

Project Proposal

Title: Shape Finding Methods and Design of Thin Reinforced Concrete Shell

Proposal:

Thin shell concrete structures were developed in the nineteen-sixties in response to the need for economy in large-span structures and to the design and aesthetic program of the modern movement in architecture. The unique characteristics of reinforced concrete shell – easily shaped, having both tensile as well as compressive strength, durable and fire resistant, has since made it popular with architects throughout the world.

In this paper, I would like to address the various shape finding methods and the design of concrete shell structure. The shape of a shell can be selected purely arbitrarily, or designed with care to minimize the weight corresponding to a given loading and boundary condition. With progress made in the development of finite element analysis and the construction of shell structure, shell of almost any shape can now be analyzed and constructed. However, shell of arbitrary forms may not be self-stabilizing and need the help of stiffening elements to restrain its boundaries. An example of such form is the spherical shell roof of Kresge Auditorium whose sides are heavily restrained by edge beams. An alternative and more elegant way of designing the shell would be to analyze the key geometrical parameters (like span and height) and the load and the desired stress state, then design a natural self-supporting shell shape with free edges. This form could be generated in many ways, among which is through analysis of physical model, through computer simulation based on geometrically nonlinear membrane theory or by finite element methods. Some examples of free-edge shell structures include the recently completed Auditorio de Tenerife by Santiago Calatrava, Cathedral at New Norcia by Luigi Nervi and Kilcher Factory by Heinz Isler.