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Using Passive Cooling Strategies to Reduce Thermal Cooling Load for Coastal High-Rise Buildings of Jeddah, Saudi Arabia

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Abstract : With the development of the economy in recent years, Saudi Arabia has been maintaining high economic growth. Therefore, its energy consumption has increased dramatically. This economic growth reflected on the expansion of high-rise tower's construction. Jeddah coastal strip (cornice) has many high-rise buildings planned to start next few years. These projects required a massive amount of electricity that was not planned to be supplied by the old infrastructure. This research studies the effect of the building envelope on its thermal performance. It follows a parametric simulation methodology using Ecotect software to analyze the effect of the building envelope design on its cooling energy load for an office high-rise building in Jeddah, Saudi Arabia, which includes building geometrical form, massing treatments, orientation and glazing type effect. The research describes an integrated passive design approach to reduce the cooling requirement for high-rise building through an improved building envelope design. The research used Ecotect to make four simulation studies; the first simulation compares the thermal performance of five high-rise buildings, presenting the basic shape of the plan. All the buildings have the same plan area and same floor height. The goal of this simulation is to find out the best shape for the thermal performance. The second simulation studies the effect of orientation on the thermal performance by rotating the same building model to find out the best and the worst angle for the building thermal performance. The third simulation studies the effect of the massing treatment on the total cooling load. It compared five models with different massing treatment, but with the same total built up area. The last simulation studied the effect of the glazing type by comparing the total cooling load of the same building using five different glass type and also studies the feasibility of using these glass types by studying the glass cost effect. The results indicate that using the circle shape as building plan could reduce the thermal cooling load by 40%. Also, using shading devices could reduce the cooling loads by 5%. The study states that using any of the massing grooving, recess or any treatment that could increase the outer exposed surface is not preferred and will decrease the building thermal performance. Also, the result shows that the best direction for glazing and openings from thermal performance viewpoint in Jeddah is the North direction while the worst direction is the East one. The best direction angle for openings - regarding the thermal performance in Jeddah- is 15 deg West and the worst is 250 deg West (110 deg East). Regarding the glass type effect, comparing to the double glass with air fill type as a reference case, the double glass with Air-Low-E will save 14% from the required amount of the thermal cooling load annually. Argon fill and triple glass will save 16% and 17% from the total thermal cooling load respectively, but for the glass cost purpose, using the Argon fill and triple glass is not feasible.

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