Typical Study and Application of Wide Span Structure System in Building

Aissyah Hanrini Nurshokh
Department of Architecture,
Faculty of Science and Technology,
State Islamic University of Maulana Malik Ibrahim (UIN MALIKI) Malang, Indonesia
hanrinian@gmail.com

Trischa Awalia Octarisa
Department of Architecture,
Faculty of Science and Technology,
State Islamic University of Maulana Malik Ibrahim (UIN MALIKI) Malang, Indonesia
Ririsoctarisa15@gmail.com

Moch. Arsyad Bahar
Department of Architecture,
Faculty of Science and Technology,
State Islamic University of Maulana Malik Ibrahim (UIN MALIKI) Malang, Indonesia
Arsyad.bahar@gmail.com

Abstract- **The structure is a building element, structural elements serve to support the existence of nonstructural elements which include visible elements, interior, and architectural details so as to form a single unit. The existence of magnificent and column-free buildings can be seen from the shape, strength, and structure of the building which is one of the factors of progress in the field of architecture. Excavation and analysis of wide and column-free span structures are important because of an alternative method used in architectural design. Therefore, this study is structured to determine the typology of the wide structure system and to know the application of the types of structural systems. The study focused on the typology and documentation of the types of wide structure system in wide and free column buildings. The study method used is qualitative to analyze from literature reviews and precedent studies. There are 3 important aspects that will be proposed in the framework of the study of the typology of wide-span structures, namely aspects of principle, function and physical form. The framework is expected to be able to make a positive contribution in the form of visualization and documentation of the broad-span structure typology in the development of Indonesian architecture.**

Keywords— Structure, Wide Span, and Typologi

I. INTRODUCTION

Progression of sophistication this mature technology is very rapid, the caused by human needs supporting facilities are on the rise. Thus Spake It also results in the creation of the magnificent buildings of the draft beright one form of advancement in the field of architecture. The existence of the magnificent buildings seen from the shape, the power structure and extensive building. Likewise, new breakthroughs, namely wide-span buildings that require broad space and free column needs of these growing and growing needs. In Islam it has a joint, that is, a human being is a social being, so he is interconnected and in need. Therefore, wide span buildings and can be used to accommodate human social needs, in the form of meeting rooms, halls, etc. The statement of the Qur'an in the verse al-hujurat verse 13, which states that *"O people, truly We created you from a man and a woman and you are nations and you know people. Surely the noblest of you in the sight of Allah are the most careful among you. Verily Allah is the Knower, the Knower. "*

God expects every individual to merge, gather and have the same goals, and socialize and communicate without identity, symbolity, sociality and nationality.

Important structures in buildings. In addition to working as a building form, the structure also supports nonstructural elements in the form of visible, interior to architectural details of the building. The use of wide width buildings for construction of quality structures.

Quality is an influence on the strength, beauty, security and comfort that results. Excavation and deepening of the analysis of wide-span structures in large and free buildings becomes important as one of the alternative methods used in architectural designers. Wide span building is a building that allows using a column free space that has a wide stretch and as long as possible. Activities needed there are exhibitions, conventions, concerts / shows.

There are various types of wide-span structures and each type of typology has different complexity. In the literature there are 8 types of widespan structural typologies according to need, folding structure, shell structure, cable structure, membrane structure, space frame structure, truss structure, biomorphic structure, and solid structure.

II. METHODS

The main title research on the typology and application Types of Structural Systems in Buildings Landscape Wide Area and Free Column, as an alternative method of Landscape Architectural Design Width. Scope of this research is the study of a wide landscape design solution that can be implemented in accordance with the needs of the building is based on the geographical location, the function of the building, and its constituent materials.

There are several methods used in this study, qualitative methods, literature and the study of precedent. Qualitative methods are used to explore and analyze the typology and

application types of system wide span structures on the vast building and free columns. Literature study method serves to determine the basic principles of system wide span structures on the object area and free building design fields. Method precedent study serves to determine the efficiency of applications on a wide-span structural system and column-free area of the building is based on the geographical location, the function of the building, and its constituent materials.

