

Saudi Standards, Metrology and Quality Org (SASO)

Project No. 33716 : 2024

أعمدة من البوليستر المقوى بالألياف الزجاجية لعلامات المرور - علامات المرور العامودية الثابتة

**Fiberglass Reinforced Polyester Poles (GFRP) Poles For Traffic Signs
Permanent Vertical Road Traffic Signs**

This document is a draft of the General Saudi Standards under revision. Therefore, it is subject to change and should not be referred as the Saudi Standards, unless being approved by the Board of Directors.

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Introduction

The Saudi Standards, Metrology and Quality Organization (SASO) has prepared the Saudi Standards for Fiberglass Reinforced Polyester Poles (FRP) for permanent vertical road traffic signs after reviewing the specifications of Arab, foreign and international standards and reviewing the related reference literature.

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Fiberglass Reinforced Polyester Poles (GFRP) For Permanent Vertical Road Traffic Signs

1. Scope

This standard specifies requirements for fiberglass reinforced polyester (FRP) poles for permanent vertical road traffic signs inside Population Areas

Not covered by this standard:

- a) Traffic FRP
- b) High mast FRP
- c) Highway FRP with road traffic signs

2. Complementary References

2.1 SASO-EN-40-1 "Lighting columns - Part 1: Definitions and terms"

2.2 SASO-EN-40-2 "Lighting columns - Part 2: General requirements and dimensions".

2.3 SASO-EN-40-3-1 "Lighting columns - Part 3-1: Design and verification - Specification for characteristic loads".

2.4 SASO-EN-40-3-2 "Lighting columns - Part 3-2: Design and verification - Verification by testing".

2.5 SASO-EN-40-3-3 "Lighting columns - Part 3-3: Design and verification - Verification by calculation".

2.6 AASHTO 6th Edition 2013 – Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

2.7 SASO-ISO-527-1 "Determination of tensile properties (General principles)"

2.8 SASO-ISO-527-4 "Plastics - Determination of tensile properties – Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites.

2.9 SASO-ISO-527-5 "Plastics - Determination of tensile properties – Part 5: Test conditions for unidirectional fibre-reinforced plastic composites.

- 2.10 SASO-ISO-14125" Fibre-reinforced plastic composites -Determination of flexural properties.
- 2.11 SASO-ISO-180 "Plastics - Determination of Izod impact strength.
- 2.12 ASTM D256:2010- Standard Test Method for Determining the Izod Pendulum Impact Resistance of Plastic
- 2.13 ASTM D149.20- Standard Test Method for Dielectric Breakdown Voltage and Dielectric strength of Solid Electrical Insulation Material at Commercial Power Frequencies
- 2.14 SASO-ASTM-D635 " Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastic in a Horizontal Position".
- 2.15 ANSI C136.20:2010- American National Standard for Roadway and Area Lighting Equipment – Fiber-reinforced Composite (FRC) Lighting Poles
- 2.16 SASO-EN-12767" Passive safety of support structures for road equipment-Requirements, classification and test methods".
- 2.17 SASO-ISO-1461" Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods".
- 2.18 SASO-ASTM-G154 " standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials"

3. Terms and Definitions

3.1Traffic Signs FRP Poles

FRP Poles carrying Signs conveying information, instructions, or warnings about traffic laws, hazards, or directions to drivers and pedestrians such as speed limit signs, stop signs, etc.

3.2Pole body:

A vertical tubular or conical structure at the upper end of which the sign or (arm carrying the sign) is to be fixed.

3.3 Arm:

A component for carrying the sign at a fixed point from the axis of the pole body. It may be in single, double or multiple form, it may be integral with the pole or demountable from the pole end.

3.4 Signs fixing component (spigot):

The part, at the end of a post-top pole or of an arm, for connecting the arm to the pole.

3.5 Total length of a pole with a sign:

The perpendicular distance between the bottom of the pole and the horizontal line passing through its junction with the axis of the sign

3.6 Total length of a pole without an arm:

The perpendicular distance between the bottom of the pole and the highest point of the pole (excluding the sign-fixing component).

