 5.50 am and 6 am (estimated time of the collapse), was 46.5 knots (23.9 m/s) and the average wind speed was 40.1 knots (20.6 m/s). This is significantly higher than the average monthly surface wind speed of 2.5 m/s in August 2016 (<http://www.weather.gov.sg/climate-climate-of-singapore/>).

As can be observed from the time series plot of average and maximum wind speed, the wind speed rose suddenly at about 5.35 am.

A rough calculation was conducted by a Professional Engineer (PE), in accordance with CP3: Chapter V: Part 2: 1972, on a pro-bono basis. Using parameters provided by site personnel, it was found that the factor of safety against overturning was less than 0.7. The key overturning moment was due to the wind pressure acting on the free-standing formworks on the windward side. The wind pressure was magnified due to the height of the formwork (10.2 m). Other factors contributing to the overturning include the uplift, wind drag and the lack of stabilising moments. Once the formworks on the windward side collapsed, they triggered a domino effect, leading to the collapse of the 24 formworks.

### Implications for design and construction

This incident should remind the industry of the need to consider stability issues for formwork and other tempo-

rary structures. It was fortunate that site personnel stored the table formworks away from the building edges and the formworks did not fall off the building. In addition, the collapse occurred when there were no workers in the vicinity. However, a recurrence of such an incident can easily lead to multiple fatalities and severe injuries.

With the implementation of the Workplace Safety and Health (Design for Safety) Regulations on 1 August 2016, stability of temporary structures must be considered during design for safety reviews, more specifically, during GUIDE-3: Pre-construction review. During the review, tall formworks should be avoided, whenever possible, through pre-fabrication or other measures. If formworks are used, the stability of the formwork has to be considered in sufficient detail, including the possible effects of wind and other lateral loads. It will be necessary to have detailed discussions with the suppliers of system formwork, to understand possible measures to prevent instability. It is also recommended that suppliers of formwork systems should provide specific instructions to their clients on ways to prevent similar incidents from happening.

Other possible risk controls during construction include:

- Careful site and work planning, taking into consideration the possible hazards at different stages of construction. In this particular incident, the location for dismantling the

formworks was not suitable, as the tall, free-standing table formworks were stored at a substantial height and the site was in a coastal area, where the effects of wind become more significant.

- Reducing the exposure of free-standing table formwork to effects of wind, by dismantling them as part of the lifting process and as soon as possible.
- Weighing down vertical footings of formwork, by means of anchorage or temporary counterweights.
- Attaching outriggers to vertical footing of formwork.
- Providing for diagonal and horizontal bracing, to connect the table formworks to form a more rigid integrated structure.

### Conclusions

Construction work will always be constrained by many factors like time, cost and space. Thus, it will be more effective, if hazards are considered upstream during design, so that inherently safer methods of work can be implemented during construction. Nevertheless, equipment suppliers and contractors have to conduct detailed risk assessment to identify and implement suitable risk control measures, to ensure that work can be conducted safely. More fundamentally, all stakeholders must see safety as an important aspect of their work. If not, safety regulations, risk assessment and safety measures will have no effect at all.

It must be noted that this article was written, based on information collected informally, and the authors do not have the authority and resources to verify all the details about the incident. Nevertheless, this article presents useful information and hopefully it will help to prevent such incidents.

### References

- Circular on Safety Requirements for Formwork Structures [https://www.wshc.sg/files/wshc/upload/cms/file/20130131-55\\_Safety\\_Requirements\\_for\\_Formwork\\_Structures.pdf](https://www.wshc.sg/files/wshc/upload/cms/file/20130131-55_Safety_Requirements_for_Formwork_Structures.pdf)
- Workplace Safety and Health Guidelines - Design for Safety [https://www.wshc.sg/files/wshc/upload/cms/file/WSH\\_Guidelines\\_Design\\_for\\_Safety\(1\).pdf](https://www.wshc.sg/files/wshc/upload/cms/file/WSH_Guidelines_Design_for_Safety(1).pdf)