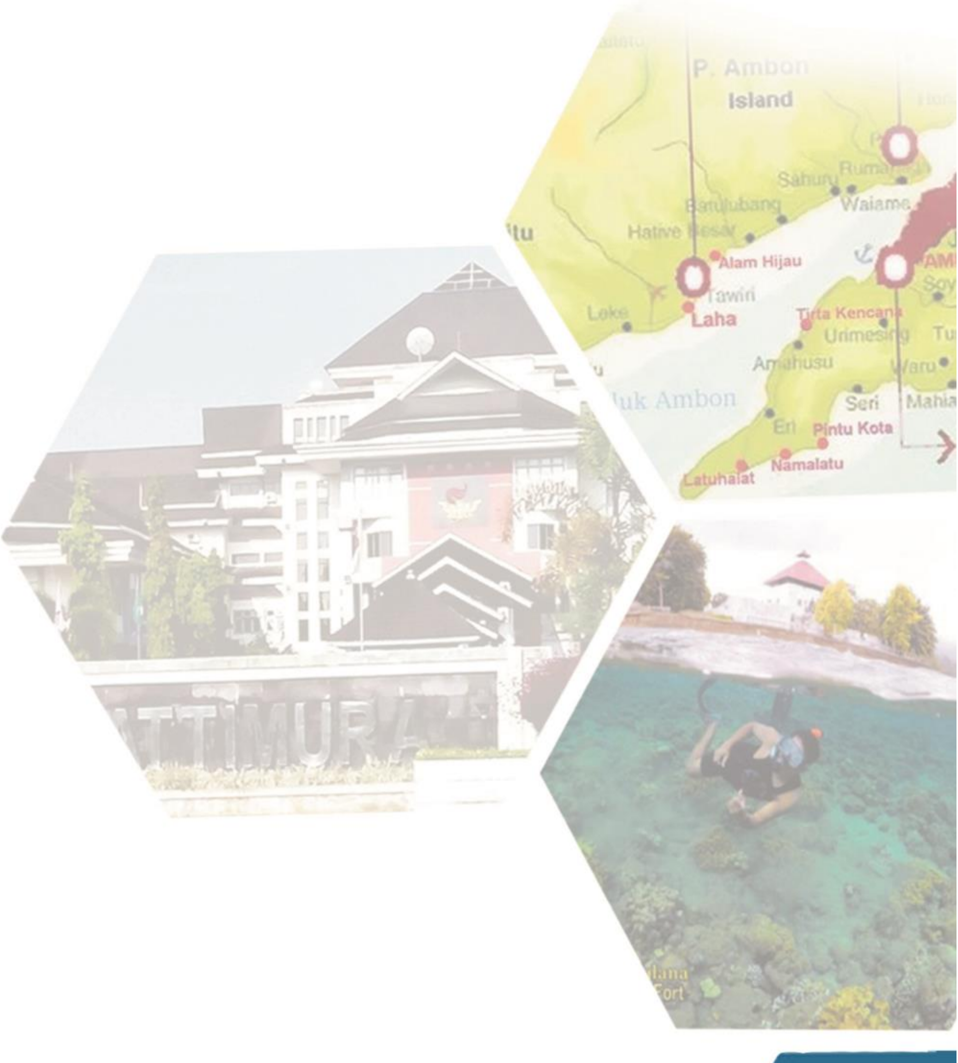
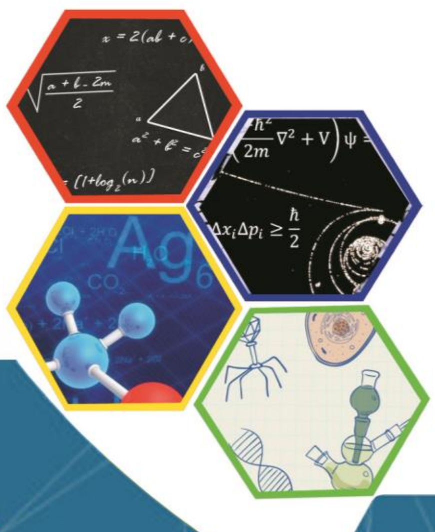
PROCEEDING

