The humanity demand for energy is rapidly increasing every day, hence and to recover the expected future shortage in fossil resources, alternative energy recourses will play a major role. Experience and research along the previous decades, let conclude that the future is natural resources particularly wind and solar light. The Solar Updraft Power Plant (SUPP) is one potential and promising engineering system, which combines two kinds of natural energy gains. However, the challenge is to design a holistic system fulfilling both, reasonable structural reliability and clear investment goals.

SUPP has the advantages over alternative systems of providing electricity 24 hours a day and not demanding any fuel or cooling water, which make it suitable in extremely dry regions. The solar chimney combines three familiar techniques: the simple roof hot air collector, the chimney, and wind turbines with generators. In particular, the solar chimney exploits diffused radiation when it is cloudy. The total efficiency of a SUPP is a combination of all parts contribution. The higher the efficiency of these parts is, the higher the harvested electrical energy will be.

Based on previous studies of cooling towers and other optimization studies Krätzig & Partner provided potential dimensions of a SUPP. Their structure is a 1000 m high reinforced concrete shell with variable thickness that starts from 60 cm at base and ends with a minimum diameter of only 25 cm at top. The upper diameter of the cylindrical shape, which extends from 450 m height to 1000 m, is 150 m. From ground to 450 m height the structure is hyperbolic with a base diameter of 280 m. At best, ten stiffening rings are distributed over the height of the tower, which stiffen the structure and reduce the vertical tensile and compressive stresses, and improve the vibration sensitivity in oval modes providing a beam like behavior (Fig. 1).

The chimney structure is one of the main parts of the SUPP. Its height plays a major role in generation of electricity. The behavior of such an extremely large shell structure (Mega-shell) under loading effects plays a major role in the
reliability of the structural chimney design, as well as from an economic point of view in providing a long service life. Already the chimney design is a big challenge for engineers. All factors contribute, e.g. loading (particularly wind loads), material requirements, soil structure interaction, and durability.

SUPPs are suggested to be built in remote regions offering sufficient space (collector varies from 1.5 to 7.0 kilometers in diameter), and also high solar irradiation. North African countries are ranked best for the previous demands and especially for an easy transfer of electricity gains to European countries. In these regions such structures could be built on coastal areas, where the required land is available. Then corrosion of the reinforcement could be the main cause of concrete deterioration and limiting structural service life. Hence, it is important to have a good understanding of the vulnerabilities of concrete in order to help minimize the costs of SUPPs.

For a realistic estimation of the life time of a SUPP, the concrete material model implemented should account for plastic behavior. The concrete damaged plasticity model has the potential to simulate the total inelastic behavior of concrete in both, tension and compression including damage characteristics. Abaqus software is seen a powerful tool with respect to concrete material models and development of a proper damage simulation strategy. It will be useful for the analysis of reinforced concrete structures under any load combinations including both static and dynamic effects. Thereby, the concrete damaged plasticity model assumes that the two main failure mechanisms in concrete are the tensile cracking and the compressive crushing.

Good understanding and implementation of damage plasticity model in Abaqus and further consideration of chloride ingress in proportion to the percentage of cracked area of the section would lead to good approximation of the long service life of SUPP, reduce the costs of the structure and contribute in making the idea of Professor Schlaich and his team back to 1972, a reality.

![Concrete Damaged Plasticity Model](image)

**Fig. 2: Concrete Damaged Plasticity Model**

- a. Tensile behavior associated with tension stiffening
- b. Compressive behavior associated with compression hardening