

A REVIEW OF SAFETY CONSTRUCTION OF BILLBOARD AROUND BANJARMASIN

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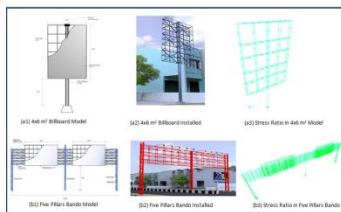
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Graphical abstract



Abstract

A safe and standard billboard construction is very important everywhere as well as in and around Banjarmasin. Therefore, the research using cross-sectional descriptive design to analyze the ratio of axial-flexible stress of pillars was conducted. The inclusion criteria for the billboards are billboards with dimension of 4x6 m2, 5x10 m2 and cross-road horizontal billboard or Bando. Meanwhile the exclusion criteria are billboards with dimension of 2x4 m2, 1x1 m2 and non-steel materials billboards. The result shows that billboard construction that is considered safe as well as standard one is billboard with the dimension of 4x6 m2, 10" pillar, 5x5 cm2 angled steel profile; and five pillars Bando with 18" middle pillar, two ϕ 10" side pillars (2.5" truss). Meanwhile billboard construction which is not considered safe are 5x10 m2 billboard, 18" pillar, 2" truss, 5x5 cm2 angled steel profile; and Bando with three 18" pillars, 2" truss. The improvement for 5x10 m2 billboards is by adding 2" diagonal truss, 18" pillar, 2" truss; for three pillars Bando, the improvement is by adding four ϕ 6" pillar, 18" pillar, 2.5" truss.

Keywords: Billboard, construction, safe, dimension, pillar

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1.0 INTRODUCTION

Billboard construction is a construction that is different from residential or other public constructions. There are many factors that can cause failure in billboard construction. Especially in and around Banjarmasin, analysis on failure risk of billboard construction is illustrated in a fishbone scheme (Figure 1a). In general, billboard construction consists of a set of structures that must be able to carry axial (tensile/compress) load and flexible moment [1]. The beam-column element in Billboard construction can be illustrated as an uncertain static portal (Figure 1b).

Axial and flexible force interaction equations were considered by calculating the compress member that held concentric force caused by factored load (N_u) by fulfilling factored compress force requirement $N_u \leq \phi N_n$ (SNI 03-1729-2002 Table 6.4-2), ratio of the slinness of sectional elements $\lambda_{element} < \lambda_r$, the structure component

slinness of member $\lambda_{member} = \frac{L_k}{r} < 200$, and the ratio of width and thickness which should bigger than the value of λ_r (Table 1). In addition, the flexibility condition was calculated based on the following:

a. Connection of External Load Impact, for strong axis (x-axis) must fulfill $M_{ux} \leq \phi M_{nx}$ and for weak axis (y-axis) must fulfill $M_{uy} \leq \phi M_{ny}$. M_n , the smaller value from sectional nominal strength is taken, for flexible moment toward x axis, or structure component nominal strength for flexible moment toward x axis determined by the steel profile.

b. Flexible Stress and Plastic Moment. The distribution of stress in a sectional caused by flexible moment. In service load area, the sectional is still elastic, the elastic condition occurs until the outermost fiber reaches its melting point (f_y). After it reaches the melting point (ϵ_y), the stress will continually increase without followed by the increase of stress. When the

melting point is reached at the outer most fiber, nominal moment resistance equals to M_{yx} melting moment, with magnitude $M_{ny} = M_{yx} = S_x \cdot f_y$. When the top condition of stress is reached, all fibers in the sectional exceed its melting point, and the condition is known as plastic condition. Nominal moment

resistance in this condition is called moment plastic M_p , and the $M_p = f_y \cdot Z$, as well

c. Stability; When the beam can be calculated in full plastic condition then the nominal moment strength can be considered as plastic moment capacity. $M_n = M_p$ or $M_n < M_p$

Table 1 Ratio of Maximum Width toward Thickness for Pressed Element (f_y in MPa) ^a

