建築耐風設計規範之載重組合及簡易風力修正研究

Study on Load Combination and Simplified Wind Load in Taiwan Code

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摘要

我國建築物耐風設計規範及解說之內容僅適用於近似矩形之建築物。其中，風力計算方法參照國外規範，以陣風反應因子法作為順風向風力的計算理論，橫風向及扭轉向風力的計算則採用經驗式，以擬合風洞試驗的結果獲得。在依據規範公式計算獲得風力後，應該如何合理地組合這些風力，仍是一個急待解決的問題。根據目前作法，順、橫、扭轉向風力首先須分別獨立作用於結構模型上進行靜力分析，獲得了結構物的結構反應後再進行組合。接著取其組合後的最大反應者，對應此最大反應的來風方向的順、橫、扭轉向風力作為設計風力。實際上，目標結構物的結構反應可能因為結構系統之選擇而有所不同；而且三個方向的風力未必在同一時間發生最大值，故組合時理應存在機率問題。

本研究採用之研究方法有二：(1)以傳統的風洞物理模擬方法執行計畫內容有關必要的風力或風壓數據之取得及後續探討；(2)以 MATLAB 程式語言撰寫建築物結構分析程式進行靜力分析及動力分析；並以 MATLAB 程式語言撰寫探討載重組合所需要的機率分析理論程式。研究團隊針對規範修訂分為兩部分提出建議。首先是第十二節的部分，研究團隊提出三種不同方法以載重直接進行組合的方式，與動力分析結果進行比較。其結果雖然相較於日本規範及 ISO 規範採用結構效應組合的方式來得稍偏保守，但採用外力直接進行組合的方式較為快速且同樣具有與動力分析結果相同的變化趨勢。研究團隊也納入了目前國內外實驗室常採用的聯合機率方式來進行估算，證實了此種方式在具有風洞實驗數據的狀況下，可以獲得最佳的準確度，然而相對地，其計算過程也最為繁複。

接著是第十三節簡易風力的修訂部分，研究團隊認為簡易風力可以改用放大順風向風力的風載重效應的方式來涵蓋橫風向及扭轉向風力的作法。此作法在日本規範及 ISO 規範均已揭示許久，執行起來又十分快速便利。

關鍵詞：靜力分析、設計風力、載重組合、風洞試驗

Abstract

In Taiwan's design wind code, it is clearly defined that the regulation content regarding the design wind load on the mainframe system and local component claddings is only applicable to those buildings with regular rectangular shapes. In design loads of the mainframe system, the along-wind load is estimated based on the gust response factor, the across-wind load and the torsional wind load are based on empirical models approximated from wind tunnel test data. Reasonably combining along-wind, across-wind, and torsional wind loads is one of the essential issues to define. According to the current regulation, the along-wind, across-wind, and torsional wind loads are individually applied to the structural model to obtain the corresponding individual structural responses. By selecting the target structural response quantity, individual along-wind responses, across-wind response, and torsional response are combined based on the SRSS concept as a resultant response. The maximum wind loads in the along-wind, across-wind, and torsional directions are not necessarily happening simultaneously. It would be reasonable to involve a joint probability relationship when combining them.

This research adopts two approaches: (1) to obtain necessary wind force data of buildings based on conventional wind tunnel testing; and (2) to proceed with static analysis and dynamic analysis based on MATLAB-language programs for structural response estimation. The research team has proposed two revision suggestions. The first suggestion is to suggest a new combination of rules for the along-wind, across-wind, and torsional wind forces. There are three approaches tested with the dynamic analysis results. Although the comparison results are more conservative, they are genuinely faster than the original way in the current code. The SRSS approach has also been verified to be precise enough and applicable. Finally, the research team would like to propose a procedure based on the same combination of rules in AIJ and ISO codes. The second suggestion in this research is to replace the current simplified procedure with the same one adopted in AIJ and ISO codes. If the existing code has remained, we can propose a new simplified formula for the torsional wind force to replace the current one. The new one will provide a better convergent result with the general formula for the torsional wind force.

Keywords: **static analysis, design wind load, load combination, wind tunnel test**.