Every technological development in the field of architecture will have an influence on the surrounding environment. Various aspects of the new system gave rise to meet the space requirements for humans. One form of the human needs of the space is wide-span building a broad and free columns. The building spans the width of the wide and free columns require a special structural system. There are different typologies of system structure and how to apply.

System wide span structures to adjust to the geographical location, function, and the constituent materials of the building. For that, look for factors that cause the appearance of various types of system wide span structures are widely and freely column, can be input for the process of strategy formulation and policy development.

III. DISCUSSION

A. Studi Literatur

The use of structures for buildings based on the function of the building and developed towards the aesthetic to be able to achieve what would be intended by the architect in the design. From the development of technology, the system structure is also experiencing progress in which have developed the principles of the existing structure along with the development of the technology of building materials.

Is the development of technology is a technology design of buildings using building materials that can meet the aspirations of the design architect. Stretch is a distance between two objects as buffers should be held and transmitted to the Foundation as a place for supporters of the end of a building. This stretch has a stretch of Division criteria:

1. Short Stretch if the distance pedestal less than 10.00 m.
2. Medium Stretch after stretch if it reaches a distance of 10.00 until 20.00 m.
3. Stretch width (length of span), if stretch has reached a distance of more than 20.00 m.

This wide span Buildings mostly used for public buildings that require a spacious grounds and spacious room is not obstructed the existence of pillar/column, so that more emphasis on a system with wide span roof structure.

Demands will be structural system that can solve a wide expanse, pretty much how. Wide Span Building Structure System is structured as follows:

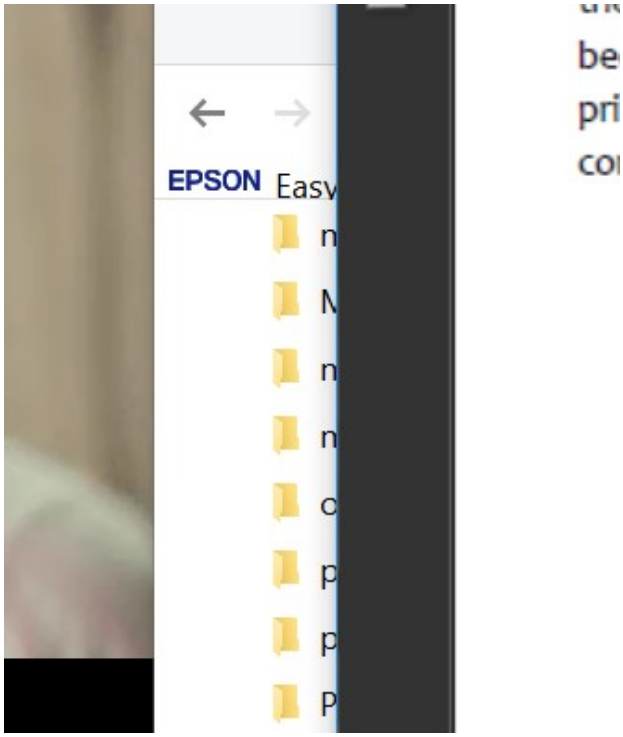
1. Structure of Solids (solid structure)
2. Field structure (surface structure)
3. Frame structure (skeleton)

B. Studi Preseden

The discussion in this precedent studies about buildings using wide-span structure system due to the space requirements and functions. Here are some examples of buildings that use system wide span structures.

a.) New Samarinda Airport

System space frame structure can be applied to building an airplane hangar in New Samarinda Airport. Taking into account serviceability, efficiency, construction materials and structural systems. System space frame structure suitable to be applied to building airplane hangars for good service ability in which a space frame structure system has a fairly high stiffness although using a material structure light. In the application space frame structure system has good efficiency, which use materials that are easily found and already frabricated, so that the process does not take long. The landscape of the building is 70 meters. With column-free space requirements covering70 x 50 meters and soil conditions are reached a depth of 24 meters to touch the ground hard, the results of the analysis that the structure of the space frame. can meet the needs of design, because this structure can divide the system run private load evenly and easily applied in the area of the complex design of the New Samarinda Airport. Implementation of space frame structure / framework of space in the design of airplane hangar in New Samarinda Airport, with an area of 70x 50 meter column-free.



