I.J. Mathematical Sciences and Computing, **2019, 2, 71-81**
Published Online April 2019 in MECS (http://www.mecs-press.net)
DOI: 10.5815/ijmsc.2019.02.06

Available online at http://www.mecs-press.net/ijmsc

Edge Stable Sets and Secured Edge Stable Sets in Hypergraphs

D. K. Thakkar [1] and V. R. Dave [2*]

[1] *Department of Mathematics, Saurashtra University, Rajkot – 360 005, India*
[*2] *Shree M. & N. Virani Science College, Kalavad Road, Rajkot – 360 005, India*

Received: 20 September 2018; Accepted: 17 October 2018; Published: 08 April 2019

Abstract

In this paper, we have proved several results regarding edge stable sets and maximal edge stable sets in hypergraphs. We have also proved various results regarding edge stable sets and maximal edge stable sets in partial subhypergraphs. We have introduced the concept of secured edge stable set, maximum secured edge stable set and i_s^1- Set in this paper and proved several results about them.

Index Terms: Hypergraph, Edge Stable Set, Maximum Edge Stable Set, Maximal Edge Stable Set, Secured Edge Stable Set, Maximum Secured Edge Stable Set, i_s^1- Set, Partial Subhypergraph.

AMS Subject Classification (2010): 05C15, 05C69, 05C65.

1. Introduction

Domination related parameters for graphs have been studied by several authors. These parameters can also be extended to hypergraphs and new parameters related to hypergraph can be defined. We introduced the concept of edge stable sets and edge independent set in [10].In a hypergraph if minimum edge degree is at least two; every edge independent set is an edge stable set. In this paper, we introduce some new concepts namely secured edge stable set, maximum secured edge stable set, and i_s^1- Set for hypergraphs and proved several results regarding them. We have proved that in a hypergraph if minimum edge degree k (k ≥ 2) every set of k – 1 or less edges is a secured edge stable set. We have also proved that in a hypergraph with minimum edge degree ≥ 2, if there is a maximum secured edge stable set F of G such that e ∈ F then $\beta_{ss}^1(G - e) < \beta_{ss}^1(G)$ where $\beta_{ss}^1(G)$ denotes the edge stability number of the hypergraph G.

*Corresponding author.
E-mail Address:

2. Preliminaries

This section contains basic definitions and notations required.

Definition 2.1(Hypergraph)[4] A *hypergraph* G is an ordered pair $(V(G), E(G))$ where $V(G)$ is a non-empty finite set & $E(G)$ is a family of non-empty subsets of $V(G) \ni$ their union $= V(G)$. The elements of $V(G)$ are called *vertices* & the members of $E(G)$ are called *edges of the hypergraph G*.

We make the following assumption about the hypergraph.

(1) Any two distinct edges intersect in at most one vertex.
(2) If e_1 and e_2 are distinct edges with $|e_1|, |e_2| > 1$ then $e_1 \not\subseteq e_2$ & $e_2 \not\subseteq e_1$

Definition 2.2(Edge Degree)[4] Let G be a hypergraph & $v \in V(G)$ than the *edge degree* of $v = d_E(v)$ = the number of edges containing the vertex v. The minimum edge degree among all the vertices of G is denoted as $\delta_E(G)$ and the maximum edge degree is denoted as $\Delta_E(G)$.

Definition 2.3(Dominating Set in Hypergraph)[1] Let G be a hypergraph & $S \subseteq V(G)$ then S is said to be a *dominating set* of G if for every $v \in V(G) - S$ there is $u \in S \ni$ u and v are adjacent vertices.
A dominating set with minimum cardinality is called *minimum dominating set* and cardinality of such a set is called *domination number* of G and it is denoted as $\gamma(G)$.

Definition 2.4(Edge Dominating Set)[7] Let G be a hypergraph & $S \subseteq E(G)$ then S is said to be an *edge dominating set* of G if for every $e \in E(G) - S$ there is some f in S $\ni$ e and f are adjacent edges.
An edge dominating set with minimum cardinality is called a *minimum edge dominating set* and cardinality of such a set is called *edge domination number* of G and it is denoted as $\gamma_E(G)$.

Definition 2.5(Sub Hypergraph and Partial Sub Hypergraph)[3] Let G be a hypergraph & $v \in V(G)$. Consider the subset $V(G) - \{v\}$ *of* $V(G)$. This set will induce two types of hypergraphs from G.