Element Type	Ratio toward thickness (λ)	Ratio of Maximum Width Toward Thickness	
		λ_r (compact)	λ_r (compact)
Wing plate beam-I and inner flexible channel	b/t	$170/\sqrt{f_y}[c]$	$370/\sqrt{f_y - f_y}[c]$
Wing plate beam-I hybrid or arranged beams flexible inner welded	b/t	-	$\frac{420}{\sqrt{f_{xf} - f_r/kc}}[c][f]$
Wing plates from arranged components in compressed form	b/t	-	$290/\sqrt{f_y/kc}[f]$
Free wing from twin angled profile that joint with other wings, wing plate from channel structure component in axial stress, angled and plate profiles that join with the compressed structure of beam or component	b/t	-	$250/\sqrt{f_y}$
Wing from single angled profile in support, wing from multiple angled profiles with couple plates in support, element that is not stiffening, i.e. supported in one of the sides.	b/t	-	$200/\sqrt{f_y}$
Body plate of T profile	b/t	-	$335/\sqrt{f_y}$

^aSource: SNI 03-1729-2002, Table 7.5-1

Main load arises as axial load (tensile/compress) and flexible moment in billboard construction in and around Banjarmasin Municipality is caused by a very strong wind movement or downburst wind that usually occurs in transition season [2]. Based on data from National Meteorology and Climatology Board, for the last five years, the average wind speed in and around Banjarmasin is 25 knots = 46.3 km/hour, when it is converted towards wind working load in the construction it becomes 40 kg/m². The value of the wind load exceeds the value of wind load works in constructions according to Indonesia Loading Regulation year 1989, namely minimum 25 kg/m² for area with more than 5 km distance to the sea, while for the sea nearby area the minimum working load is 40 kg/m². For a space truss structure with square cross section with perpendicular wind direction in one of truss

planes [3], the wind coefficient for the first truss in wind side is +1,6, and for the second truss behind the wind is +1,2, as shown in Figure 1c.

Based on the condition, license board of Banjarmasin Municipality government has strengthened the requirements for proposing billboard Building Permits, and one of the requirements is to have a report of structure calculation related to loading caused by downburst wind [4-7]. In this case, the writer has summarized and analyzed the level of safety for some billboard constructions and designed a standard recommendation for billboard construction that can be used as a reference for some types of billboards as well as to give enforcement solution information in some billboards that is relatively not safe without unloading the overall construction.

