



# Some matrix constructions of non-symmetric regular group divisible designs

SHYAM SAURABH

**Abstract.** Saurabh and Sinha [17, 19] obtained solutions of  $L_2$ -type designs, semi-regular group divisible and symmetric regular group divisible designs in the range of  $r, k \leq 10$  using certain combinatorial matrices. Here by using matrix approaches, solutions of non-symmetric regular group divisible (RGD) designs listed in Clatworthy [3] are obtained except few. As special case we obtain a series of  $\mu$ -resolvable balanced incomplete block designs and quasidouble solutions of some RGD designs.

## References

- [1] H. Bekar, C. Mitchell and F. Piper, Tactical decomposition of designs. *Aequationes Math.*, **25** (1982), 123–152.
- [2] M. Buratti, Small quasimultiple affine and projective planes: Some improved bounds, *J. of Combin. Des.*, **6** (1998), 337–345.
- [3] W.H. Clatworthy, *Tables of two-associate-class partially balanced designs*, U.S. Department of Commerce, National Bureau of Standards, Washington, DC Report No. NBS-AMS-63, 1973.
- [4] P.J. Davis, *Circulant matrices: Second edition*. AMS Chelsea Publishing, 2012.
- [5] W. de Launey, GBRDs: some new constructions for difference matrices, generalised Hadamard matrices and balanced generalised weighing matrices. *Graphs Combin.* **5**(1989), no.2, 125–135.
- [6] W. de Launey, *Bhaskar Rao designs* in “Handbook of Combinatorial designs, Second edition”, C.J. Colbourn, and J.H. Dinitz, eds. Chapman & Hall/ CRC, New York, (2007), 299–301.
- [7] W. de Launey, *Generalized Hadamard matrices*, in “Handbook of Combinatorial designs, Second edition”, C.J. Colbourn, and J.H. Dinitz, eds. Chapman & Hall/ CRC, New York, (2007), 301–306.

- [8] A. Dey, Construction of regular group divisible designs, *Biometrika*, **64** (1977), 647–649.
- [9] A. Dey, *Incomplete Block Designs*, Hindustan Book Agency, New Delhi, 2010.
- [10] G.H. Freeman, A cyclic method of constructing regular group divisible incomplete block designs, *Biometrika*, **63** (1976), 555–558.
- [11] P.B. Gibbons and R. Mathon, Construction methods for Bhaskar Rao and related designs. *J. Austral. Math. Soc. (Series A)*, **42** (1987), 5–30.
- [12] D. Jungnickel, On the existence of small quasimultiples of affine and projective planes of arbitrary order, *Discrete Math.*, **85** (1990), 177–189.
- [13] D. Jungnickel, On the existence of small quasimultiples of affine and projective planes of arbitrary order II *J. Combin. Des.*, **3** (1995), 427–432.
- [14] M. Pavone, A quasidouble of the affine plane of order 4 and the solution of a problem on additive designs, *Finite Fields Appl.*, **92** (2023), Paper no. 102277, 19 pp.
- [15] S. Saurabh and D. Prasad, Certain incomplete block designs from combinatorial matrices, *J Indian Soc Probab Stat*, **24** (2) (2023), 535–544.
- [16] S. Saurabh, K. Sinha and M.K. Singh, Unifying constructions of group divisible designs, *Stat. Appl. (N.S.)* **19** (1) (2021), 125–140.
- [17] S. Saurabh, and K. Sinha, Some matrix constructions of  $L_2$ -type Latin square designs *Bull. Inst. Combin. Appl.*, **95** (2022a), 93–104.
- [18] S. Saurabh, and K. Sinha (2022b). Algebraic constructions of group divisible designs, *Ex. Countex.*, <https://doi.org/10.1016/j.exco.2022.100094>
- [19] S. Saurabh and K. Sinha, Matrix approaches to constructions of group divisible designs. *Bull. Inst. Combin. Appl.*, **97** (2023a), 83–105.
- [20] S. Saurabh and K. Sinha, A list of new partially balanced designs. *Comm. Statist. Theory Methods*, **52** (2023b), 8607–8610.
- [21] S. Saurabh and K. Sinha, Regular group divisible designs using symmetric groups, *Stat. Appl.*, **21** (1) (2023c), 23–26.
- [22] M.K. Singh and S. Saurabh, On certain classes of rectangular designs, *Calcutta Stat. Assoc. Bull.*, **75** (1) (2023), 72–96.

- [23] K. Sinha, Construction of semi-regular group divisible designs, *Sankhyā Ser. B*, **53(2)** (1991), 229–232.