(1) The first type of hypergraph: Here the vertex set = $V(G) - \{v\}$(where {v} is not an edge of G) and the edge set $= \{ e' / e' = e - \{v\} \text{ for some } e \in E(G) \}$. This hypergraph is called the *sub hypergraph* of G & it is denoted as $G - \{v\}$.
(2) The second type of hypergraph: Here also the vertex set = $V(G) - \{v\}$ and edges in this hypergraph are those edges of G which do not contain the vertex v.This hypergraph is called the *partial sub hypergraph* of G.

Definition 2.6(Edge Stable Set)[10] Let G be a hypergraph & F be a set of edges of G then F is said to be an *edge stable set* of G if for every vertex x with edge degree of $x \geq 2$ there is an edge e_x containing $x \ni e_x \notin F$.

Definition 2.7(Maximum Edge Stable Set)[10] Let G be a hypergraph. An edge stable set with maximum cardinality is called a *maximum edge stable set*. The cardinality of a maximum edge stable set is called *edge stability number* of a hypergraph & it is denoted as $\beta_s^1(G)$.

Definition 2.8(Maximal Edge Stable Set)[10] Let G be a hypergraph. An edge stable set F is said to be a *maximal edge stable set* if $F \cup \{e\}$ is not an edge stable set for every edge e in $E(G) - F$.

3. Main Results

This section contains several results related to edge stable sets, secured edge stable sets and related concepts. Several examples have also been given.

Theorem 3.1 Let G be a hypergraph & F be an edge stable set of G. Let $F' = \{e' \ni e \in F\}$ where $e' = e - \{v\}$ then F′ is an edge stable set of G – v.

Proof Let G be a hypergraph & F be an edge stable set of G. Let $F' = \{e' \ni e \in F\}$ where $e' = e - \{v\}$. Let x be a vertex of $G - v \ni$ edge degree of $x \geq 2$ in $G - v$.

Now, edge degree of $x \geq 2$ in G also. Since F is an edge stable set of G $\exists$ an edge e_x containing $x \ni e_x \notin F$. Let $e_x' = e_x - \{v\}$ also $e_x' \notin F'$ as $e_x \notin F$.

$\therefore$ F′ is an edge stable set of G – v.

Example 3.2 Consider the hypergraph G whose vertex set V(G) = {1, 2, 3, 4, 5, 6} & edge set $E(G) = \{e_1, e_2, e_3, e_4, e_5, e_6\}$

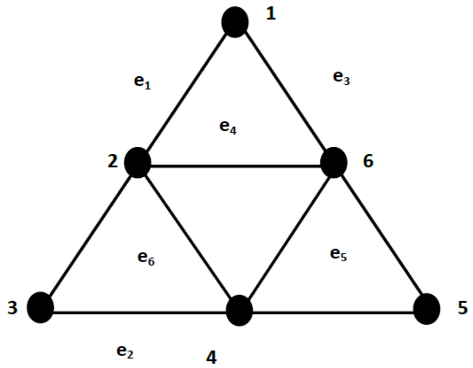

Fig.1. Hypergraph G

Consider sub hypergraph $G' = G - \{1\}$

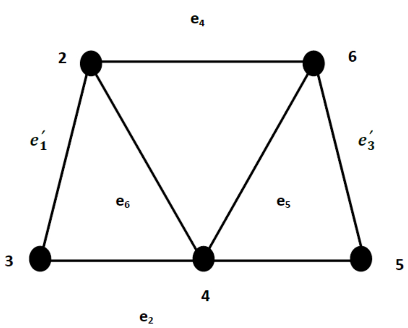

Fig. 2. Sub hypergraph G′ = G – {1}

Here F′ = {e_1', e_3'} is an edge stable set in G′ but { e_1, e_3} is not an edge stable set in G.

Theorem 3.3 Let G be a hypergraph & v ∈ V(G) ∍ {v} is not an edge of G. Let F be a maximal edge stable set of G then F′ is a maximal edge stable set of G – v if and only if ∀ e ∈ E(G) – F there is a vertex x in e ∍ x ≠ v & all the edges of G containing x except e are in F.

