Counterexamples to Hamada's conjecture

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In 1973, Hamada made the following conjecture: Let D be a geometric design having as blocks the d-subspaces of $PG(n,q)$ or $AG(n,q)$, and let m be the p-rank of D. If D' is a design with the same parameters as D, then the p-rank of D' is greater or equal m, and the equality holds if and only if D' is isomorphic to D. In 1986, Tonchev, and more recently Harada, Lam and Tonchev, Jungnickel and Tonchev, and Clark, Jungnickel and Tonchev found designs having the same parameters and p-rank as certain geometric designs, hence provide counter-examples to the "only-if" part of Hamada's conjecture. In this work, we discuss some properties of the three known nonisomorphic 2-(64,16,5) designs of 2-rank 16, one being the design of the planes in the 3-dimensional affine geometry over the field of order 4, and try to find an algebraic way to use the similarities between these designs in a search for counter-examples to Hamada's conjecture in affine spaces of higher dimension.

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