b.) Sydney Opera House

Sydney Opera House including the building shell structure of the system applied. Roof of this building is a form of

metaphor by applying the system shell free form. Where the existing shell shape does not follow the pattern structurally bonded geometry but in this case there remains geometrical form but not a major factor. *shell* the Sydney Opera House formed from the rotational direction vertical to the curved two directions (vertical and horizontal) / double curved shell with curved surfaces sinklastic.

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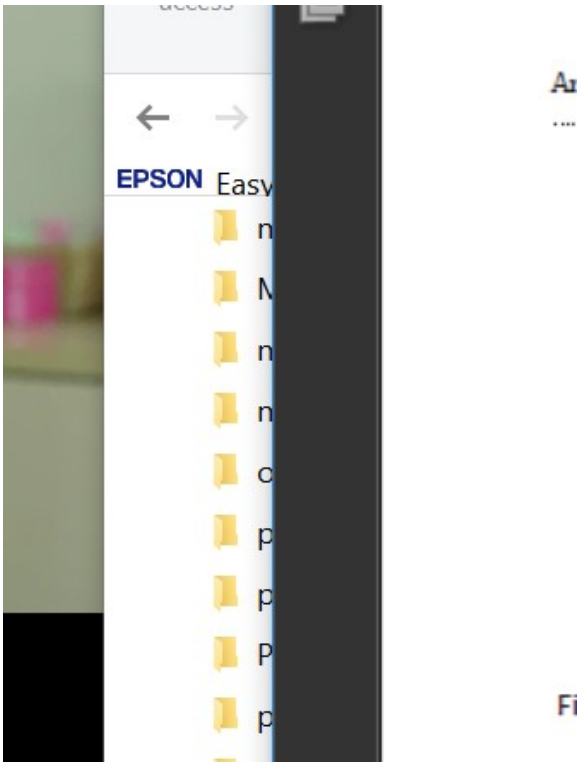
c.) USA Music Pavillion

The application of membrane structures (tents) in the architecture of the building is on the Music Pavilion located in Sun Valley Idaho, USA. This building is a building that serves as a music hall. Type of membrane structure used is a tent structure, with support arch pole lies in the connection between permanent and non-permanent structure on the roof. But the membrane system in the building is also combined with a cable system or funicular. Membrane system at the wide span buildings usually mash should be assisted by a cable structure or space frame structure, because the membrane system when exposed to the force of the wind there should be an appeal to the pedestal (foundation). Therefore, it acts as a conduit cable load, the force would be directed ketumpuan (stakes) without the aid of wires as the dealer.



IV. RESULT

This research tries to study the typology and application of wide-span structural systems to buildings with wide and free space requirements as alternatives in architectural design. The chart below is a grouping of various kinds of wide span structures.

1. Solid Structure
Massif structure / solid / Mass can be said as one of the structures used by humans in the early civilization in the form of a simple building for religious purpose, such as memorials, cemeteries and places to stay together. The composition of the solid pile of rocks can be found on building the pyramids, temples and shrines.

Figure 8 Borobudur Temlpe

2. Field structure (surface structure)
A. Flat Field structure (plates, panels)
B. Sector Structure Folding (folded plate)
C. Struktir Field Curvature / Eggshell (Shells);
divided into:
a) Single arch structure
b) Double Curved Structures
- Unidirectional (dome): radial dome, dome schwedler, lattice dome and geodesic dome
- In contrast (hyperbolic paraboloid) As for a description of each field structure is as follows:
A. Flat Field structure (Plate, Panel Structure)
Flat Field structure is often called the plate is made of a rigid planar structure of a monolithic material thickness smaller than the other dimensions.