Proof Suppose the condition is satisfied. Let e′ be any edge of G – v ∍ e′ ∉ F′ then e ∉ F. Since F is a maximal edge stable set of G and the condition is satisfied ∃ a vertex x ≠ v ∍ every edge h containing x except e is in F.

∴ Every edge h′ of G – v containing x except e′ is in F′.
∴ F′ is a maximal edge stable set of G – v.

Conversely, suppose F′ is a maximal edge stable set of G – v. Let e be any edge of G ∍ e ∉ F then e′ ∉ F′. Since F′ is a maximal edge stable set of G – v there is a vertex x of G – v ∍ x ∈ e′ & every edge h′ of G – v containing x except e′ is in F′. Then x ∈ e & x ≠ v also every edge h containing x except e is in F. Thus, the condition is satisfied.

Theorem 3.4 Let G be a hypergraph with minimum edge degree of G ≥ 2 & let v ∈ V(G) ∍ {v} is not an edge of G. Let F_1 be a set of edges of G – v & let F be the set of edges of G ∍ F_1 = {e – {v} ∍ e ∈ F} then

(1) If F_1 is an edge stable set of G – v then F is an edge stable set of G if and only if there is an edge e containing v ∍ e ∉ F.
(2) If F_1 is a maximal edge stable set of G – v then F is a maximal edge stable set of G if and only if F is an edge stable set of G.

Proof (1) Suppose F is an edge stable set of G. By definition of edge stability there is an edge e containing v ∍ e ∉ F.

Conversely, suppose the condition is satisfied. Let x be any vertex of G.

Case 1: Suppose x = v

By the given condition there is an edge e containing v ∍ e ∉ F.

Case 2: Suppose x ≠ v

Since F_1 is an edge stable set of G – v there is an edge h′ of G – v containing x ∍ h′ ∉ F_1. Let h be the edge of G ∍ h – {v} = h′ then h ∉ F & x ∈ h.

Thus, F is an edge stable set of G.

(2) Suppose F is a maximal edge stable set of G then obviously F is an edge stable set of G.

Conversely, suppose F is an edge stable set of G. Let e be any edge of G ∍ e ∉ F then e′ ∉ F_1. Since F_1 is a maximal edge stable set of G – v there is a vertex x of G – v ∍ x ∈ e′ & for every edge h′ of G – v with x ∈ h′, h′ ≠ e′ & h′ ∈ F_1 then for every edge h containing x with h ≠ e, h ∈ F. Thus, F is a maximal edge stable set of G.

Theorem 3.5 Let G be a hypergraph & v ∈ V(G) ∍ {v} is not an edge of G then β_s^1(G) ≤ β_s^1(G - v).

Proof Let F be a maximum edge stable set of G. Let F_1 = {e – {v}/ e ∈ F} then F_1 is an edge stable set of G – v and $|F_1| = |F|$.

$\therefore\ \beta_s^1(G - v) \geq |F_1| = |F| = \beta_s^1(G)$
$\therefore\ \beta_s^1(G) \leq \beta_s^1(G - v)$

Example 3.6 Consider the hypergraph and subhypergraph of the example 3.2.
Let $F = \{e_4, e_5, e_6\}$ then F is a maximum edge stable set of G.

$\therefore\ \beta_s^1(G) = 3$

Let v = 1 & consider the sub hypergraph G – {1}. Consider the set $E = \{e_1', e_3', e_5, e_6\}$ then E is a maximum edge stable set of G – {1}.

$\therefore\ \beta_s^1(G - 1) = 4$

Hence, in this example $\beta_s^1(G) < \beta_s^1(G - 1)$.

Edge Stability & Partial Subhypergraph:

Let G be a hypergraph & $v \in V(G)$. Now, we consider the partial sub hypergraph G – v.
We make an attempt to relate the edge stable set of G – v with the edge stable set of G.
We begin with the following example.