3.7 Depth of installation:

The length of the lower portion of the pole which is buried below ground surface.

3.8 Nominal height:

The total length of the pole minus the depth of installation.

3.9 Installation height:

The vertical distance from the central of the sign to the ground surface.

3.10. Sign wind project area:

The horizontal distance between the vertical axis of the traffic signs and the vertical line passing through the point of the arm axis farthest from the traffic signs.

3.11. Base plate:

A galvanized steel plate welded to the galvanized steel pipe to be fitted to the bottom of the fiberglass pole, which is installed on a concrete base with anchor bolts.

3.12. Out-of-roundness:

The difference between the maximum and minimum diameters of the pole at any cross section.

3.13. Design load:

The resultant of the various forces to which the pole normally subjected. It includes forces produced by weight of the sign, arm, wind forces and other forces of nature.

3.14. Pole deflection:

The distance between the original position of the top of the unloaded pole and the position of the same point when the pole subjected to the design load.

3.15. Type test:

Initial test, which carried out on the poles for the first time, or whenever, deemed necessary.

3.16. Routine test:

Frequency test, which is, carried out on the poles every production shift.

4. Materials**4.1. Fiber Reinforced Plastic (FRP) Composition**

A composite that typically made as a mixture of reinforcing materials, thermosetting or phthalic polyester resin, and additives accordance ANSI C136.20

4.2. Reinforcement Materials

Fiber glass its type is "E"-type glass in the form of combination of roving and chopped strand mats mechanically bonded with a suitable agent that will provide a suitable bond between the glass reinforcement and the resin.

4.3. Unsaturated Polyester Resin

A cross-linkable/cure-able polymeric material, commonly used to produce fiber reinforced composites.

4.4. Additives

Functional substances added to the FRP composition for the purpose of coloring, hardening, and/or improving the physical and chemical properties of the composition. Those can include pigments/dyes; curing agents; and/or UV stabilizers.

4.5. Surfacing material:

Shall be a polyester veil or fiberglass surface tissue.

5. General requirements

The following requirements shall be met in poles:

5.1 The pole

5.1.1 The cross-section of the pole shall be circular and shall be continuously tapered.

5.1.2 Pole body shall be formed in one piece

5.1.3 The ends of the pole shall be clean cut and perpendicular to the pole axis

5.1.4 No fiberglass shall appear on the outer surface.

5.1.5 The external pole surface shall be completely smooth, homogeneous and nonporous.

5.1.6 The color of the body of the pole shall be completely stabilized and impregnated from the surface through its wall thickness.

5.1.7 The outer layer of the pole shall consist of pure polyester veil or fiberglass tissue of thickness 0.3 to 1.0 mm.

5.1.8 The design of poles without arms shall be in such a way as to protect the poles against the entry of foreign matter such as water, sand and dust.

5.1.9 The pole shall be resistant to ultraviolet radiation.

5.1.10 Pole top should be cover by top cap made from FRP, GS or Al.

5.2 Mechanical and electrical properties

Mechanical and electrical properties of the fiberglass reinforced polyester poles mentioned below in table (1) just for information only and should not be used for design.

TABLE (1)
MINIMUM REQUIRED MECHANICAL AND ELECTRICAL PROPERTIES OF
FIBERGLASS POLES

Mechanical properties					Electrical properties		
Tensile strength (N/mm ²)	Elongation %	Flexural strength(N/mm ²)	E-modulus (N/mm ²)	Impact strength (N/mm ²)	Surface resistivity (ohms)	Volume Resistivity (ohms-mm)	Dielectrical Strength (KV/mm)
250	7.5	170	18000	5	10 ¹³	10 ¹⁶	30

5.2.1 Design and design verification.

5.2.1.1 The design and verification of fiber reinforced polymer composite poles

Shall be in accordance with ASHTTO, SASO-EN-40-3-1, SASO-EN-40-3-2 and SASO-EN-40-3-3 and the additional requirements of annex B of this standard. The column shall be designed to sustain the dead loads and the wind loads, specified in accordance with SASO-EN-40-3-1. The structural design of a lighting column shall be verified by either calculation in conformity to SASO-EN-40-3-3, or by testing, in conformity to SASO-EN-40-3-2. If calculation is used, the method of calculation. In addition, parameters used shall be verified by appropriate physical type testing (see annex E).