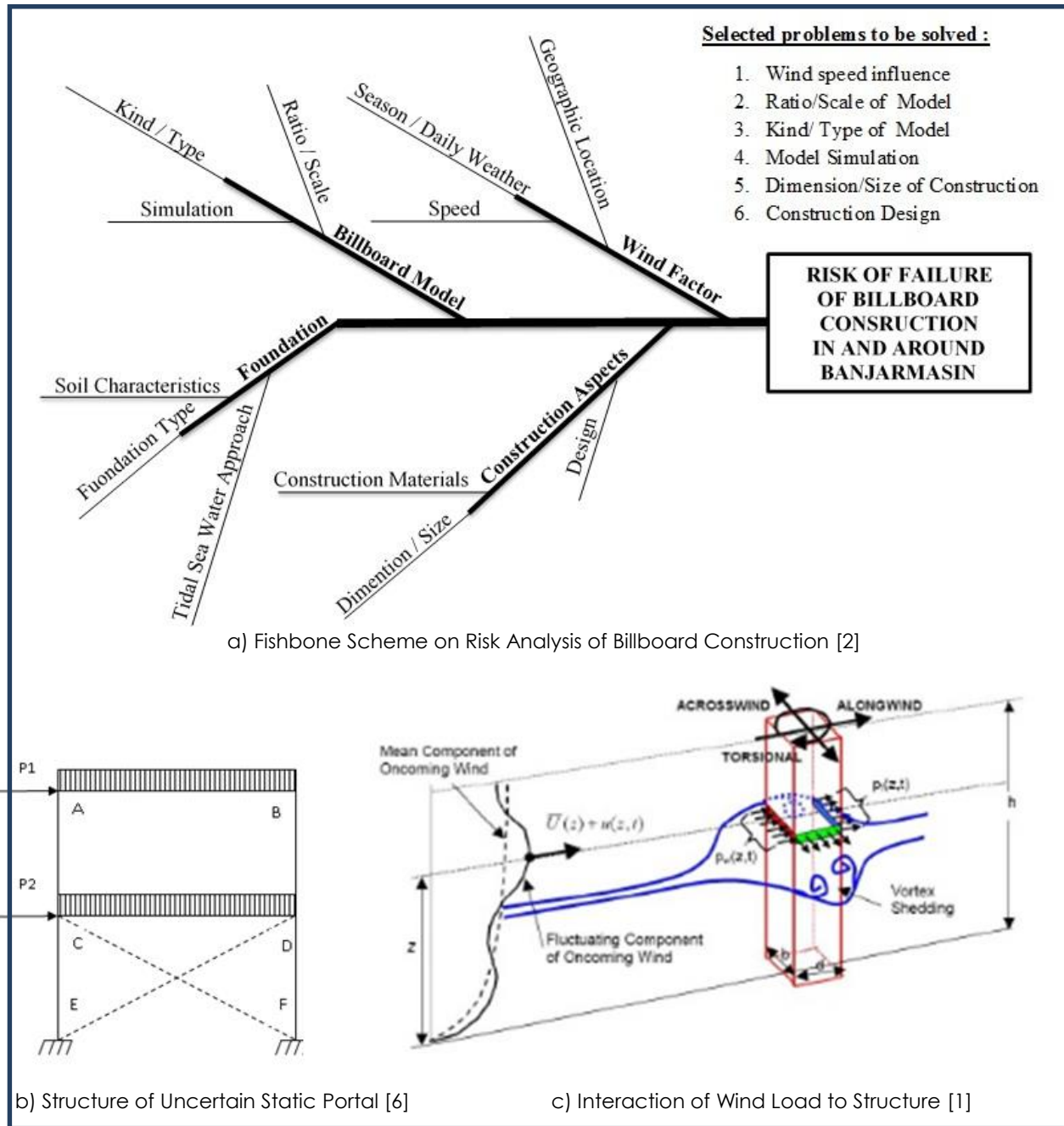


Figure 1 Risk analysis and loading aspects in billboard construction

2.0 MATERIAL AND METHODS

In this research, cross-sectional descriptive design where the researcher described the level of safety of billboard construction in and around Banjarmasin by considering the ratio of flexible axial stresses of the structural components. Wind load is assumed as positive stress (push wind) and negative stress (suction wind) which work perpendicularly toward the reviewed planes [4]. The value of the positive and negative stress is in kg/m² (Indonesia Loading Regulation, 1983). The

inclusion criteria are billboards with dimension of 4x6 m² (19 units, 40.43%), 5x10 m² (10 units, 21.28%) and cross-road horizontal billboard or Bando (18 units, 38.29%) which distributed in around Banjarmasin (Figure 2). Meanwhile the exclusion criteria are billboards with dimension of 2x4 m², 1x1 m² and non-steel materials billboards.

For the billboards modeling, SAP 2000 Version 16.0.2. Evaluation computer software was used. Structure component which experienced, flexible moment and

axial force must be calculated to fulfill the requirement (SNI Q3-1729-2002 clause 11.3):

$$\text{For } \frac{N_u}{\phi N_n} < 0,2 \text{ then } \frac{N_u}{2\phi N_n} + \left(\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}} \right) \leq 1,0$$

$$\text{For } \frac{N_u}{\phi N_n} \geq 0,2 \text{ then } \frac{N_u}{\phi N_n} + \frac{8}{9} \left(\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}} \right) \leq 1,0$$

The ratio for determining structure that considered not safe is the structure which has flexible and axial stress with the limit of >1, showed in red color in some construction sketches in the program output.