Example 3.7 Consider the hypergraph of the example 3.2.
Let $F = \{e_4, e_5, e_6\}$ then F is an edge stable set of G.
Now, consider the partial subhypergraph G – {1}

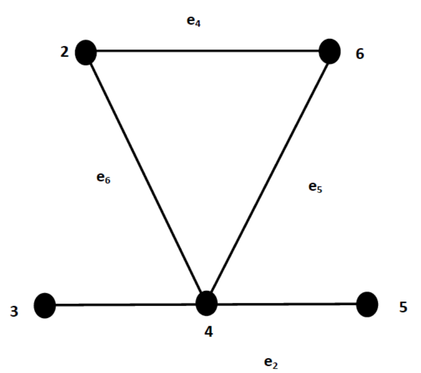

Fig.3. Partial Sub hypergraph G – {1}

The set $F = \{e_4, e_5, e_6\}$ is not an edge stable set of G – {1}.
Thus, an edge stable set of G even if it does not contain any edge containing v may not be an edge stable set of G – v.

Proposition 3.8 Let G be a hypergraph & $v \in V(G)$. If F is an edge stable set of G – v then F is also an edge stable set of G.

Proof Since F is an edge stable set of G – v, it does not contain any edge containing v.

Let x ∈ V(G) ∍ x ≠ v. Then x is a vertex of G – v. There is an edge h of G – v ∍ x ∈ h & h ∉ F. Every edge of G – v is an edge of G. Thus, h is an edge of G ∍ x ∈ h & x ∉ F.

Thus, F is an edge stable set of G.

Theorem 3.9 Let G be a hypergraph & v ∈ V(G) then $\beta_s^1(G - v) \leq \beta_s^1(G)$.

Proof Let F be a maximum edge stable set of G – v. By the above proposition F is an edge stable set of G.

$\therefore \beta_s^1(G) \geq |F| = \beta_s^1(G - v)$
$\therefore \beta_s^1(G - v) \leq \beta_s^1(G)$.

Example 3.10 Consider the hypergraph of the example 3.2.

Let F = $\{e_4, e_5, e_6\}$ then F is a maximum edge stable set of G.

$\therefore \beta_s^1(G) = 3$

Now, consider the partial subhypergraph G – {1}

Let F′ = $\{e_5, e_6\}$ then F′ is a maximum edge stable set of G – {1}.

$\therefore \beta_s^1(G - 1) = 2$

Hence, in this example $\beta_s^1(G - 1) < \beta_s^1(G)$.

We may note that a maximal edge stable set of G – v need not be a maximal edge stable set of G.

Example 3.11 Consider the hypergraph of the above example.

Let F′ = $\{e_5, e_6\}$ then F′ is a maximal edge stable set of G – {1} but it is not a maximal edge stable set of G.

Proposition 3.12 Let G be a hypergraph. Let e be any edge of G & edge degree of every vertex in e is at least 2. Then any edge stable set of G – e is also an edge stable set of G.

Proof Let G be a hypergraph. Let F be any edge stable set of G – e.

Let x be any vertex of G then x is a vertex of G – e also.

Now, F is an edge stable set of G – e, so ∃ an edge h containing x ∍ h ∉ F.

Now, h is an edge of G also. So, F is an edge stable set of G.

Proposition 3.13 Let G be a hypergraph. Let e be any edge of G then $\beta_s^1(G - e) \leq \beta_s^1(G)$.

Proof Let G be a hypergraph. Let F be a maximum edge stable set of G – e then $|F| = \beta_s^1(G - e)$.

Since F is a maximum edge stable set of G – e it is an edge stable set of G also.

$\therefore |F| \leq \beta_s^1(G)$.

Thus, $\beta_s^1(G - e) \leq \beta_s^1(G)$.

Proposition 3.14 Let G be a hypergraph. Let e be any edge of G ∍ edge degree of any vertex in e ≥ 2. Let F be an edge stable set of G & e ∈ F then F – {e} is an edge stable set of G – e.

Proof Let $F_1 = F - \{e\}$

Let x be any vertex of G – e then x is a vertex of G also. Since F is an edge stable set of G ∃ an edge h ∈ G ∍ x ∈ h & h ∉ F.

Now, h ≠ e because e ∈ F & h ∉ F. So, h is an edge of G – e also.

Now, $F_1 \subseteq F$. So, $h \notin F_1$ also.

So, F – {e} is an edge stable set of G – e.

Theorem 3.15 Let G be a hypergraph. Let e be any edge of G ∍ edge degree of each vertex x of e ≥ 3 then $\beta_s^1(G) > \beta_s^1(G - e)$.

Proof Let F be a maximum edge stable set of G – e. Let $F_1 = F \cup \{e\}$. Let x be any vertex of G ∍ edge degree of x ≥ 2 in G.

