Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 188 (2024) 15-26 EISSN 2392-2192

Inverse Blast Distance-2 Domination Number of ϑ – Obrazom

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ABSTRACT

A non-empty subset D' of vertices in a graph G is a Inverse blast distance dominating set if every vertex in $V - D'$ is within distance-2 of atleast one vertex in D'. The Inverse blast distance-2 domination number $\gamma'^{tc}_{c\leq 2}(G)$ is the minimum cardinality of a minimal Inverse blast distance-2 dominating set in G.The hub of this article is a search of the behavior of the blast distance-2 domination and the inverse blast distance-2 domination for $\vartheta -$ obrazom of some particular graphs.

***Keywords*:** Blast domination number, Inverse blast domination number, Distance-2 domination number, Blast distance-2 domination number, Inverse blast domination number, Inverse blast distance-2 domination number, ϑ – Obrazom

AMS Subject Classification: 05C69, 05C76

1. INTRODUCTION

In this paper, we considered only simple, finite, connected and undirected graphs of order n and m respectively. Generally, for a graph $G,$ we denote $V(G), E(G), \Delta(G), \delta(G),\ \lambda(G), i(G)$

(Received 28 October 2023; Accepted 20 November 2023; Date of Publication 22 November 2023)

and for its vertex set, edge set, maximum degree, minimum degree edge connectivity and independent set respectively. Degree of a vertex, denoted by $d_G(v)$.

We refer to [2-4] for any undefined terms in basic graph theory and for basic domination theory concepts respectively. A non-empty subset D of V is called a dominating set if every vertex in $V - D$ is adjacent to at least one vertex in D. The minimum cardinality taken over all such minimal dominating sets is called the domination number $\gamma(G)$.

Kulli and Sigarkanti [6] introduced the concept of inverse domination in graphs (1991). Let D be the minimum dominating set in a graph $G = (V, E)$. If $V - D$ contains a dominating set D' of G, then D' is called an inverse dominating set with respect to D. The inverse domination number $\gamma'(G)$ of G is the minimum cardinality of the minimal inverse dominating set of G.

A dominating set D of a graph G is an independent dominating set if the induced sub graph $< D >$ has no edges. The independent domination number $i(G)$ of a graph G is the minimum cardinality of an independent dominating set of G. Let D be the minimum independent dominating set of G. If $V - D$ contains an independent dominating set D' of G, then D' is called an inverse independent dominating set with respect to D. The inverse independent domination number $i'(G)$ of G is the minimum cardinality of a minimal inverse independent dominating set of G.

In [10] Sampathkumar and Walikar introduced the concept of connected domination in graphs. It was further was further studied in numerous article such as [1, 5]. Kaspar. S and M.P. Kulandaivel introduced towards connected domination in graphs (2017). In this paper, we defined the inverse blast distance-2 domination transition number of a graph G.

G. Mahadevan et.al introduced the concept of blast domination number of a graph with real life application. ϑ −obrazom plays a vital role of links between a range of areas of graph theory. After the introduction of blast domination number of a graph theory, many researchers attempted the important role in graph theory [12-20]. A wide range of researches emerge on the studies and applications of ϑ −obrazom. With gaze at, in this paper, the authors have made a yeoman attempt in getting the inverse blast distance-2 domination for the ϑ −obrazom of W_n, $K_{1,n}$ and $K_{m,n}$ graphs. Let $\lceil x \rceil$ denote the greatest integer not greater than x and $\lfloor x \rfloor$ denote the smallest integer not smaller than x.

2. PRELIMINARIES

Definition 2.1.[8]

A graph G is said to be triple connected, if any three vertices of G lie on a path.

Definition 2.2.[11]

A set D of vertices in a graph G is a distance-2 dominating set if every vertex in $V - D$ is within distance-2 of atleast one vertex in D. The distance-2 domination number $\gamma_{\leq 2}(G)$ is the minimum cardinality of a distance-2 dominating set in G.

Definition 2.3.[8]

A non-empty subset D of V of a connected graph G is called a Blast dominating set (or) BD-set, if D is a connected dominating set and the induced sub graph $< V - D >$ is triple connected. The minimum cardinality taken over all such Blast dominating sets is called the Blast domination number of G and is denoted by $\gamma_c^{tc}(G)$.

