Limit state approach for structurally informed design of shells composed of interlocking blocks

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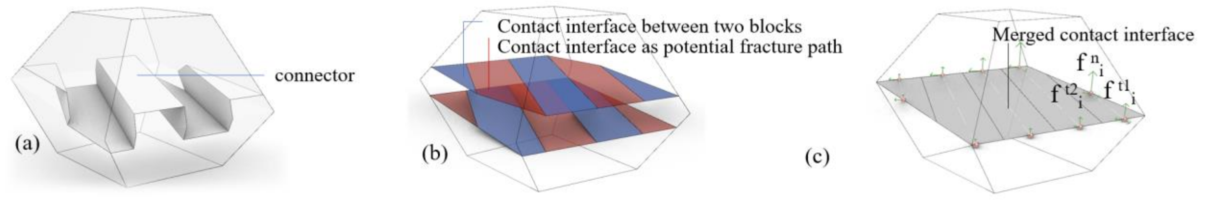
Abstract

This work demonstrates an extension of the *Livesley's rigid block limit analysis* method [1] to design three dimensional assemblages of dry jointed interlocking blocks with orthotropic sliding resistance. The interlocking interfaces increase the block sliding resistance without adhesives during or after the construction. The paper introduces the sliding resistance as a function of the geometric parameters of interlocking interfaces and therefore considers their modeling as a structurally informed design problem. Interlocking blocks with customized shape can be manufactured by advanced machines such as CNC mills. The **key motivation** of the paper is to provide a computationally efficient method to design structurally feasible assemblages, via tuning the geometric parameters of interlocking interfaces, beside exploring various geometries for the structure and its blocks whose interfaces were previously constrained to be normal to the stress fields [2] or to satisfy isotropic frictional constraint [1].

The paper extends the Livesley's method, based on limit analysis and point or concave contact formulation, to corrugated interlocking interfaces of rigid blocks with rectangular cross section (fig. a). The approach is extendable to other cross sections though. The joints between the connectors and the main body of blocks are potential fracture planes (fig. b- red faces), which can slide or twist when the plastic yield surfaces accounting for the interaction of normal and shear forces, torsion and bending moments are reached [3]. Besides, faces between two blocks (fig. b- blue faces) are the other potential failure planes which can only rock or slide along the direction parallel to the connectors when violate Coulomb's friction constraint. To simplify the model of the stress state, a merged contact interface is assumed (fig. c), where the end points of the face centerlines of each connector are considered *contact points* at which the stress resultants (with tangential components normal and parallel to the connectors) are computed by solving the equilibrium problem under proper sliding constraints.

Applying this method, several three-dimensional samples are modelled by varying the geometry of a shell, of hexahedral units assembled with stack bond pattern and of the interlocking interfaces including the number and orientation of the connectors, as well as the applied external loads.



References

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