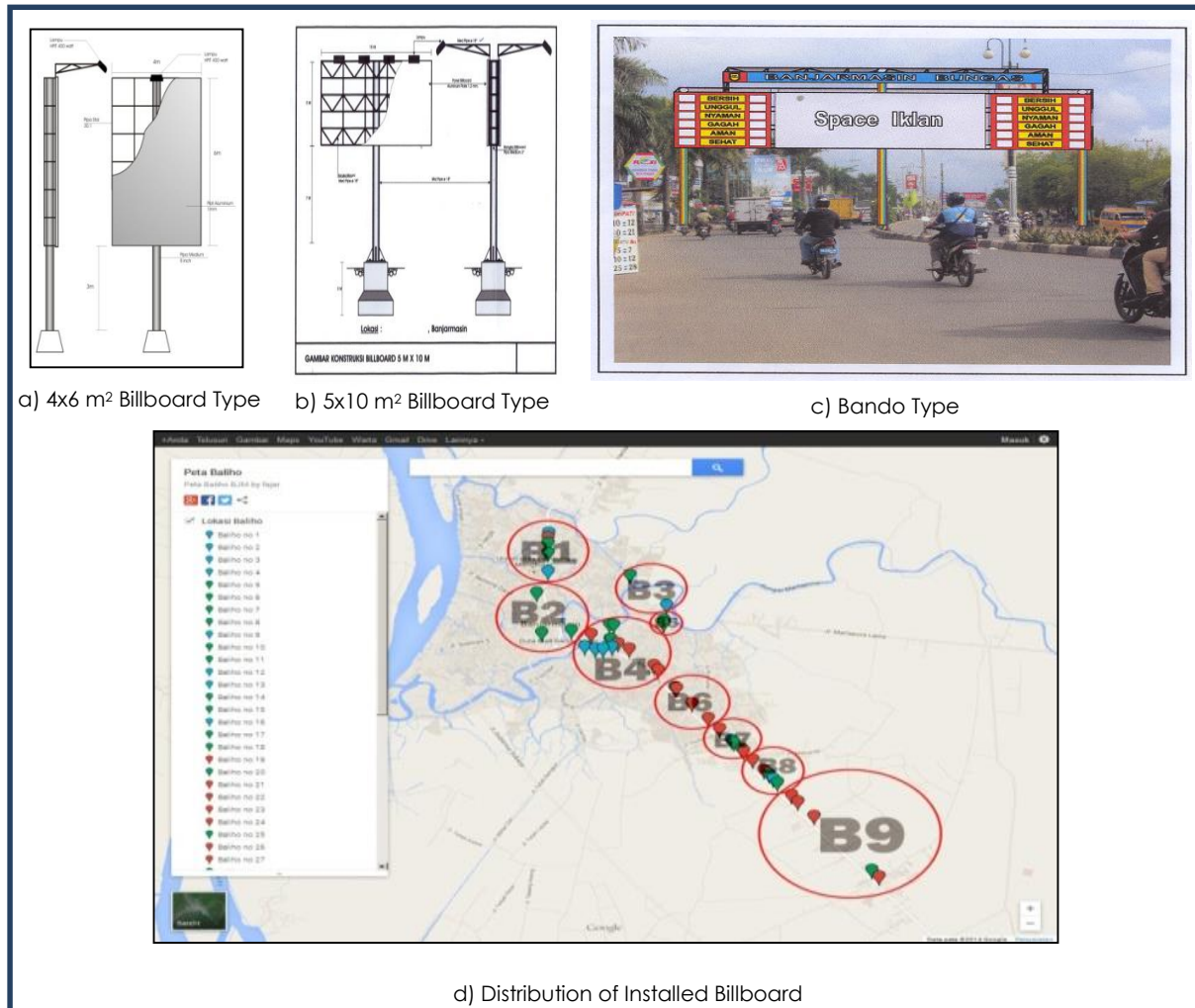


Figure 2 Types of billboard construction in and around Banjarmasin

3.0 RESULTS AND DISCUSSION

3.1 4x6 m² Billboard Type (With The Dimension Of 4x6 M2, 10" Pillar, 5x5 cm² Angled Steel Profile)

This type of billboard is recommended as safe toward working loads since it produces flexible and axial resistance ratio <1 showed by the nonexistence of red colour in the program output (figure 3.a3). This billboard type construction can be a standard for the subsequent making of 4x6 m² billboard.

3.2 5x10 m² Billboard Type (With The Dimension Of, 18" Pillar, 2"Truss, 5x5 cm² Angled Steel Profile)

This type of billboard is recommended as not safe toward working loads since it produces flexible and

axial resistance ratio equals ≥ 1 showed by the red color in some of construction elements in the program output (Figure 4.a3). The weak point of this billboard type is in the secondary element, namely the right element that joins the front and rear side of the billboard. While the front and rear truss elements as well as the main pillars are safe. Hence, improvement is only for the secondary element. The improvement is by adding diagonal member/bar as the joint between the right elements in order to produce relatively a safe improvement resistance ratio (Figure 4.a4).

3.3 Three Pillars Bando (With Three 18" Pillars, 2" Truss)

This type of billboard is recommended as not safe toward working loads, since some flexible and axial resistance ratio equals ≥ 1 showed by the red colour in some of construction elements in the program output

(Figure 4.b3). Resistance ratio condition shows that middle column and the surrounding truss are the most unsafe. Improvement for three pillars Bando is done by adding four columns in every pillar (12 pillars in total), 6" diameter additional pillars, and 2.5 pipe diagonally in around the pillar for the truss strengthening (Figure 4.b5).