5.3 Dimensions

5.3.1 The main dimensions of fiber reinforced polymer composite lighting columns shall be in accordance with SASO-EN-40-2.

5.3.1.1 Poles shall have a taper from 12 to 20 mm/m.

5.3.1.2 (Q) Length of the poles between signboard and ground surface As Fig (1, 2)

5.3.1.3 (R) length of pole underground as in Fig (1)

5.3.1.4 (P) length of sign board as in Fig (1, 2)

5.3.1.5 (O) width of sign board as in Fig (1, 2)

5.3.1.6 (N) sign board edge thickness as in Fig (1, 2)

5.3.1.7 (M) sign board middle thickness as in Fig (1, 2)

- Pole Length may be design calculated as customer request,
- Signboard should be made from FRP supported with steel plate with min thickness 3mm.

5.4. Base plate

5.4.1 Poles, which installed above ground surface, shall be mounted on a hot dip galvanized steel base plate. The dimensions of the base plate shall be as specified in Fig. (2) And average of zinc coating thickness shall be according to SASO-ISO-1461.

5.4.2 A galvanized steel tube shall be welded to the base plate with its axis perpendicular to the base plate. The dimensions of the tube shall be as specified in Fig. (2).

5.4.3 The base plate shall have holes for anchor bolts and one central hole for the cable entry.

5.4.4 Anchor bolts shall be made of galvanized, high strength steel having a minimum tensile strength of 345 N/mm².

5.5 Tolerances

Measurement shall be carried out in the horizontal position for the poles without loading. The tolerances on poles shall be as follows:

- a. Straightness: Not more than 0.2% per unit pole length ≥ 1 m.
- b. Out-of-roundness of external diameter: $\pm 1\%$.
- c. The pole shall be straight, and the deviation of the centerline of the pole body shall be not more than 0.03% of its length.
- d. Tolerance in length: ± 20 mm.
- e. Tolerance in weight:

$\pm 5\%$ for one pole
 $\pm 3\%$ for a group of poles not less than 10.000 kg.

