

## **ULS and SLS**

## A few thoughts on SLS and ULS issues and design

**Limit State** – Designers need guidance to design. In engineering design in the modern era we envision the future condition of an item – a structure. We call that condition a state.

**ULS** - One state engineers and society wants to avoid is the Ultimate Limit State (ULS). An ULS for a structure is the state of complete failure (people die, buildings collapse, and the like). One envisions the complete failure of the structure and what leads to such a failure, from which engineers design the structure to avoid the conditions lead to the ULS.

**SLS** –Serviceability Limit State, known as SLS, are states which may be harder to understand. Let us consider a few examples:

- 1. Supposing doors or windows start sticking from settlement, even though settlements have ended, one could consider those to be unacceptable. Doors should not stick. As a result one may have to continually adjust frames.
- 2. Due to frost sidewalks heave causing unevenness at building entrances. Sidewalk surfaces should integrate into the walking experience seamlessly at entrances. As a result one may have to have warnings on use, highlight the unevenness, adjust the door, and so on.

In the examples, the state of the doors and sidewalk, is not such that death occurs, but there is an element of "ongoing" or "unintended" behavior one did not want. One might say, that outside of code requirement an SLS is a state, the owner/manager of the structure did not want to deal with post construction. Another way to think of an SLS that it is a state that makes the structure "a pain in the neck" at the feature of interest so that for example owner's have to adjust doors seasonally due to frost heave or settlement. You may know you are in and SLS condition when you think "here we go again".

## **SLS Considerations**

It strikes V.A.S.E. Pro that we need to consider SLS more rigorously in the design stage. What state or states (SLS) does it the owner want for the structure or item following turnover when the structure/item is new and not in the ULS?

Examples of SLS an owner or code might consider: small deflection or no deflection, no or small vibration, a permanent deformation due to a movement or a permanent mis-alignment, or failure of a sub ULS member.

V.A.S.E. Pro would like to suggest that designers and contractors require owners to describe the SLS rigorously.

STATE	ITEM	COMMENT
SLS	SMALL MOVEMENT	GET ACTUAL VALUES e.g. 10 mm max in 10 m
SLS	SIDE WALK REMAIN LEVEL	GET ACTUAL VALUES e.g. 1% grade
SLS	VIBRATION SMALL	GET ACTUAL LIMIT e.g. less than 10Hz at floor level

A rigorous definition should be agreed to we believe, so that designers and contractors can consider and implement works to achieve these values. It may be that SLS values actually result in bigger elements that ULS members and that SLS factors not currently considered may come into effect. We consider the designer and client should agree that the ULS and SLS values are for the design period and if the ULS or SLS values change, the entire project may change, and that SLS concerns post construction when raised that were not part of the original specific SLS would not be actionable. A further concern by V.A.E.E. Pro is that SLS the owner nor designer nor contractor have allowed for may become for others states of importance. Present day design must be shown and stated to be for the specific time and conditions set out in our judgement. Because SLS are the "pain" or "not again" states, some of which can depend on user concerns not related to the initial design and requirements, we advocate more rigor.

## 844-233-7227