If x is a vertex of e then edge degree of x in G – e ≥ 2.

Therefore, there is an edge h of G – e containing x ∍ h ∉ F.

Since, h ≠ e, $h \notin F_1$ also.

Thus, there is an edge h of G containing x ∍ $h \notin F_1$.

$\therefore\ \beta_s^1(G) \geq |F_1| > |F| = \beta_s^1(G - e)$

$\therefore\ \beta_s^1(G - e) < \beta_s^1(G)$

Theorem 3.16 Let G be a hypergraph with minimum edge degree ≥ 2. Let e be an edge of G ∍ edge degree of each vertex of e ≥ 3

(1) If F is a maximal edge stable set of G – e then F ∪ {e} is a maximal edge stable set of G.

(2) If F is a maximal edge stable set of G with e ∈ F then F – {e} is a maximal edge stable set of G – e.

Proof (1) Let F be a maximal edge stable set of G – e & let $F_1 = F \cup \{e\}$. Let h be any edge of G ∍ $h \notin F_1$ then h ∉ F.

Since F is a maximal edge stable set of G – e there is a vertex x in h such that all the edges of G – e containing x are in F.

Thus, all the edges of G containing x except h are in F_1 (∵ $e \in F_1$). Thus, F_1 is a maximal edge stable set of G.

(2) Let F be a maximal edge stable set of G ∍ e ∈ F. Let F_1 = F - {e}. Let h be any edge of G - e ∍ $h \notin F_1$ then h ∉ F.

Since F is a maximal edge stable set of G there is a vertex x in h such that edge degree of x ≥ 2 & all the edges of G containing x except h are in F.

∴ All the edges of G - e containing x except h are in F_1.

Thus, F_1 is a maximal edge stable set of G - e.

Definition 3.17 (i_s^1- Set) Let G be a hypergraph. A maximal edge stable set with minimum cardinality is called an i_s^1- *Set* of G. Its cardinality is denoted as $i_s^1(G)$.

It is obvious that for any hypergraph G $i_s^1(G) \leq \beta_s^1(G)$.

Example 3.18:

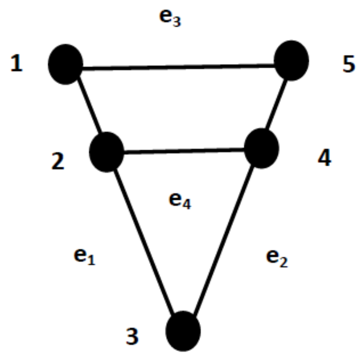

Fig.4. Hypergraph H

Consider the above hypergraph H whose vertex set V(H) = {1, 2, 3, 4, 5} and edge set E(H) = {e_1, e_2, e_3, e_4}
Let F = {e_3, e_4} then F is a maximum edge stable set of H & therefore β_s^1(H) = 2
Let T = {e_1} then obviously T is a maximal edge stable set with minimum cardinality.

$\therefore$ i_s^1(H) = 1
$\therefore$ i_s^1(H) < β_s^1(H).

Let G be a hypergraph and e be an edge of G. Now, we stat & prove a necessary & sufficient condition under which i_s^1 – number decreases when an edge is removed from the hypergraph.

Theorem 3.19 Let G be a hypergraph such that edge degree of each vertex of G ≥ 2. Let e be an edge of G ∍ edge degree of each vertex of e ≥ 3 then i_s^1(G - e) < i_s^1(G) if and only if there is an i_s^1 – set S of G ∍ e ∈ S.

Proof First suppose that i_s^1(G - e) < i_s^1(G). Let F_1 be an i_s^1 – set of G – e. Let F = F_1 ∪ {e}. Then by the above theorem F is a maximal edge stable set of G. Since |F| = |F_1| + 1, F is i_s^1 – set of G & e ∈ F.

Conversely, suppose there is an i_s^1 – set S of G ∍ e ∈ S. Let F_1 = F - {e}. Then by the above theorem F_1 is a maximal edge stable set of G - e.

$\therefore$ i_s^1(G - e) ≤ |F_1| < |F| = i_s^1(G).

Thus, i_s^1(G - e) < i_s^1(G)

Secured Edge Stable Set

Definition 3.20 (Secured Edge Stable Set) Let G be a hypergraph & F be a set of edges of G then F is said to be *secured edge stable set* if

(1) F is an edge stable set
(2) ∀ e ∈ F , there is an edge f in E(G) – F which is adjacent to e & (F – {e}) ∪ {f} is an edge stable set.