Definition 2.4.

A non-empty subset D of vertices in a graph G is a blast distance-2 dominating set if every vertex in $V - D$ is within distance-2 of atleast one vertex in D. The blast distance-2 domination number $\gamma_{c\leq 2}^{tc}(G)$ is the minimum cardinality of a blast distance-2 dominating set in G.

Definition 2.5.

Let D be a minimum blast dominating set in a graph $G = (V, E)$. If $V - D$ contains a blast dominating set D' of G, and then D' is called an inverse blast dominating set with respect to D. The Inverse blast domination number $\gamma'^{tc}_c(G)$ of G is the cardinality of a minimum Inverse blast dominating set of G.

Definition 2.6.

A non-empty subset D' of vertices in a graph G is a Inverse blast distance dominating set if every vertex in $V - D'$ is within distance-2 of atleast one vertex in D'. The Inverse blast distance-2 domination number $\gamma'^{tc}_{c\leq 2}(G)$ is the minimum cardinality of a minimal Inverse blast distance-2 dominating set in G.

Definition 2.7.

A non-empty subset D of a graph $V(G)$ is called an equitable dominating set of a graph G if for every $v \in V - D$, there exists a vertex $u \in D$ such that $uv \in E(G)$ and $|\deg(u) - \deg(v)| \leq 1$. The minimum cardinality of a minimal equitable domination number of G and it is denoted by $\gamma_e(G)$.

Definition 2.8. [8]

ϑ −obrazom of G denoted by $L(G)$ is the graph with the vertex set $E(G)$, where the vertices x and y in G. It is also called line graph of G.

3. ϑ − OBRAZOM OF WHEEL GRAPH

In this section, we investigated Blast distance-2 domination number and the inverse blast distance-2 domination number of some special graphs and many bounds are obtained.

Theorem 3.1.

In a Wheel graph, with $n \geq 3$, $\gamma'^{tc}_c[L(W_{1,n})] = \left\lfloor \frac{n+1}{2} \right\rfloor$

Proof

Let $V\left(L(W_{1,n})\right) = E(W_{1,n}) = \{e_i : 0 \leq i \leq n-1 \text{ subscripts modulo } n\} \cup \{e_i' : 0 \leq i \leq n-1\}$. We know that $\gamma_c^{tc}\left(L(W_{1,n})\right) = \left\lfloor \frac{n+1}{2} \right\rfloor$.

In $L(W_n)$, let us presume $D' = \begin{cases} e'_p: \ p = 1,2,5 \dots n-1 \\ \quad otherwise \end{cases}$

(i) If p is odd then n is even

To Prove the result for $n = 4$, Choose $\{e'_1, e'_3\}$ are the vertices which are adjacent to $\{e_0, e_1, e_2, e_3\}$ in $L(W_n(V-D))$. Clearly whose induced sub graph $< e'_1, e'_3 >$ is connected and $< e_0, e_1, e_2, e_3 >$ is triple connected. That is $L(W_{1,n}(V-D))$ contains a blast dominating set. Hence $\gamma_c'^{\,tc}[L(W_{1,4})] = 2$.

(ii) If p is even then n is odd

To Prove the result is true for $= 7$, Let us fix $\{e'_2, e'_4, e'_6, e_6\}$ be the vertices adjacent to $\{e_1, e_2, e_3, e_4, e_5, e_6\}$ in $L(W_{1,n}(V-D))$. Therefore $\{e'_2, e'_4, e'_6, e_6\}$ whose induced sub graph $< D' >$ is connected dominating set and simultaneously the induced sub graph of its complement $< V - D' >$ is triple connected. That is $L(W_{1,n}(V-D))$ contains a blast dominating set. Hence $\gamma_c'^{\,tc}[L(W_{1,7})] = 4$.

Thus in succession, the inverse blast dominating set of $L(W_{1,n})$ is the minimum blast dominating set of $L(W_{1,n})$.

Thus, $\gamma'^{tc}_{c}[L(W_{1,n})] = \gamma_c^{tc}\left(L(W_{1,n})\right) = \left\lfloor\frac{n+1}{2}\right\rfloor$.

Proposition 3.2.