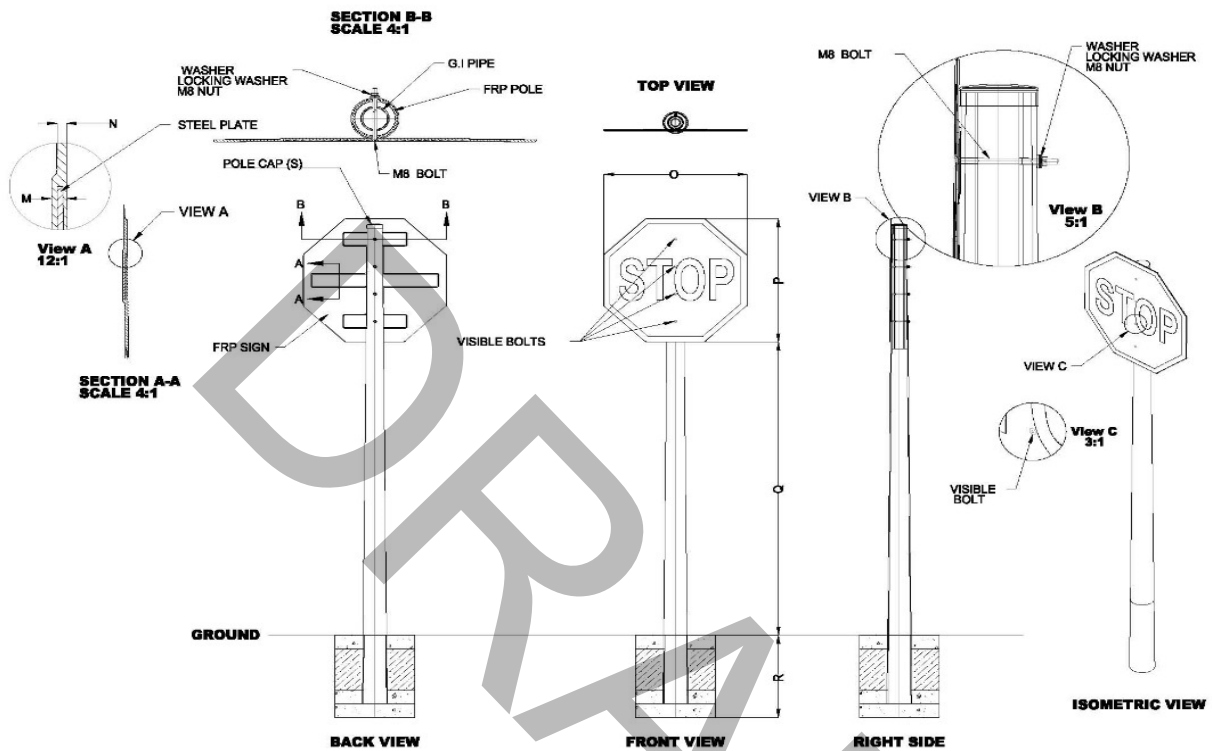


Fig (1) length of pole underground

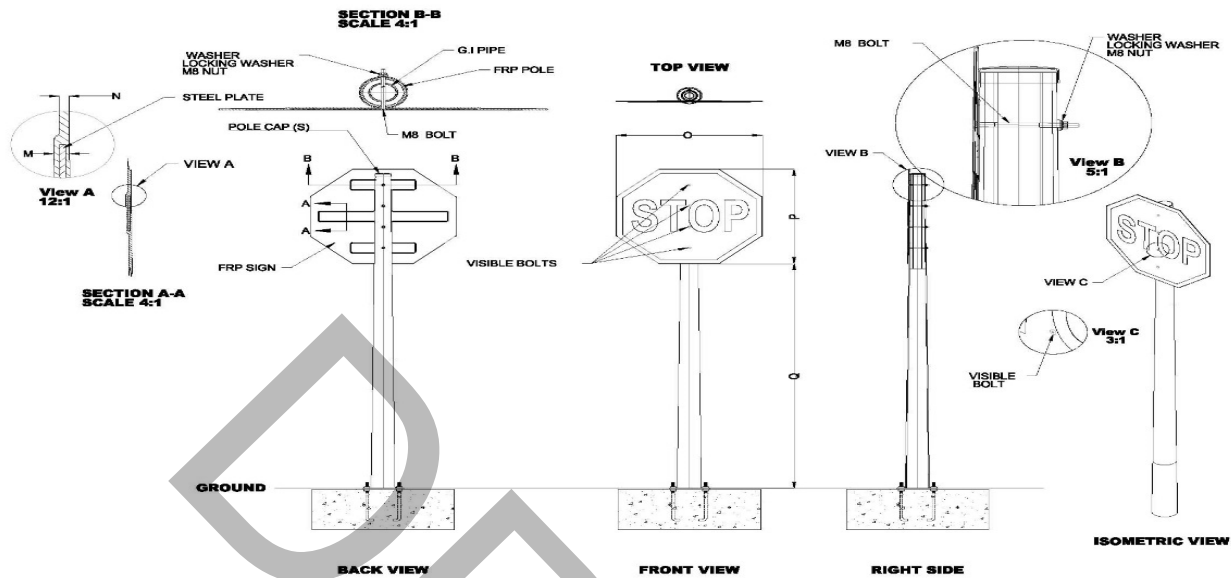


Fig (2) sign board edge thickness

5.6. Installation

5.6.1 Anchor Bolt Foundations

- 5.6.1.1 The concrete foundation must be designed by a qualified engineer with knowledge of the local soil conditions.
- 5.6.1.2 Anchor bolt diameter, length, and psi are specifically selected to withstand load limitations listed in calculation sheet.
- 5.6.1.3 When leveling nuts are used, the bottom of the lowest leveling nut should not be more than 1" from the concrete surface.
- 5.6.1.4 Large spaces between the pole base plate and the concrete can cause excessive stresses in the anchor bolts.