The 2nd International Seminar of Basic Science

Natural Science For Exploration The Sea-Island Resources

Ambon, May 31st 2016





Organized by
Faculty of Mathematics and Natural Science
Pattimura University

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The 2nd International Seminar of Basic Science

"Natural Science for Exploration The Sea-Island Resources"

Poka-Ambon, 31st May 2016

Mathematic and Natural Science Faculty
Universitas Pattimura
Ambon
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2nd edition

Welcoming Address By The Organizing Committee

Today, We have to thank the The Almighty Allah SWT for the implementation of this international seminar. This is the second seminar about Basic Science in The Faculty of MIPA Pattimura University. The seminar under the title “Natural Sciences for Exploration the Sea-Island Resources” will be carried out on May 31st 2016 at Rectorate Building, Pattimura University. There are 200 participants from lecturers, research institute, students, and also there are 34 papers will be presented.
My special thanks refer to the rector of Pattimura University and the Dean of MIPA Faculty, Prof. Dr. Pieter Kakissina, S.Pd., M.Si. I also would like to express my deepest gratitude to Prof. Amanda Reichelt-Brushett, M.Sc., Ph.D. ; Kazuhiko Ishikawa, Ph.D. ; Nicolas Hubert, Ph.D. ; Prof. Dr. Kirbani Sri Brotopuspito ; Prof. Dr. Marjono, M.Phil. ; Gino V. Limon, M.Sc., Ph.D. as the keynote speakers.

The last, We hope this international seminar usefull for all of us, especially Mollucas People and very sorry if any mistake. Thank you very much.

Dr. La Eddy, M.Si.
Chairman of Organizing Committee

Opening Remarks
By Dean of Mathematic and Natural Sciences Faculty

I express my deepest gratitude to The Almighty God for every single blessing He provides us especially in the process of holding the seminar until publishing the proceeding of International Seminar in celebrating the 18th anniversary of MIPA Faculty, Pattimura University. The theme of the anniversary is under the title "Natural Sciences for Exploration the Sea-Island Resources". The reason of choosing this theme is that Maluku is one of five areas in Techno Park Marine in Indonesia. Furthermore, it is expected that this development can be means where the process of innovation, it is the conversion of science and technology into economic value can be worthwhile for public welfare especially coastal communities.

Having the second big variety of biological resources in the world, Indonesia is rich of its marine flora and fauna. These potential resources can be treated as high value products that demand by international market. Basic science of MIPA plays important role in developing the management of sustainable marine biological resources.

The scientific articles in this proceeding are the results of research and they are analyzed scientifically. It is expected that this proceeding can be valuable information in terms of developing science and technology for public welfare, especially people in Maluku.

My special thanks refer to all researchers and reviewers for your brilliant ideas in completing and publishing this proceeding. I also would like to express my gratefulness to the dies committee-anniversary of MIPA Faculty for your creativity and hard working in finishing this proceeding, God Bless you all.

Prof. Dr. Pieter Kakisina, S.Pd., M.Si.
Dean of Mathematic and Natural Sciences Faculty

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"The 2nd International Seminar of Basic Science 2016"

Hotel Mutiara Ambon

Contents

THE TOTAL IRREGULARITY STRENGTH OF THE CORONA PRODUCT OF A PATH WITH A WHEEL

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ABSTRACT

A totally irregular total *k*-labeling $\lambda : V \cup E \rightarrow \{1, 2, \ldots, k\}$of a graph G is a total labeling such that G has an edge irregular total labeling and a vertex irregular total labeling at the same time. In other words, for any two different edges (and vertices), their weights are distinct. The minimum value k for which G has a totally irregular total *k*-labeling is called the total irregularity strength of G, denoted by $ts(G)$. In this paper, we determine the exact value ts of the corona product of a path with a wheel which is equals to the lower bound.