3.4 Five Pillars Bando (With 18" Middle Pillar, Two 10" Side Pillars, 2.5" Truss)

This type of billboard is recommended as safe toward the working loads, since it produces flexible and axial resistance ratio < 1 showed by the nonexistence of red colour in the program output (Figure 3.b3). This billboard type construction can be a standard for the subsequent making of five pillars Bando type.

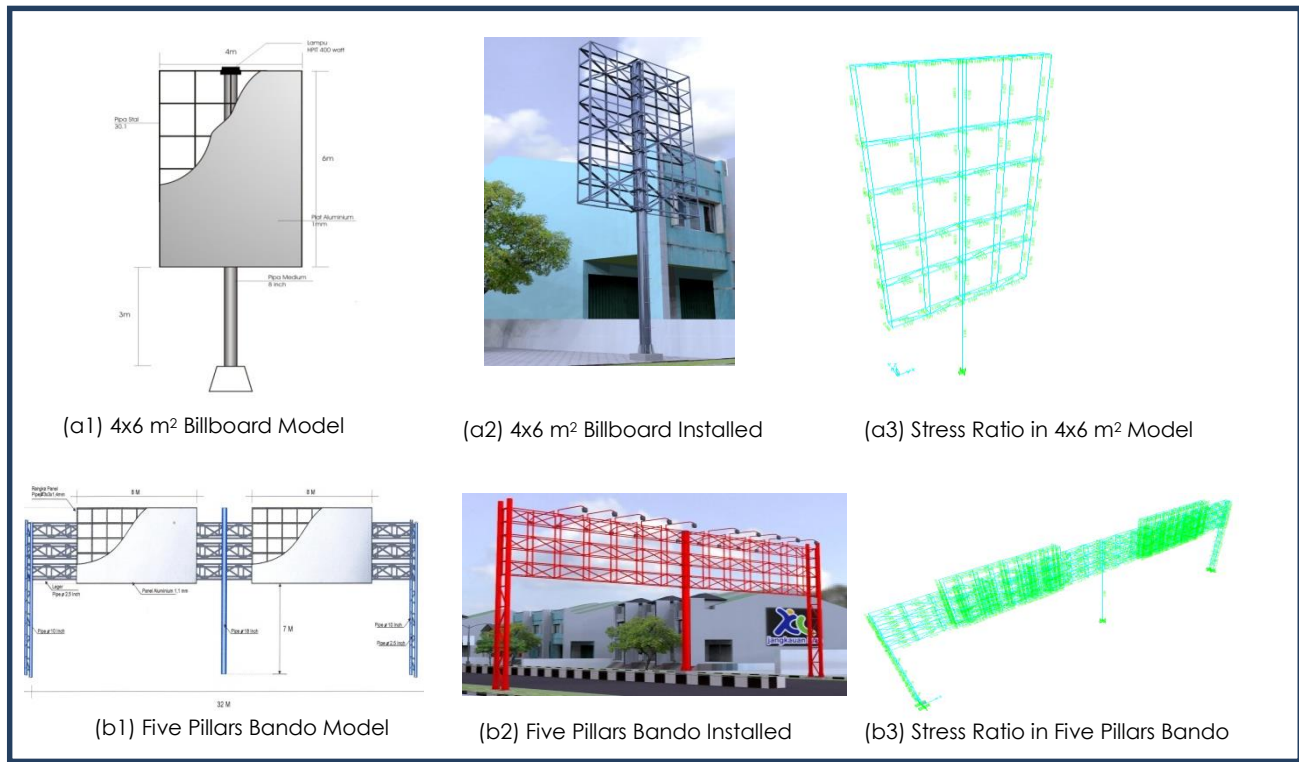


Figure 3 Safe billboards (standard)