For any Wheel graph with $n \geq 3$, $2 \leq \gamma_{c\,\leq 2}'^{\,tc}(L(W_{1,n})) \leq \left\lfloor\frac{\Delta}{2}\right\rfloor$

Proposition 3.3.

For a ϑ −obrazom of $W_{1,n}$ with n vertices and maximum degree Δ, $\left\lceil\frac{\Delta-1}{n}\right\rceil \leq \gamma_c'^{\,tc}(L(W_{1,n}))$.

Observation 3.4.

If we can take a minimal blast dominating set in $L(W_{1,n})$ then the induced sub graph $< D >$ is a clique dominating set.

Proof

Let us presume $D = \{e_i{}' : 0 \leq i \leq n-1\}$. Now choose the vertices $\{e_i{}' : 0 \leq i \leq n-1\}$ is adjacent to $\{e_i : 0 \leq i \leq n-1\}$ in $L(W_{1,n})$, whose induced sub graph is connected and a complete graph graph. It's complement $< V - D >$ is triple connected.

Therefore, our presumed result hold. That is minimal blast dominating set in $L(W_{1,n})$ is clique dominating set.

Observation 3.5.

If we take a minimal blast dominating set in $L(W_{1,n})$ then the induced sub graph $< V - D >$ is cycle of length $n-1$.

Observation 3.6.

In a ϑ −obrazom of $W_{1,n}$, $\frac{n}{\Delta+1}+1 \leq i(G) \leq \frac{n\Delta}{\Delta+1}-1$.

Proposition 3.7.

Every distance-2 dominating set is an blast dominating set in $W_{1,n}$

Observation 3.8.

For a ϑ −obrazom of $W_{1,n}$, then

(i) $\gamma_{c\leq 2}^{tc}(L(W_{1,n})) < \gamma_c^{tc}(L(W_{1,n}))$

(ii) $\gamma_c'^{\,tc}(L(W_{1,n})) \leq \gamma_c^{tc}(L(W_{1,n}))$

(iii) $\gamma(L(W_{1,n})) \leq \gamma_c^{tc}(L(W_{1,n}))$

(iv) $\gamma'(L(W_{1,n})) \leq \gamma_c'^{\,tc}(L(W_{1,n}))$.

Problem 1.

Characterize the $L(W_{1,n})$ graph G for which,

(i) $\gamma_c^{tc}(G) = \gamma_c'^{tc}(G)$

(ii) $\gamma_{c\leq 2}^{tc}(G) = \gamma_{c\leq 2}'^{tc}(G)$.

Problem 2.

Characterize the $L(W_{1,n})$ graph G for which,

$$\gamma_c^{tc}(G) + \gamma_c'^{\,tc}(G) = \begin{cases} n & if\ n = 3 \\ n+1 & if\ n \leq 5 \\ n+2 & if\ n\ \ is\ even\ (n \geq 6) \\ n+1 & if\ n\ \ is\ odd\ (n \geq 5) \end{cases}$$

Problem 3.

Characterize the $L(W_{1,n})$ graph G for which, $i(G) = i'(G)$

4. ϑ −OBRAZOM OF STAR GRAPH

In this section discussed on some bounds on $L(K_{1,n})$ graphs.

Theorem 4.1.

For a star graph with $n > 4$, $\gamma_c'^{\,tc}\left(L(K_{1,n})\right) = 1$.

Proof

Ever since the ϑ −obrazom of a star graph $K_{1,n}$ is the complete graph and we know that $\gamma_c^{tc}(K_{1,n}) = 1$. Therefore $\gamma_c^{tc}(K_{1,n}) = 1$. In factual of $L(K_{1,n})$ whose $V - D$ contains a blast dominating set is an inverse blast dominating set.

Now, we can presume $D' = \{v_2\}$ which satisfies the blast dominating condition because clearly $< D' >$ is connected and $< V - D' >$ is triple connected. Hence $\gamma_c'^{\,tc}\left(L(K_{1,n})\right) = 1$.

Proposition 4.2.

If a graph $G = L(K_{1,n})$ graph of order $n \geq 4$ then

$$(i)\gamma(L(K_{1,n}) = \gamma'(L(K_{1,n}) = \gamma_c^{tc}\left(L(K_{1,n})\right) = \gamma_c'^{\,tc}\left(L(K_{1,n})\right) = \gamma_{c\leq 2}^{tc}\left(L(K_{1,n})\right) = \gamma_{c\leq 2}'^{tc}\left(L(K_{1,n})\right) = 1$$

Proposition 4.3.