Keywords : *corona product, path, total irregularity strength,wheel*

INTRODUCTION

Let G be a finite, simple, and undirected graph with vertex set V and edge set E. A total labeling of G is a mapping that sends $V \cup E$ to a set of numbers (usually positive or nonnegative integers). According to the condition defined in a total labeling, there are many types of total labelings. For a total labeling $\lambda : V \cup E \rightarrow \{1,2, \ldots, k\}$, the weight of a vertex v and the weight of an edge $e = xy$ are defined by $w(v) = \lambda(v) + \sum_{uv \in E} \lambda(uv)$ and $w(xy) = \lambda(x) + \lambda(y) + \lambda(xy)$, respectively. If all the vertex weights are distinct, then λ is called a vertex irregular total k-labeling, and if all the edge weights are distinct, then λ is called an edge irregular total k-labeling. The minimum value of k for which there exist a vertex (or an edge) irregular total labeling $\lambda : V \cup E \rightarrow \{1,2,,k\}$ is called the total vertex (or edge) irregularity strength of G and is denoted by $tvs(G)$ ($tes(G)$), respectively.

This notions are introduced by Baca *et al.* in [2]. They gave the boundary for the $tvs(G)$ that for every (p, q)-graph G with minimum degree $\delta(G)$ and maximum degree $\Delta(G)$,

$$\left\lceil \frac{p + \delta(G)}{\Delta(G) + 1} \right\rceil \leq tvs(G) \leq p + \Delta(G) - 2\delta(G) + 1; \qquad (1)$$

and for the total edge irregularity strength of graph G, that is

$$\left\lceil \frac{|E(G)| + 2}{3} \right\rceil \leq tes(G) \leq |E(G)|. \qquad (2)$$

In [8], Nurdin *et al*. determined the total edge-irregular strengths of the corona product of paths with some graphs. They found that for $m \geq 2$ and $n \geq 3$,

$$tes(P_m \odot W_n) = \left\lceil \frac{(3n+2)m+1}{3} \right\rceil. \quad (3)$$

Later, in [7], Nurdin *et al*. improved the lower bound of tvs of any connected graph G. For $\delta = \delta(G)$ be the minimum degree of vertex in G, $\Delta = \Delta(G)$ be the maximum degree of vertex in G, and n_i be the number of vertex of degree i, where $\delta \leq i \leq \Delta$,

$$tvs(G) \geq \max\left\{ \left\lceil \frac{n_\delta + \delta}{\delta + 1} \right\rceil, \left\lceil \frac{n_\delta + n_{\delta+1} + \delta}{\delta + 2} \right\rceil, \cdots, \left\lceil \frac{\sum_{i=\delta}^{\Delta} n_i + \delta}{\Delta + 1} \right\rceil \right\} \quad (4)$$

For further results on $tvs(G)$ and $tes(G)$, one can refer to [3].

Combining previous conditions on both total labeling, Marzuki et al. in [6] introduced another irregular total labeling. A total k-labeling $\lambda : V \cup E \rightarrow \{1,2,\cdots,k\}$ of G is called a *totally irregular total k-labeling* if for any pair of vertices x and y, their weights $w(x)$ and $w(y)$ are distinct and for any pair of edges $x_1x_2$and y_1y_2, their weights $w(x_1x_2)$ and $w(y_1y_2)$ are distinct. The minimum value k for which G has a totally irregular total labeling is called the *total irregularity strength* of G, denoted by $ts(G)$. They gave the lower bound of $ts(G)$,

$$ts(G) \geq max\{tes(G), tvs(G)\}; \quad (5)$$

and determined the exact value of total irregularity strength of paths and cycles. In [9], Ramdani and Salman determined the ts of several cartesian product graphs. Later, Ramdani et al. [11] determined the ts for gear graphs, fungus graphs, $ts(Fg_n)$, for n even, $n \geq 6$; and for disjoint union of stars. Tilukay *et al*. in [12] and [13] determined the ts of fan, wheel, triangular book, friendship graphs, complete graph, and bipartite graph, which are equal to the lower bound. Some other results can be seen in [1], [4], [5], and [10].

In this paper, we determine the exact value ts of the corona product of a path with a wheel which is equals to the lower bound.

RESULTS AND DISCUSSION

The corona product of G with H, denoted by $G \odot H$, is a graph obtained by taking one copy of an n-vertex graph G and n copies $H_1, H_2, \cdots, H_n$ of H and then joining the i-th vertex of G to every vertex in H_i. For instance, corona product of a path P_3 with a wheel W_8 is given in Figure 1.

