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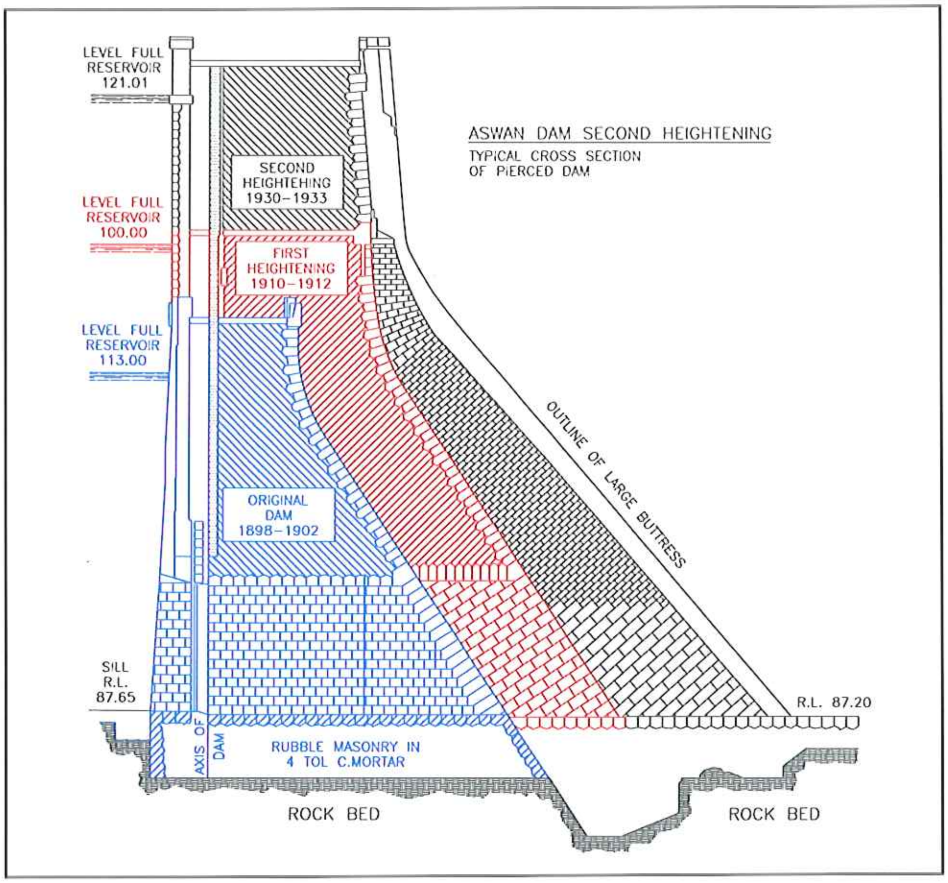
ANCONEWS

ENERGY, SYSTEMS, & STRUCTURES



ASWAN DAM MODEL VERIFIED BY VIBRATION TESTS

EARLY 20TH CENTURY MARVEL

The lower Aswan dam, constructed across the Nile in 1898-1902 under the direction of the famed British engineer, Sir Benjamin Baker, was hailed as an engineering marvel at the beginning of the twentieth century. The two- kilometer long gravity dam, originally 20 meters in height, was raised twice, to 25 meters in 1912 and 34 meters in 1933, as illustrated in the accompanying figure. Construction consists of granite block and mortar walls, plus filling of the core with "Herculean Concrete" - rubble stones and mortar deposited, unmixed, by hand, and accounting for 40% of the volume of the dam. The construction was performed by a work force of 11,000 men. The lower dam was used to control the Nile flooding for the 1,000 kilometers between Aswan, Cairo, and the Mediterranean Sea, and revolutionized Egyptian irrigation and agriculture. The lower dam was also used for power production until it was replaced by the upper Aswan earth fill dam, built five kilometers upstream by the Soviets during 1960-1971. The upper dam impounds Lake Nassar and currently provides approximately 40% of Egypt's electric power requirements. The lower dam continues to be important for tail race control at the upper dam, as a vital Nile road traffic crossing, and because the city of Aswan (with a population of approximately 200,000) lies directly below the lower dam.