Example 3.21 Consider the hypergraph of the example 3.2.

Let $F = \{e_4, e_5, e_6\}$ then F is a secured edge stable set of G.

Remark 3.22 Let G be a hypergraph with minimum edge degree of $G \geq k$ ($k \geq 2$). Let F be a set of j edges where $1 \leq j < k$. Then F is an edge stable set of G.

Let $e \in F$ & $x \in e$. There is an edge h containing $x \ni h \notin F$.

Now, h is adjacent to e & $h \notin F$.

Let $F_1 = (F - \{e\}) \cup \{h\}$ then $|F_1| = j$ which is less then k

$\therefore$ F_1 is an edge stable set of G.

Definition 3.23 (Maximum Secured Edge Stable Set) Let G be a hypergraph. An edge stable set with maximum cardinality is called a *maximum secured edge stable set*. The cardinality of a maximum secured edge stable set is called the secured edge stability number of the hypergraph and it is denoted as $\beta_{ss}^{1}(G)$.

Proposition 3.24 Let G be a hypergraph with minimum edge degree of $G \geq k$ ($k \geq 2$). Suppose $1 \leq j < k$. If F is any set having j edges then F is a secured edge stable set of G.

Proof We have already proved in remark 3.22 that F is an edge stable set.

Let $f \in F$. Let $x \in f$ then there is an edge e containing $x \ni e \notin F$.

Let $F_1 = (F - \{f\}) \cup \{e\}$ then $|F_1| = |F| < k$. Again by remark 3.22 F_1 is an edge stable set of G. Therefore, F is a secured edge stable set of G.

Proposition 3.25 Let G be a hypergraph & $\{F_1, F_2, \ldots, F_k\}$ be the set of all edge stable sets of G having the same cardinality. Suppose one of these edge stable sets is a secured edge stable set then $F_1 \cap F_2 \cap \ldots \cap F_k = \phi$

Proof Suppose for some j, F_j is a secured edge stable set of G.

Suppose $f \in F_1 \cap F_2 \cap \ldots \cap F_k$ then $f \in F_j$. Since F_j is a secured edge stable set there is an edge $e \ni e \notin F_j$ & $F_j' = (F_j - \{f\}) \cup \{e\}$ is an edge stable set of G.

Now, $F_j' \in \{F_1, F_2, \ldots, F_k\}$ but $f \notin F_j'$. This is a contradiction.

$\therefore$ $F_1 \cap F_2 \cap \ldots \cap F_k = \phi$

Corollary 3.26 Let G be a hypergraph & suppose the intersection of all maximum edge stable sets of G is non-empty then $\beta_{ss}^{1}(G) < \beta_{s}^{1}(G)$.

Proof It is obvious that $\beta_{ss}^{1}(G) \leq \beta_{s}^{1}(G)$.

Suppose $\beta_{ss}^{1}(G) = \beta_{s}^{1}(G)$.

Let $\{F_1, F_2, \ldots, F_k\}$ be the set of all maximum edge stable sets of G. Since $\beta_{ss}^{1}(G) = \beta_{s}^{1}(G)$ this set will contain all (and therefore at least one) maximum secured edge stable set of G. Then by the above proposition $F_1 \cap F_2 \cap \ldots \cap F_k = \phi$. This contradicts the hypothesis.

$\therefore$ $\beta_{ss}^{1}(G) < \beta_{s}^{1}(G)$.

Proposition 3.27 Let G be a hypergraph & e be an edge of G. If F is a secured edge stable set of G – e then F is also a secured edge stable set of G.

Proof We have already proved that F is an edge stable set of (Proposition 3.12)

Let $f \in F$. Then f is an edge of G – e because $f \neq e$. Since F is a secured edge stable set of G – e there is an edge h of G – e ∋ h ∉ F & (F – {f}) ∪ {h} is an edge stable set of G – e. Now, h is also an edge of G & (F – {f}) ∪ {h} is an edge stable set of G. Thus, F is a secured edge stable set of G.

Theorem 3.28 Let G be a hypergraph & e be any edge of G then $\beta^1_{ss}(G - e) \leq \beta^1_{ss}(G)$.