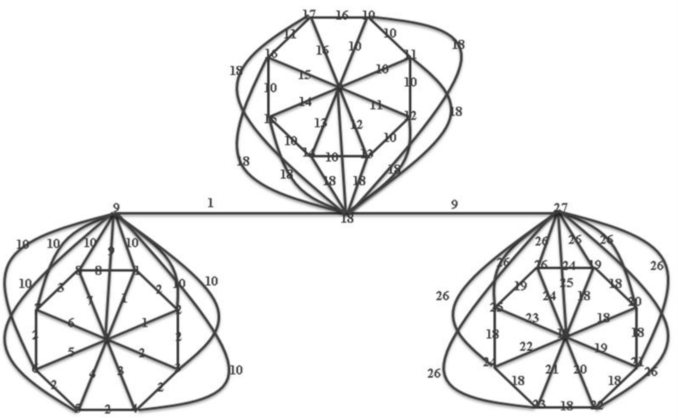

Figure 1. $P_3 \odot W_8$ with totally irregular total 27-labeling

Theorem 2.1 For $m \geq 2$ and $n \geq 3$, let $P_m \odot W_n$, be a corona product of a path P_m and a wheel W_n with $m(n+2)$ vertices and $(3n+2)m-1$ edges. Then

$$ts(P_m \odot W_n) = \left\lceil \frac{(3n+2)m+1}{3} \right\rceil.$$

Proof:
Since $|V(P_m \odot W_n)| = m(n+2)$, $|E(P_m \odot W_n)| = (3n+2)m-1$, $\delta = 4$ and $\Delta = n+2$, by (3), (4) and (5), we have $ts(P_m \odot W_n) \geq \left\lceil \frac{(3n+2)m+1}{3} \right\rceil$
Next, we proof that $ts(P_m \odot W_n) \leq \left\lceil \frac{(3n+2)m+1}{3} \right\rceil$. Let $t_i = \left\lceil \frac{(3n+2)i+1}{3} \right\rceil$ for $2 \leq i \leq m$. Let the vertex set $V(P_m \odot W_n) = \{x_{i\,,} y_i^j \mid 1 \leq i \leq m \text{ and } 1 \leq j \leq n+1\}$ and the edge set

$$E(P_m \odot W_n) = \{x_i y_i^j \mid 1 \leq i \leq m \text{ and} 1 \leq j \leq n+1\} \cup \{y_i^j y_i^{j+1} \mid 1 \leq i \leq m \text{ and } 1 \leq j \leq n-1\}$$
$$\cup \{y_i^1 y_i^n \mid 1 \leq i \leq m \text{ and } 1 \leq j \leq n-1\} \cup \{y_i^j y_i^{n+1} \mid 1 \leq i \leq m \text{ and } 1 \leq j \leq n\}$$
$$\cup \{x_i x_{i+1} \mid 1 \leq i \leq m-1\}$$

From the definition above, we know that y_i^{n+1} is the center of W_i.
We construct an irregular total labeling $\lambda : V(G) \cup E(G) \to \{1, 2, 3, \ldots, k\}$.
We divide the construction into two cases as follows:

Case 1. $n \leq 7$

$$\lambda(x_i) = \begin{cases} 1, & \text{for } i = 1; \\ t_i - n + 1, & \text{for } 2 \leq i \leq m; \end{cases}$$

$$\lambda(y_i^j) = \begin{cases} j, & \text{for } i = 1 \text{ and } 1 \leq j \leq n+1; \\ t_i - n + j, & \text{for } 2 \leq i \leq m \text{ and } 1 \leq j \leq n; \\ t_i, & \text{for } 2 \leq i \leq m \text{ and} j = n+1; \end{cases}$$

$$\lambda(x_i y_i^j) = \begin{cases} 1, & \text{for } i = 1 \text{ and } 1 \leq j \leq n+1; \\ (3n+2)i - n - 1 - 2\,t_i, & \text{for } 2 \leq i \leq m \text{ and } 1 \leq j \leq n; \\ (3n+2)i - n - 2t_i, & \text{for } 2 \leq i \leq m \text{ and } j = n+1; \end{cases}$$

$$\lambda(y_i^1 y_i^n) = \begin{cases} 3, & \text{for } i = 1; \\ (3n+2)i + 1 - n - 2t_i, & \text{for } 2 \leq i \leq m; \end{cases}$$