SEISMIC SAFETY STUDIES

Over the past thirty years, grouting of the lower dam has been required to reduce leakage. Because of the required grouting and the location of the city of Aswan below the dam, the Egyptian High Aswan Dam Authority contracted with HARZA Engineers of Chicago to perform a complete evaluation of the dam, including its seismic adequacy. HARZA conducted extensive coring to determine dam integrity and to assess material properties for use in a dynamic finite element model. Coring provided local but not global (or average) material properties. The variability of the unusual and undocumented construction materials suggested that dynamic vibration tests be used to measure global dynamic properties of the dam for use in verifying the computer finite element model. HARZA contracted with ANCO to perform field eccentric mass vibration tests on three sections of the lower Aswan dam and lock.

ANCO used its MK-18 eccentric mass vibrator to excite the dam with a sinusoidal force up to ten tons over the range of 1 Hz to 25 Hz. Acceleration responses on the order of .001 g to .0001 g were recorded and analyzed by spectral techniques to reveal a first transverse mode of dam vibration with a resonant frequency of 8 Hz. This information, along with the measured mode shape and dynamic stiffness, was used by HARZA to refine the assumed density and stiffness of the dam material properties in the finite element model used to predict seismic response. Using this verified model, HARZA was able to reduce the level of conservatism required in its analysis, which ultimately indicated that the Aswan dam had sufficient seismic capacity (resistance to uplift and sliding).

FIELD TESTING OF CIVIL STRUCTURES

ANCO has used field testing to verify the dynamic properties of a variety of civil structures, including dams, bridges, offshore oil platforms, power plant boiler structures, turbine foundations, office buildings, stacks, historical office structures, and nuclear power plant containment buildings. Testing uses portable equipment and can be performed in a matter of days. The identified dynamic properties, namely damping, resonant frequency, mode shape, and dynamic stiffness, allow for the validation and modification of dynamic models, so as to reduce conservatism, demonstrate increased safety margins, detect changes due to structural degradation, suggest optimal modeling approaches, and advance the state-of-the-art in structural modeling.

Combined testing and analytical efforts can significantly reduce the overall cost of dynamic modeling of critical and unusual structures. These efforts often reveal margins that reduce or eliminate the need for costly strengthening or other structural modifications.

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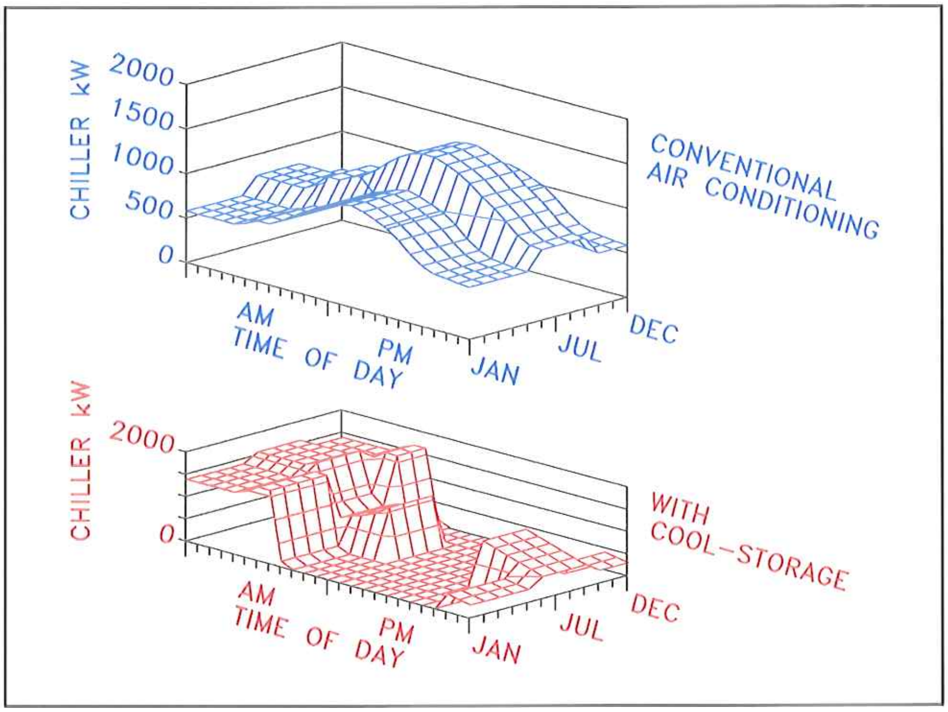

THERMAL ENERGY STORAGE CUTS PEAK LOAD

LESS EFFICIENT, BUT BETTER

Doing something less efficiently is usually not a good idea. Running large air-conditioning chillers at night to make and store cold water, or ice, to handle the peak cooling loads of a summer day is less efficient than the traditional handle-the- load-as-it-happens method. But it IS a good idea; and it's becoming increasingly popular.

