Types of carbonate karsts in the tropics, their origin, detection and geotechnical significance

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Karst (named after a region of the same name in the former Republic of Yugoslavia) refers to a characteristic topographic feature or landscape which can be developed by rocks undergoing dissolution by downward percolating meteoric water. Many features of karst are also developed by flowing water which had flowed laterally on reaching the water-table. Several rock types under such natural "weathering/solution" environment can develop karstic topography. They include limestone, dolomite, gypsum, salt deposits and silica rocks. However, the most common and the best known are those developed by carbonates calcite ($CaCO_3$) and dolomite [$(Mg, Ca)CO_3$]. Under tropical humid conditions, calcitic and dolomitic limestones or their metamorphosed equivalents develop tropical karstic features which show spectacular tall steep-sided hills (tower karst or mogote) and solution features such as karren, dolines, uvalas, and cockpits (locally referred to as wangs). Where the percolating water had reached the water-table, the lateral flow of the water can carve out cave systems which given enough time will develop secondary karstic features such as stalagmites, stalactites, scalloped surfaces, reverse pinnacles, bell holes etc. Other karstic features such as overhanging caves, rock windows and spleothems could have developed subsequently.

In the Southeast Asian Region, limestone or marble constitute one of the major rock types and they have formed large areas with above surface spectacular karstic features. There are ample evidences to indicate that in the past [probably from Pliocene (6 to 2 million years ago) to around Early to Middle Pleistocene (2 to 0.5 million years ago)] the sea levels, in several episodes, had receded way beyond the continental shelf area for significant lengths of time in response largely to the ice accumulations in the polar regions during the Quaternary Glaciation. A large continent (the Sunda Continent) had existed then and it encompassed the whole of Southeast Asia and the surrounding seas including Straits of Malacca, South China Sea, Sunda Sea. During these periods of regressions (or sea level lows), the climatic conditions in this region had been quite different from the humid tropical type prevailing presently. A cooler and dryer climate is believed to had been active. This had allowed development of a few

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karstic types in the Southeast Asian region which had not been recognized elsewhere in the world.

Four (4) distinct karstic types are recognized. They include (a) tower or mogote karst, (b) subsurface karst, (c) submarine karst, dan (d) stratigraphic karst.

In the long past geologic history, where limestone had been formed and had been exposed to the atmospheric conditions, apparently similar types of solution and karstic formation probably had occurred. When such surfaces were submerged and other rock units were deposited on top of them this gave rise to the fourth type of karst which is called the stratigraphic karst.

The lowering of the sea levels in the past geologic history of this region had superimposed solution features on the subsurface and stratigraphic karsts which were formed and preserved. This has added to the potential geotechnical problems and hazards of these two types of karsts when high-rise and other infra-structures were constructed over areas underlain by them. Site investigation of difficult karstic areas requires input by the geologist who understands karst and karst formation.