$$\lambda(y_i^j y_i^{j+1}) = \begin{cases} n + 3 - j, & \text{for } i = 1 \text{ and } 1 \leq j \leq n-1; \\ (3n+2)i + 1 - j - 2t_i, & \text{for } 2 \leq i \leq m \text{ and } 1 \leq j \leq n-1; \end{cases}$$

$$\lambda(y_i^j y_i^{n+1}) = \begin{cases} n + 2, & \text{for } i = 1 \text{ and } 1 \leq j \leq n; \\ (3n+2)i + 1 - 2t_i, & \text{for } 2 \leq i \leq m \text{ and } 1 \leq j \leq n; \end{cases}$$

$$\lambda(x_i x_{i+1}) = \begin{cases} 4n + 2 - t_2, & \text{for } i = 1; \\ (3n+2)i + 2n - t_i - \mathrm{t}_{i-1}, & \text{for } 2 \leq i \leq m. \end{cases}$$

Hence, we have

$$w(x_i y_i^j) = (3n+2)i - 3n + j, \quad \text{for } 1 \leq i \leq m \text{ and } 1 \leq j \leq n+1;$$
$$w(y_i^1 y_i^n) = (3n+2)i - 2(n-1), \quad \text{for } 1 \leq i \leq m;$$
$$w(y_i^j y_i^{j+1}) = (3n+2)i - 2(n-1) + j, \quad \text{for } 1 \leq i \leq m \text{ and } 1 \leq j \leq n-1;$$
$$w(y_i^j y_i^{n+1}) = (3n+2)i - (n-1) + j, \quad \text{for } 1 \leq i \leq m \text{ and } 1 \leq j \leq n;$$
$$w(x_i x_{i+1}) = (3n+2)i + 2, \quad \text{for} 1 \leq i \leq m;$$

and

$$w(x_i) = \begin{cases} n + t_2, & \text{for } i = 1; \\ n(5n + 7 - 2t_2) + 3, & \text{for } i = 2, m = 2; \\ (n+2)(3n+2)i - n^2 - n - (2n-1)t_i - t_{i-1} - t_{i+1} + 1, & \text{for } 2 \leq i \leq m-1, m \neq 2; \\ (n+2)(3n+2)i - n^2 - n - (2n-2)t_i - t_{i-1} + 1, & \text{for } i = m, m \neq 2; \end{cases}$$

$$w(y_1^j) = \begin{cases} 2n+9, & \text{for } j=1; \\ 3n+10-j, & \text{for } 2 \le j \le n; \\ n(n+2)+j+1, & \text{for } j=n+1; \end{cases}$$

$$w(y_i^j) = \begin{cases} 4i(3n+2)-3n-7t_i+2 & \text{for } 2 \le i \le m, j=1; \\ 4i(3n+2)-2n-7t_i-j+3 & \text{for } 2 \le i \le m, 2 \le j \le n; \\ 4i(3n+2)-n-7t_i+3 & \text{for} 2 \le i \le m, j=n+1; \end{cases}$$

It easy to check that the maximum label is t_i. By verifying the edge weights, we have

$\{w(x_i y_i^j)\} = \{(3n+2)i-3n+1, (3n+2)i-3n+2, \dots, (3n+2)i-2n+1\}$;

$\{w(y_i^1 y_i^n)\} = \{n+4, 4n+6, \dots, 3mn+2m-2n+2\}$;

$\{w(y_i^j y_i^{j+1})\} = \{(3n+2)i-2(n-1)+1, (3n+2)i-2(n-1)+2, \dots, (3n+2)i-n+1\}$;

$\{w(y_i^j y_i^{n+1})\} = \{(3n+2)i-(n-1)+1, (3n+2)i-(n-1)+2, \dots, (3n+2)i+1\}$;

$\{w(x_i x_{i+1})\} = \{3n+4, 6n+6, \dots, 3mn+2m+2\}$.

Hence, the edge weights form a consecutive sequence $3, 4, \dots, (3n+2)m+1$.

For the vertex weights, it can be checked that there is no two vertices of the same weight.