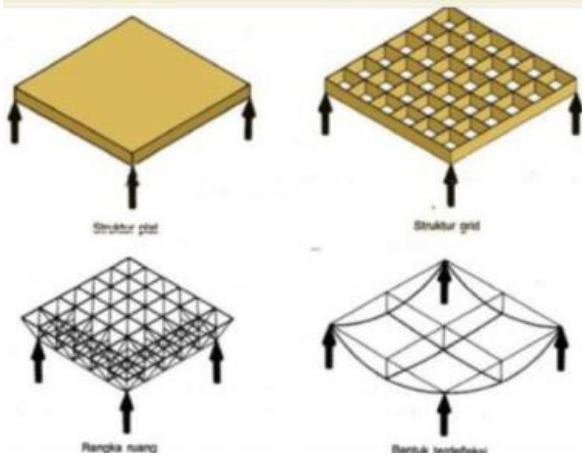


Figure 9 Kinds of Fold Structure

Flat Field properties:
 Nature of the work load has many directions and spread. Because the forces that work can be continued throughout all areas.
 Flat field / plate made of a homogeneous solid material has the same properties in all directions.
The spread of one-way system (1) Plates berrib: when the plate is used as the rigid rib arrangement will serve as a plate in one direction rather than as balokbalok parallel. Or the design of the structure will be viewed as a series of blocks T in the longitudinal direction. Slab transversl considered as a continuous plate in one direction over the beams. (2) Plates folding.
The deployment of two-way system: If the plate does not have a rib in two directions or have a beam in the margins. So that the force which is supplied to the plate leading to a four-way leading to the column or to the edge beams.

B. Folded Plate Structure
Fold the Field structure is a form of structure that has a stiffness in one direction are enlarged by removing the planar surface completely and make large deformation at high structural plate so that the larger plate.

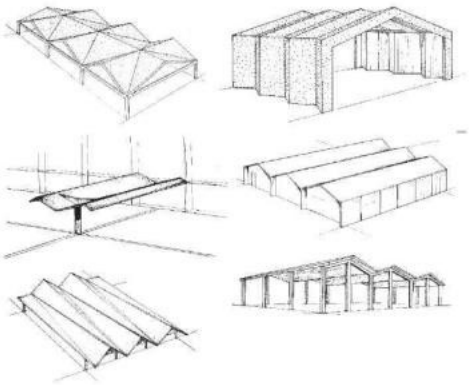


Figure 10 Folging System
(Source : Tanggoro, 2015)

Field structure folding system generally serves as a roof. The forces that arise in the system of this structure:
1. Style / dead load of the structure itself
2. Style / live loads more due to rain and wind load
3. Fashion / other expenses
Basic Shapes Construction Curl:
1. The shape of pyramidal namely folded forms that consist of triangular folds field.
2. The form of prismatic and consists of flat areas angular elbows form a prism.
3. Shape prismatic spring is occurring form of a combination of pyramidal and prismatic shapes.

C. *Shells* Structure

System structure is a structure of curved half / portion of a large round ball, which is made of a thin curved concrete material called shells (shells). This curved structure is divided into two types:

a) Single arch structure

Single arch system field structure is a structure half / portion of a large round pipe, which is made of a thin curved concrete material called barrel. The shell shape Barrel

 The shell of a short barrel

 The shell of a long barrel

b) Double Curved Structures

System double curved structure is a structure half / portion of a large round ball, which is made of a thin curved concrete material called shells (shells).

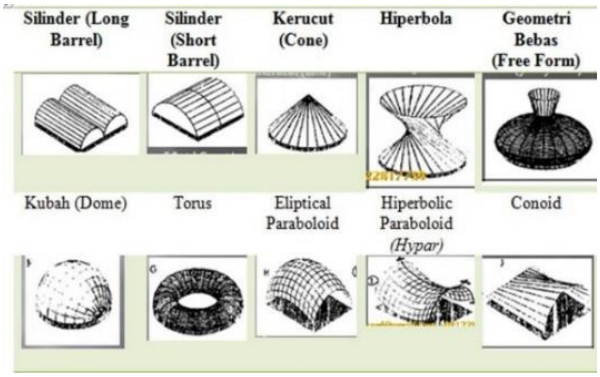


Figure 11 Arch Structure
(Source : Tanggoro, 2015)

a. Double Curved Field Structure

Unidirectional (Synclastic) Curved surface that occurred from dual unidirectional warping system will form a circle on the horizontal plane and a semi-circle on the field as in the vertical or truncated hemispherical, also known as something structural shell / shell.

