Chapter 8
Pattern of PBIB Design Having Higher Associated Class by Juxtapositions in Association Matrices

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ABSTRACT

This chapter represents two new series of partially balanced incomplete block (PBIB) designs. Association matrices based on incidence relation of vertices of a bi-partite graph of order s (s>=3) are being taken as base design. The foundation series of given PBIB designs are used to construct two more series of PBIB patterns, having three and four associated class, respectively, through promoting an idea of juxtapositions in association matrices of base design. To better comprehend the construction procedures, association schemes, P – matrices, efficiency factors of all types, as well as total efficiency, factors have been examined with examples from above series.

INTRODUCTION

As we are aware of some statistical techniques such as sampling, probability theory, statistical inference as well as a partially balanced incomplete block (PBIB) design plays an important role in modern statistics having wide applications in agricultural experimentation, medical research, population studies, and other relative fields. Intently, observations and data collection, based on sampling techniques, experimenter faces the difficulties to study the characters/ features of the study and the target population based on selected sampling units for a particular purpose based on objectives of defined problem, because of the

heterogeneity nature of given population units. Another best approach to study the problem/situation by using an appropriate incomplete block design. But, sometimes the existing Balanced Incomplete Block(BIB) designs as well as two associate class PBIB designs in the available literature are either unable to interpreted the problem or not to fit for a particular parametric situation under study. So, there is a need to develop higher associate class PBIB designs. For this purpose, an analytical approach of reviewing the construction methodologies of following PBIB designs to develop new series of higher associate class PBIB designs.

"Doubly Linked Block Association Scheme" based on their intersection number of treatment in given blocks for some combinatorial is defined by Meitei(2015). Sharma and Garg (2017) presented the construction methodology of three associate PBIB designs using some sets of initial blocks. Agrawal.et.al (2019) gives the construction method of α-resolvable group divisible (GD) designs based on dualisation of certain known affine resolvable balanced incomplete block designs. Kaur & Garg (2020) constructed Tm – type and Tm – assisted PBIB designs. Some higher associate class PBIB Designs using method of Duality, Juxtapositions and Literals of K – Maps were developed by Garg and Gurinder (2011,2014, 2022).

In the continuation of juxtaposition of association matrices of existing/ base design, two new series of higher associate class PBIB designs have been explored along with their association schemes in generalized form is presenting in research work.

General Introduction of Base Series-1 of Higher Associate Class PBIB Designs

This section presents an introduction to base series of three associate class partially balanced incomplete block designs by choosing bi – partite graph $K_{s,s}$, where s (>=3) constructed by the authors. In general, first and second kind of parameters of base-series of PBIB design are given as

$$v = 2s,\ b = s(s\text{-}1)/2,\ r = s\text{-}1,\ k = 4,\ \lambda_1 = s\text{-}1,\ \lambda_2 = \lambda_3 = 1,\ n_1 = 1,\ n_2 = n_3 = s - 1 \text{ where } (s>=3) \qquad (1)$$

P matrices are

$$P_1 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & s-1 \\ 0 & s-1 & 0 \end{bmatrix} \quad P_2 = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & s-2 \\ 1 & s-2 & 0 \end{bmatrix} \quad P_3 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & s-2 & 0 \\ 0 & 0 & s-2 \end{bmatrix}$$

Construction Methodology

The construction methodology of a series of three associate class symmetric PBIB designs as well as series of PBIB designs having four associate classes, both based on the concept of juxtapositions of ith (i=0,1,2,3) association matrices of series-1 to develop the incidence matrices of new series.

Treatment structure matrix of new series satisfied all axioms of block design and hence, the new patterned matrix representing two more series of three and four associate class PBIB designs along with their association schemes in the following theorems respectively. The expressive study of construction methodologies, association schemes and numerical illustrations of existing series have been deliberated in detail in the following sub–sections:

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