If G is the ϑ −obrazom of $K_{1,n}$ then the inequality $n-1 \geq \lambda(G) \geq n-2$ hold.

Observation 4.4.

(i) If we can take a minimum (or) minimal dominating set in $\mathrm{L(K_{1,n})}$ then the induced sub graph $< \mathrm{V - D} >$ is an clique dominating set.

(ii) Every dominating set in $\mathrm{L(K_{1,n})}$ is an equitable dominating set.

(iii) Every blast dominating set in $\mathrm{L(K_{1,n})}$ is an equitable dominating set.

(iv) Every inverse blast dominating set in $\mathrm{L(K_{1,n})}$ is an equitable dominating set

(v) Every dominating set in $\mathrm{L(K_{1,n})}$ is a blast dominating set.

(vi) Every inverse dominating set in $\mathrm{L(K_{1,n})}$ is a blast dominating set.

(vii) Every distance-2 dominating set in $\mathrm{L(K_{1,n})}$ is a blast distance-2 dominating set.

(viii) Every inverse distance-2 dominating set in $\mathrm{L(K_{1,n})}$ is a inverse blast distance-2 dominating set.

5. ϑ −OBRAZOM OF COMPLETE BI-PARTITE GRAPH

In this section, we obtained inverse blast distance-2 domination number of $L(K_{m,n})$ graph.

Theorem 5.1.

For any Complete-bipartite graph $K_{m,n}$ with $m, n \geq 2$,

$$\gamma'^{tc}_{c}[L(K_{m,n})] = \begin{cases} m & if\ m < n \\ n & if\ m > n \\ m\ or\ n & if\ m = n \end{cases}$$

Theorem 5.2.

For any Complete-bipartite graph $K_{m,n}$ with $m.n \geq 2,\ \gamma'^{tc}_{c\leq 2}[L(K_{m,n})] = 1.$

Observation 5.3.

(i) Every blast dominating set in $L(K_{m,n})$ is an equitable dominating set.

(ii) Every inverse blast dominating set in $L(K_{m,n})$ is an equitable dominating set.

Observation 5.4.

If a Complete-bipartite graph $K_{m,n}$ with $m,n \geq 3$, then $i[L(K_{m,n})] = \begin{cases} m & if\ m < n \\ n & if\ m > n \\ m\ or\ n & if\ n = m \end{cases}$

The following are some problems for further investigation

Problem 1.

Characterize the $L(K_{m,n})$ graph G for which,

$(i)\ \gamma(L(K_{m,n}) = \gamma'(L(K_{m,n})$

$(ii) \gamma_c^{tc}[L(K_{m,n})] = {\gamma'}_c^{tc}[L(K_{m,n})]$

$(iii) \gamma_{c\leq 2}^{tc}[L(K_{m,n})] = {\gamma'}_{c\leq 2}^{tc}[L(K_{m,n})]$

$(iv) \gamma_c^{tc}[L(K_{m,n})] + {\gamma'}_c^{tc}[L(K_{m,n})] = 2$

$(v) \gamma_{\leq 2}[L(K_{m,n})] + \gamma'_{\leq 2}[L(K_{m,n})] = 2$

6. BLAST AND INVERSE BLAST TRANSITION NUMBER

Definition 6.1.

Let G be a connected graph. We define the blast transition number as the difference between the blast domination number γ_c^{tc} and the domination number $\gamma(G)$ and denote it by τ_c^{tc}

That is $\tau_c^{tc}(G) = \gamma_c^{tc}(G) - \gamma(G)$.

Also define $\tau_{c\leq 2}^{tc}(G) = \gamma_{c\leq 2}^{tc}(G) - \gamma_{\leq 2}(G)$ and $\tau'^{tc}_{c\leq 2}(G) = \gamma'^{tc}_{c\leq 2}(G) - \gamma'_{\leq 2}(G)$.

Theorem 6.2.

