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**Non-linear shape functions over time in the space-time finite element method**

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*Abstract*

This work presents a generalisation of the space-time finite element method proposed by Kączkowski in his seminal of 1970's and early 1980's works. Kączkowski used linear shape functions in time. The recurrence formula obtained by Kączkowski was conditionally stable. In this paper, non-linear shape functions in time are proposed.