Case 2. $n \ge 8$

$$\lambda(x_i) = \begin{cases} n+1, & \text{for even } n, i=1; \\ n-1, & \text{for odd } n, \ i=1; \\ t_i, & \text{for } 2 \le i \le m; \end{cases}$$

$$\lambda(y_i^j) = \begin{cases} n-j+1, & \text{for } i=1 \text{ and } 1 \le j \le n; \\ 1, & \text{for } i=1 \text{ and } j=n+1; \\ t_i-n+j-1, & \text{for } 2 \le i \le m \text{ and } 1 \le j \le n+1; \end{cases}$$

$$\lambda(x_i y_i^j) = \begin{cases} n+2, & \text{for even } n, \ i=1 \text{ and } 1 \le j \le n; \\ n+1, & \text{for even } n, \ i=1 \text{ and } j=n+1; \\ n+4, & \text{for odd } n, \ i=1 \text{ and } 1 \le j \le n; \\ n+3, & \text{for odd } n, \ i=1 \text{ and } j=n+1; \\ (3n+2)i-n-2t_i, & \text{for } 2 \le i \le m \text{ and } 1 \le j \le n+1; \end{cases}$$

$$\lambda(y_i^1 y_i^n) = ni, \quad \text{for } 1 \le i \le m;$$

$$\lambda(y_i^j y_i^{j+1}) = \begin{cases} 3, & \text{for } i=1 \text{ and } j=1; \\ 2, & \text{for } i=1 \text{ and } 2 \le j \le n-1; \\ 1, & \text{for odd } n, i=1 \text{ and } j=n-1; \\ 3+(i-1)n, & \text{for } 2 \le i \le m \text{ and } 1 \le j \le n-1; \\ 2+(i-1)n, & \text{for } 2 \le i \le m \text{ and } 1 \le j \le n-1; \\ 1+(i-1)n, & \text{for odd } n, 2 \le i \le m \text{ and } j=n-1; \end{cases}$$

$$\lambda(y_i^j y_i^{n+1}) = \begin{cases} n-j, & \text{for } i=1 \text{ and } 1 \le j \le n-1; \\ 1, & \text{for } i=1 \text{ and } j=n; \\ 2, & \text{for odd } n, i=1 \text{ and } j=n-1; \\ (3n+2)i+1-j-2t_i, & \text{for } 2 \le i \le m \text{ and } 1 \le j \le n-1; \\ (3n+2)i+2-j-2t_i, & \text{for } 2 \le i \le m \text{ and } j=n; \\ (3n+2)i+1-j-2t_i, & \text{for odd } n, 2 \le i \le m \text{ and } j=n; \end{cases}$$

$$\lambda(x_i x_{i+1}) = \begin{cases} 1, & \text{for even } n, i=1; \\ 3, & \text{for odd } n, i=1; \\ (3n+2)i+2n-t_i-t_{i+1}, & \text{for } 2 \le i \le m-1. \end{cases}$$

Hence,

$w(x_i y_i^j) = (3n+2)i + 2 - j, \quad \text{for } 1 \le i \le m \text{ and } 1 \le j \le n+1;$
$w(y_i^1 y_i^n) = (3n+2)i - (n+1), \quad \text{for } 1 \le i \le m;$

$$w(y_i^j y_i^{j+1}) = \begin{cases} (3n+2)i - n + 4, & \text{for } 1 \le i \le m \text{ and } j = 1; \\ (3n+2)i - n + 1 + 2j, & \text{for } 1 \le i \le m \text{ and } 2 \le j \le n-2; \\ (3n+2)i - n + 2j, & \text{for odd } n, 1 \le i \le m \text{ and } j = n-1; \\ (3n+2)i - n + 1 + 2j, & \text{for even } n, 1 \le i \le m \text{ and } j = n-1; \end{cases}$$

$$w(y_i^j y_i^{n+1}) = \begin{cases} (3n+2)i - n - 2j, & \text{for } 1 \le i \le m \text{ and } 1 \le j \le n-2; \\ (3n+2)i - 3n + 3, & \text{for odd } n, 1 \le i \le m \text{ and } j = n-1; \\ (3n+2)i - 3n + 2, & \text{for even } n, 1 \le i \le m \text{ and } j = n-1; \\ (3n+2)i - 3n + 1, & \text{for } 1 \le i \le m \text{ and } j = n; \end{cases}$$