For any Wheel graph $W_{1,n}$ with $n \geq 3$, $\tau_c^{tc}(L(W_{1,n})) = \left\lceil \frac{n+1}{2} \right\rceil - \left\lceil \frac{n}{3} \right\rceil + 1$

Theorem 6.3.

The blast distance-2 domination transition number of $L(W_{1,n})$ is $\tau_{c\leq 2}^{tc}\left(L(W_{1,n})\right) = 0$

Theorem 6.4.

The inverse blast distance-2 domination transition number of $L(W_{1,n})$ is ${\tau'}^{tc}_{c\leq 2}\left(L(W_{1,n})\right) = 0$.

Proposition 6.5.

For a ϑ −obrazom of $W_{1,n}$ with n vertices and minimum degree δ,

(i) $\delta \geq \gamma_c'^{tc}(L(W_{1,n})) \geq \tau_c'^{tc}(L(W_{1,n}))$ for $n = 3\ to\ 7$

Proposition 6.6.

If a $L(W_{1,n})$ graph $n \geq 3$ then $\tau_c'^{tc}\left(L(W_{1,n})\right) \leq 1 \leq \frac{\Delta-2}{2}$.

Proposition 6.7.

If a $L(W_{1,n})$ graph $n \geq 3$ with minimum degree δ, then $\tau'^{tc}_{c\leq 2}(L(W_n)) \leq \delta$.

Problem 1.

Characterize $L(W_{1,n})$ graphs for which, $\tau^{tc}_{c\leq 2}(L(W_n)) + \tau'^{tc}_{c\leq 2}(L(W_n)) = 2$

Problem 2

Characterize $L(W_{1,n})$ graphs for which, $\tau_c^{tc}(L(W_{1,n})) = \tau_c'^{tc}(L(W_{1,n}))$

Proposition 6.8.

The blast domination transition number $\tau_c^{tc}(L(K_{1,n}))$ is zero.

Proposition 6.9.

The inverse blast domination transition number $\tau_c'^{tc}(L(K_{1,n}))$ is zero

Proposition 6.10.

The blast domination transition number $\tau_c^{tc}(L(K_{m,n}))$ is zero.

Proposition 6.11.

The inverse blast domination transition number ${\tau'}^{tc}_c(L(K_{m,n}))$ is zero.

Proposition 6.12.

For a $L(K_{m,n})$ graph then $\tau'^{tc}_{c\leq 2}\left(L(K_{m,n})\right) \leq \gamma_{\leq 2}(L(K_{m,n}))$for every $m, n \geq 2$.

Proposition 6.13.

If a $L(K_{m,n})$ graph $\tau'^{tc}_{c\leq 2}(L(K_{m,n})) \leq \gamma'^{tc}_{c\leq 2}(L(K_{m,n}) \leq \gamma_{\leq 2}'(L(K_{m,n}))$.

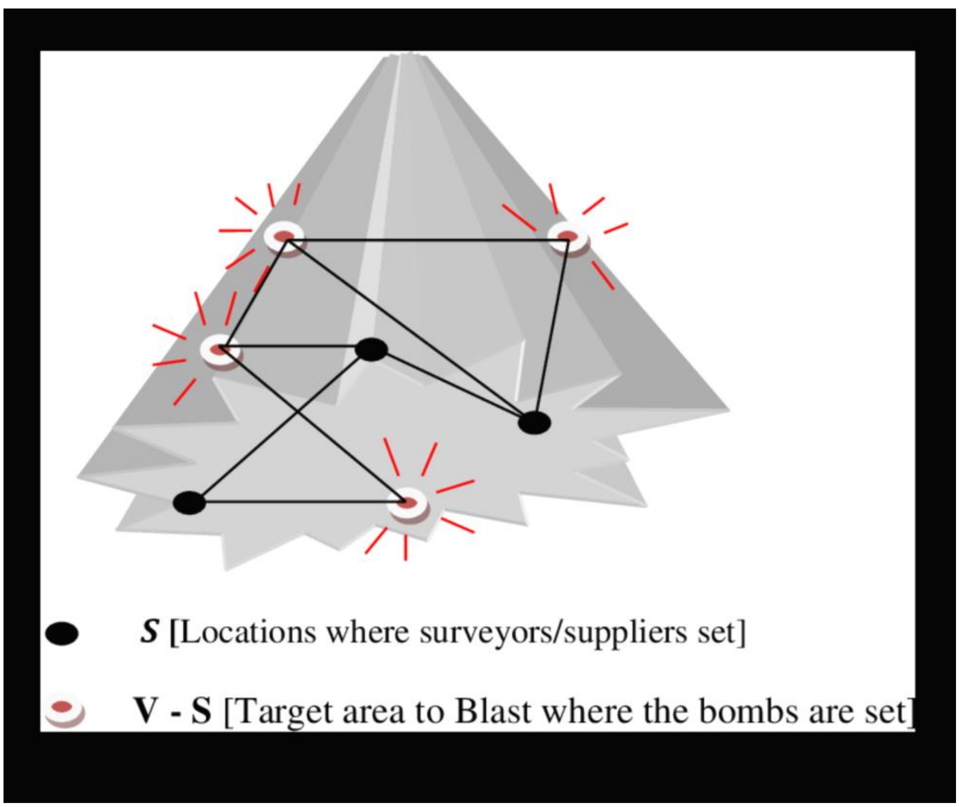
Observation 6.14.