Proof Let M be a maximum secured edge stable set of G – e then M is also a secured edge stable set of G.

$\therefore \beta^1_{ss}(G - e) = |M| \leq \beta^1_{ss}(G)$.
$\therefore \beta^1_{ss}(G - e) \leq \beta^1_{ss}(G)$.

Theorem 3.29 Let G be a hypergraph with minimum edge degree ≥ 2; if there is a maximum secured edge stable set F of G ∋ e ∈ F then $\beta^1_{ss}(G - e) < \beta^1_{ss}(G)$.

Proof Since F is an edge stable set of G, F – {e} is an edge stable set of G – e.
Let h ∈ F – {e}
Now, h ∈ F & F is a secured edge stable set of G. There is an edge h′ of G ∋ (F – {h}) ∪ {h′} is an edge stable set of G. It is obvious that ((F – {e}) - {h}) ∪ {h′} is an edge stable set of G – e. Thus, F – {e} is a secured edge stable set of G – e.
Since, $\beta^1_{ss}(G - e) \leq \beta^1_{ss}(G)$, F – {e} must be a maximum secured edge stable set of G – e.
Thus, $\beta^1_{ss}(G - e) < \beta^1_{ss}(G)$.

4. Conclusion and Future Scope

It may happen that the edge stability number remains same when some edges are removed from the hypergraph. It may be interesting to investigate and to find the lower bound of the minimum number of edges whose removal decreases the edge stability number of a given hypergraph. It may be interesting to find the relation between the lower bound of the hypergraph G and the lower bound for the subhypergraph or partial subhypergraph obtained by removing a vertex from the hypergraph.

Acknowledgement

The authors would like to thank the editors and the referees for their comments and suggestions.

References

[1] Acharya B., *Domination in Hypergraphs*, AKCE J. Graphs. Combin., 4, NO. 2(2007) 111 – 126.
[2] Behr A., Camarinopoulos L., *On the domination of hypergraphs by their edges*, Discrete Mathematics,187(1998), 31 – 38.
[3] Berge C., Graphs and Hypergraphs, North - Holland, Amsterdam (1973).
[4] Berge C., *Hypergraphs*, North – Holland Mathematical Library, New York, Volume – 45 (1989).
[5] Haynes T., Hedetniemi S. and Slater P., *Domination in Graphs Advanced Topics*, Marcel Dekker, Inc., New York, (1998).
[6] Haynes T., Hedetniemi S. and Slater P., *Fundamental of Domination in Graphs*, Marcel Dekker, Inc., New York, (1998).

[7] Thakkar D. and Dave V., *Edge Domination in Hypergraph,* International Journal of Mathematics & Statistics Invention. *Volume 5, Issue 9 (2017) 13-17.*
[8] Thakkar D. and Dave V., More about *Edge Domination in Hypergraph,* International Journal of Statistics and Applied Mathematics *Volume 3, Issue 5(*2018) 01-06.
[9] Thakkar D. and Dave V., *Regarding Edge Domination in Hypergraph,* International Journal of Mathematics Trends & Technology, Volume 44, NO. 3(2017) 108 – 114.
[10] Thakkar D. and Dave V., *Edge Stable Sets & Edge Independent Sets in Hypergraphs,* Journal of Mathematics and Informatics, Volume 12 (2018), 33-39.
[11] Thakkar D.and Kakrech B., *About Secure Independence in Graphs*, Advances and Application in Discrete Mathematics, Pushpa Publishing House, accepted.

Authors' Profiles

Dr. D. K. Thakkar is a retired professor of the Department of Mathematics of Saurashtra University, Rajkot. His areas of interest are Graph Theory, Topology and Discrete Mathematics. He has published over 85 research papers in various journals.

Ms. V. R. Dave is a young research student who likes to work in a challenging environment. She is working as an Assistant Professor in Shree M. and N. virani Science College, Rajkot. Her area of interest is Graph Theory. She has published over 12 research papers in various journals.

How to cite this paper: D. K. Thakkar, V. R. Dave,"Edge Stable Sets and Secured Edge Stable Sets in Hypergraphs", International Journal of Mathematical Sciences and Computing(IJMSC), Vol.5, No.2, pp.71-81, 2019.DOI: 10.5815/ijmsc.2019.02.06