b. Double Curved field structure as the reverse (Anticlastic)

The structure of the double curved area as the reverse is a saddle shape with different curvature direction in each direction. Teather buildings in TMII Jakarta Indonesia is a building that uses a shell structure.

Figure 12 TMII Theater Hall
(Source: Personal documentation, 2011)

D. Frame structure (Skeleton)

Frame structure consists of:

a. Linear Frame Structure arches faults

 Bows (Arch)

Arch structure belonged funicular structure because it has been used by the Romans and Greeks, especially to create buildings that require a great stretch / wide.

 Curved / Vault

*Vault*is an arc structure (arch) threedimensional or simply an arch-drawn or rotated. Such as the arch, the vault can only withstand a compressive force and are not strong against gravity.

b. Frame Structure Sector

Field frame structure is a frame structure system fields are arranged into a bidag upright, which can also be called a truss / trusses. These bars are arranged to form a triangle geometry in the form of:

 two-dimensional

 Three dimension

This arrangement may provide stiffness to distribute the load / compressive force as gravity. Order field / truss / trusses can be established:

 Flat

 tilt

 arch

c. Hanging Frame Structure: cables (cables membrane); tent (net) Hanging frame structure can be used for high-rise building structural system and can also be used on a wide-span roofs. System wide span building structures can be divided into three parts:

 Cables Structure

The basic principle of the cable structure is the containment burden by an element that serves as a puller. The forces acting on the cable are vertical and horizontal force on the assumption that the cables are always in a state of tilt. The building is an example of building the Suramadu bridge.

Figure 13 Suramadu Bridge
(Source : Personal documentation, 2018)

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 Membrane structure
Membrane structure has a flexible nature, the surfaces may be stretched in accordance with the adaptation to the desired shape. The structure of the membrane is very sensitive to wind pressure which may result in a flutter on the surface and the changes occurring form. Membrane structure with the support poles and wires:
a. *Simple Saddle Membrane*
Membrane structure is simple with a pair of saddle-type linear pedestal opposite.
b. *Ridge Type Membrane*
The structure of the membrane type ridge with internal linear pedestal.
c. *Arch Type Membrane*
Membrane structure with a curved type continuous internal linear pedestal.
d. *High Point Type Membrane*
Structure of membrane type with internal fulcrum, forms a composite pedestal in the middle called humpback surface. Semarang grand mosque is a building system that uses membrane structures.

Figure 14 Semarang Musque
(Source : Personal documentation, 2018)