$w(x_i x_{i+1}) = (3n+2)i + 2, \quad \text{for } 1 \le i \le m;$

and

$$w(x_i) = \begin{cases} 2(n+1) + n(n+2) + 1, & \text{for even } n, i = 1; \\ 2(n+1) + n(n+4) + 3, & \text{for odd } n, i = 1; \\ (3n+2)2i + n - 2t_i - t_{i+1}, & \text{for even } n, 2 \le i \le m; \\ (3n+2)2i + n - 2t_i - t_{i+1} + 2, & \text{for odd } n, 2 \le i \le m; \end{cases}$$

$$w(y_1^j) = \begin{cases} 4(n+1), & \text{for even } n,\ j = 1; \\ 2(2n+3), & \text{for odd } n,\ j = 1; \\ 3n+4, & \text{for even } n,\ j = 1; \\ 3n+6, & \text{for odd } n,\ j = 1; \\ 3n - 2j + 7, & \text{for even } n, 3 \le j \le n-1; \\ 3n - 2j + 9, & \text{for odd } n, 3 \le j \le n-1; \\ 2n - (-1)^n + 7, & \text{for even } n,\ j = n; \\ 2n - (-1)^n + 6, & \text{for odd } n,\ j = n; \\ n + 3 + \dfrac{(n^2 - n)}{2}, & \text{for even } n,\ j = n+1; \\ n + 7 + \dfrac{(n-2)(n+1)}{2}, & \text{for odd } n,\ j = n+1; \end{cases}$$

$$w(y_i^j) = \begin{cases} 4i(3n+2) - 3n - 6t_i + 2, & \text{for even } n,\ 2 \le i \le m,\ j = 1; \\ 4i(3n+2) - 3n - 6t_i + 1, & \text{for odd } n,\ 2 \le i \le m,\ j = 1; \\ 4i(3n+2) - 3n - 6t_i - 3j, & \text{for even } n,\ 2 \le i \le m,\ 2 \le j \le n-1; \\ 4i(3n+2) - 3n - 6t_i - 3j - 2, & \text{for odd } n,\ 2 \le i \le m,\ 2 \le j \le n-1; \\ 4i(3n+2) - 3n - 6t_i + 6, & \text{for even } n,\ 2 \le i \le m,\ j = n; \\ 4i(3n+2) - 3n - 6t_i + 4, & \text{for odd } n,\ 2 \le i \le m,\ j = n; \\ 4i(3n+2) - n - 7t_i + 3, & \text{for } 2 \le i \le m,\ j = n+1. \end{cases}$$

It easy to check that the maximum label is t_i. By verifying the edge weights, we have

$\{w(x_i y_i^j)\} = \{(3n+2)i + 1, (3n+2)i, \dots, (3n+2)i + 1 - n\};$
$\{w(y_i^1 y_i^n)\} = \{2n+1, 5n+3, \dots, 3mn + 2m - n - 1\};$
$\{w(y_i^j y_i^{j+1})\} = \{2n+6, 5n+8, \dots, 3mn + 2m - n + 4\}$
$\cup \{(3n+2)i - n + 5, (3n+2)i - n + 7, \dots, (3n+2)i + n - 3\}$
$\cup \{(3n+2)i + n - 2\} \cup \{(3n+2)i + n - 1\};$
$\{w(y_i^j y_i^{n+1})\} = \{3\} \cup \{4\} \cup \{5\}$
$\cup \{(3n+2)i - n - 2, (3n+2)i - n - 4, \dots, (3n+2)i - 3n - 4\};$

$\{w(x_i x_{i+1})\} = \{3n + 4, 6n + 6, \ldots, 3mn + 2m + 2\}$.
Hence, the edge weights form the consecutive sequence $3, 4, \ldots, (3n + 2)m + 1$.
For the vertex weights, it can be checked that there is no two vertices of the same weight.
Then, we can conclude that λ is a totally irregular total t_i-labeling of $P_i \odot W_n$, for $1 \leq i \leq m$.
Thus,

$$ts(P_m \odot W_n) \leq \left\lceil \frac{(3n + 2)m + 1}{3} \right\rceil \qquad \blacksquare$$

OPEN PROBLEM :

1. Find $ts(P_1 \odot W_n)$ for any $(n + 1)$ – wheel graph.
2. Find the total irregularity strength of the corona product of path with any graph.

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