We recently asked Dr. Raj Gopal to expand upon this idea. Dr. Gopal has been responsible for much of ANCO's work in the field of Thermal Energy Storage (TES), and is Vice Chairman of ASHRAE's Building Operation Dynamic Committee TC4.6. The following is a summary of his comments:

Several electric utilities in the U.S. are aggressively promoting "Cool-Storage" as a means of reducing their peak system demand (see accompanying figure). They are prompted to these actions by the sharpness of their peak loads. The reward for shifting peak daylight kW's to "off-peak" periods can be a postponement in the need to construct new generating capacity, the elimination of high cost "peaking" generators, or a reduced need to purchase power from adjacent utilities.

Regardless of the specific method chosen, implementing a Cool-Storage system will increase the total energy (kW-hours) required for a given air-conditioning load. This lowered efficiency is dictated by certain basic thermodynamic laws. However, by exercising care in the design and operating scheme for such systems, the loss in the efficiency can be held to within a few percentage points. In fact, the efficiency of the overall societal power system could conceiveably increase - if, for example, the need to run an inherently inefficient gas-turbine-powered "peaking" generator could be eliminated by shifting sufficient demand away from the utilities' peak demand period.

COOL-STORAGE METHODS

Cooling capability can be stored either by chilling or freezing water (although glycol and eutectic salts have also been used). Water is the material of choice for a variety of practical and thermodynamic reasons. Its readily available, relative harmlessness, and the wide availability of equipment for its storage and handling are obvious factors dictating the selection. The choices between cooling or freezing this water, the subsequent choices in equipment, use of eutectic salts to raise freezing temperatures, etc., are far from simple. Options are numerous, and answers are not clear cut. Ultimately, the Cool-Storage method selected must meet the particular needs and constraints of the facility in which it is installed.

UTILITY REBATE

Cool-Storage systems are designed, evaluated, and approved in a real-world environment where the concerns and preferences of the electric utility must be given considerable weight. Utilities provide financial incentives to promote the inclusion of Cool-Storage methods in new and retrofitted air-conditioning systems. These incentives usually involve payment of a rebate to the end-user/customer. Special off-peak billing rate schedules are also available to the larger customers for whom separate metering of their air conditioning load is practical.

Rebates are normally predicated on the number of kW's of demand shifted to an off-peak period. Substantial payments are common. Southern California Edison's (SCE) present limit on TES rebates is $300,000, based on $200 per kW shifted. At Wisconsin Electric (WE), rebates are variable, typically $350 per kW shifted and $.08 per kWhr shifted during the May to September cooling period. The combined effect of such rebates and the reduced operating costs achieved with a properly designed TES system is typically a 2-5 year simple payback on the cost of its implementation.

A utility is, understandably, concerned with verifying the feasibility of proposed demand-shifting TES projects. Over the past four years, ANCO has been providing third-party evaluations for both SCE and WE. To-date, more than 75 feasibility studies and screening reviews have been performed by ANCO. A typical review process includes: 1) a site visit, 2) a preliminary screening study to see if cool storage is attractive, 3) a detailed feasibility study (if warranted) to determine the benefits to the customer and the utility, and 4) a technical and economic review of the Cool Storage project proposed by consultants and vendors.

In collaboration with SCE, ANCO developed an array of computerized analytical tools which accept as inputs the seasonal and diurnal cooling load profiles, a description of the proposed Cool-Storage system, and a definition of the Baseline system against which the TES system is to be compared. This model computes the technical and financial parameters required to assess feasibility. The key outputs, for both Baseline and TES, are: the annual cost of energy (kW-hr); the annual cost of demand (kW); energy usage and demand by seasonal and diurnal billing rate periods. These outputs, in conjunction with the engineering and operational judgement of ANCO's professional staff, provide an objective and realistic assessment of each Cool-Storage system proposed to SCE.

For WE, ANCO's review of over 50 TES proposals has identified a substantial number of unattractive candidate TES proposals - with a resultant savings of about $8,000 each in avoided cost for detailed design studies. Nevertheless, an estimated total of 2 megawatts of peak load was shifted to off-peak by those projects recommended by ANCO.

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