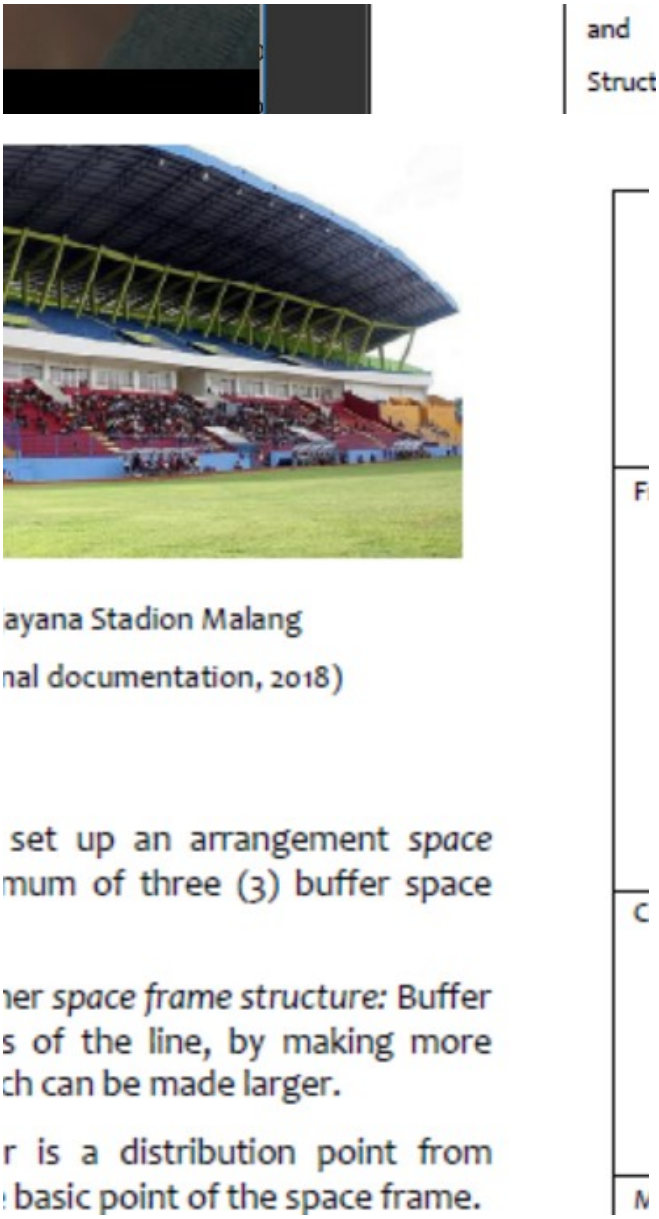
Thin tent structure, antiklastik, consisting of tensile membrane supported by a curved structure (arch) or poles (masts).
Type tents:
1. *internal masts*
Membrn contained within the pole, which sustains tianf membrane.
2. *internal Arch*
Not using a pole, but uses curved structure to support the membrane.
3. *external masts*
Using the pole but not strut on the middle of the membrane, but in the end hem.
d. Space Frame Structure
Framework (space frame) is a threedimensional framework structur system that runs both ways, where trunks were just having a compressive force or pull it. The system is a development system stem structure (trusses structure).
Space frame structure is an arrangement of modules arranged and composed in contrast between the modules with one another so that the forces that occur creeper follow the shape of the modules are arranged. These modules are mutually reinforcing each other, so that the system structure is not easily shaken. Equipment and Splicing Systems The relationship between the stem with several other rod using the construction of the connection, so installation / splicing easy and can pull out forces that occur. The connecting construction using the system:
1. *Mannesmann*
2. *Unistrud*
3. *Takenaka*
4. *Mero*
As examples of buildings that use the system structure is Gajayana stadium Malang.

Figure 15 Gajayana Stadion Malang
(Source : Personal documentation, 2018)

Buffer needed to set up an arrangement *space frame*, It takes a minimum of three (3) buffer space frame that can stand / Buffer in every corner *space frame structure:* Buffer on two opposite sides of the line, by making more poles, so that the stretch can be made larger. The column buffer is a distribution point from three, four or six of the basic point of the space frame. The following is a structure classification table according to the parameters that have been determined:

Based on the results of studies and field observations of the respondents it can be concluded that the election to the wide-span structure in meeting the needs and functions of a building. Various aspects of the new system gave rise to meet the space requirements for humans. One form of the human needs of the space is wide-span building a broad and free columns. The building spans the width of the wide and free columns require a special structural system. There are different typologies of system structure and how to apply. System wide span structures to adjust to the geographical location, function, and the constituent materials of the building. For that, look for factors that cause the appearance of various types of system wide span structures are widely and freely column, can be input for the process of strategy formulation and policy development, In buildings respondents in development policies and strategies through appropriate technology based structure had advantages and disadvantages of the chosen structure. Development to form the structure of the more unique and require special calculations can make structures that already exist in the selection of respondents as a typology. In addition, this study creates a container to provide a wide range of visualization, specification and documentation of processes that occur in a wide span system.

After classifying the structure according to its parameters, as for the shortcomings and advantages possessed by each structure, the following table has its advantages and disadvantages:



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