Every blast dominating set is non-spit dominating set but converse may not be true.

7. REAL LIFE APPLICATIONS OF BLAST DOMINATION NUMBER

7. 1. Bomb blasting in quarries and mines [8]

Blasting is one of the most feared, more hazardous, most cost effective ways and least understood aspects of mining operations in Ohio and elsewhere. The blasts are designed by highly trained and skilled blasters who are certified by the DMRM, and must meet stringent limits for ground vibration and air blast. Blasting technology is the process of fracturing material using calculated amount of explosive, such that a preset volume of material is busted. A first class blast design and execution are essential to booming mining operations. Inappropriate or poor practices in blasting can boast a rigorously negative impact on the economics of a mine. Recently, so many soft wares also available such as Master Blaster, WipWare Inc., Soft-Blast, etc., for blast design, analysis, and management.



Every vertex in $V-D$ bomb blast can be done which is of distance at most 2. (Since $S=D$)

In this regard, our latest domination parameter, blast domination number plays an essential role for designing and execution. If we draw a graph of the above said situation by identifying the number of locations D to set the surveyors/suppliers in a series connection, such that a vast target area to explode the places, $V - D$, where we set the bombs to be blasted. Then, the solution is nothing but just finding the blast distance-2 dominating set of the graph. Thus, the blasting technology may be effectively implemented by finding the minimum number of locations to set the surveyors/suppliers so that the bombs which are in a combination of 3s or more in a single stroke is reduced to find the blast distance-2 domination number of the associated graph.

8. CONCLUSION

In this paper, we defined the notion of blast distance-2 domination and the inverse blast distance-2 domination and blast transition and inverse blast transition distance-2 domination in graphs. We attained many bounds on these two new parameters. Also we discussed the application of blast distance domination in blasting of bombs in quarries and mines.

Biography

Dr. P. Rajakumari has a great fervour towards teaching profession. she has completed his Bachelor degree (2011), Master degree (2014) in mathematics at D.K.M.College for women (Autonomous) Vellore, Also completed Master of Philosophy 2015 in Complex Analysis at D.K.M.College for women (Autonomous) Vellore. She has completed B.Ed at K.K.S. Mani College of Education. She has persued Ph.D in Domination of various parameters for middle, central, total, line and zero divisor graphs at D.K.M.College for women (Autonomous) Vellore, under Thiruvalluvar university in the year of 2020. She has worked 5 years as Assistant Professor in Adhiparasakthi College of Arts and Science (Autonomous) at Kalavai. At present she is working as Assistant professor in Jeppiaar Institute of Technology, Chennai. His discipline\Area of specialization in Graph Theory and Algebra. He has published 12 research articles in national and international journals. Shee has research enthusiams Graph Theory and Topological Spaces.

I. Silambarasan received his Ph.D. degree in Mathematics from the Department of Mathematics, Annamalai University, Tamil Nadu, India, in 2021. He has published 40 research articles in various international journals (Scopus and Web of Science). He has presented research papers in international conferences and attended many conferences, workshops, and seminars held in India. His research interests are Fuzzy Mathematics. **Email ID: sksimbuking@gmail.com**

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