The virtual element methods (VEM) is a new method that can be used on arbitrarily-shaped polytopal partition to approximation PDEs. In the pioneering meta-theoretical framework of VEM by F. Brezzi and his collaborators, a key norm equivalence relation is needed to bridge the discrete stability and its continuous counterpart to guarantee the convergence. This practice requires stringent geometric assumption about the mesh, yet in practice, VEM shows great robustness with respect to the potential anisotropy in the mesh. In this study, we shall investigate this curious case from perspectives from nonconforming methods, such as discontinuous Galerkin, immersed finite elements, and ghost fluid/penalty. We also re-examine commonly used tools in simplical finite element methods to adapt them to polytopal finite element to study the reason why virtual element has such robustness.

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