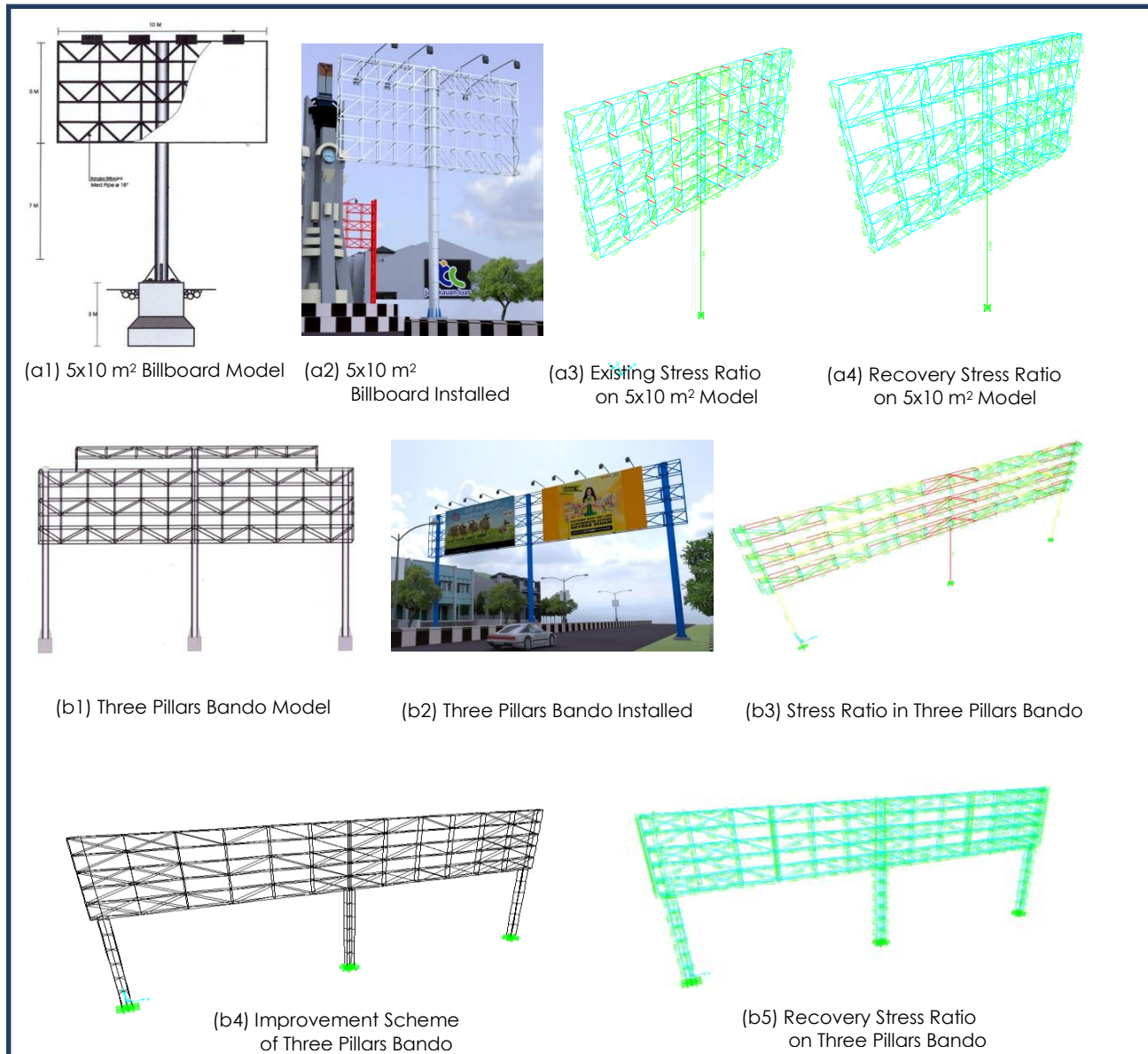


Figure 4 Unsafe and modified billboards

4.0 CONCLUSION

Billboard construction that is considered safe as well as standard one is billboard with the dimension of 4x6 m², 10" pillar, 5x5 cm² angled steel profile; and five pillars Bando with 18" middle pillar, two ϕ 10" side pillars (2.5" truss). Meanwhile billboard construction which is not considered safe is 5x10 m² billboards, 18" pillar, 2"truss, 5x5 cm² angled steel profile; and Bando with three 18" pillars, 2" truss. The improvement for 5x10 m² billboards is by adding 2" diagonal truss, 18" pillar, 2" truss; for three pillars Bando, the improvement is by adding four ϕ 6" pillar, 18" pillar, 2.5" truss.

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