5.6.2 Pole Installation Guidelines

- 5.6.2.1. Attach signboard sling to top of pole.
- 5.6.2.2 Place leveling nuts and washers on anchor bolts.

5.6.2.3 Erect pole.

5.6.2.4 Position over anchor bolts and set on leveling nut washers.

5.6.2.5 Place anchor nuts and washers on anchor bolts and tighten once pole is plumb.

5.6.2.6 See Fig (2) for clarification.

5.3 Direct Burial Foundations

5.3.1 Suggested burial depth should be as mentioned in calculation sheet.

5.3.2 Soil and site locations will vary, for this reason, it is imperative to consult with a qualified engineer with knowledge of the local soil conditions.

5.3.3 This standard cannot be responsible for decisions made regarding the installation, embedded depth or factors related to the specific site location.

5.3.4 See Fig (1) for clarification

5.4 FRP sign Board installation

5.4.1 Sign board fixation with sling to top of pole or by clamps surrounding the Pole using bolts, nuts & washers.

5.4.2 Bolts & nuts made from CS, SS or FRP.

5.4.3 Washers made from CS, SS, FRP or Nylon.

5.4.4 See Fig (1, 2) for clarification.

6. Sampling

6.1. Batch/Lot

Poles of the same type and dimensions are submitted for inspection at one time are considered one batch/lot.

6.2. Number of Samples

The number of samples from a batch/lot to be evaluated for compliance of the specifications described within this standard shall be in accordance with Table 4.

Table 4. Number of Samples and Acceptable Defective Samples per
Batch/Lot Size

Batch/Lot Size (Pieces)	Number of Samples	Acceptable Defective Samples
Up to 100	1	0
101-300	3	1
301-500	5% / batch	2
501-1500	5% / batch	3
501-3000	5% / batch	3
3001-8000	5% / batch	4
8001 and above	5% / batch	4

7. TESTING

7.1 Measuring instruments:

The following measuring instruments shall be used:

- 7.1.1 Micrometers to permit measurement of thickness to an accuracy of ± 0.03 mm.
- 7.1.2 Graduated scales to permit measurement of thickness to an accuracy of ± 0.5 mm.
- 7.1.3 Platform scale to permit measurement of weight to an accuracy of $\pm 2\%$ of the Measuring range.

7.1.4 Force measuring instrument to permit measurement of force to an accuracy of $\pm 1\%$ within the measuring range.

7.1.5 Coating thickness-measuring instruments to permit measurement of external coating thickness to an accuracy of $\pm 5\%$ of the measuring range

7.2 Prototype test:

7.2.1 This test done if manufacture have new design, new material or customer request to be sure that this design achieve the calculation design load.

7.2.2 For carrying out type approval tests, two poles shall be withdrawn at random from each category.

7.2.3 Test of mechanical and electrical properties of the fiberglass reinforced polyester used, table (1) data take for information only.

7.2.4 Test of strength and deflection of the pole:

7.2.4.1 Apparatus as shown in Fig. (3). (Or equivalent apparatus).

7.2.4.2 The pole shall be tested while it is in the horizontal position. Provision shall be made for mounting it on suitable supports to minimize the bending moment induced by the weight of the pole, and it shall be rigidly supported at the lower end for a distance equal to the depth of installation.

7.2.4.3 A suitable clamping device shall be attached to the top of the pole body, and connected in a dynamometer which connected by dynamic crane.

7.2.4.4 Gradually apply a load with the tension device until it reaches 20% of the design load and measure the deflection at the top of the pole.

7.2.4.5 Continue to load in successive steps of 20% of the design load each until the tension force reaches a value of the design load and maintain this load for at least two minutes.

7.2.4.6 The deflection and the accumulated deflection at the top of the pole shall be measured at each step of the loading and from the readings, the maximum deflection of the top of the pole at design load shall be taken.

- 7.2.4.7 After the test, the pole shall be inspected for cracks, permanent deformation or damage

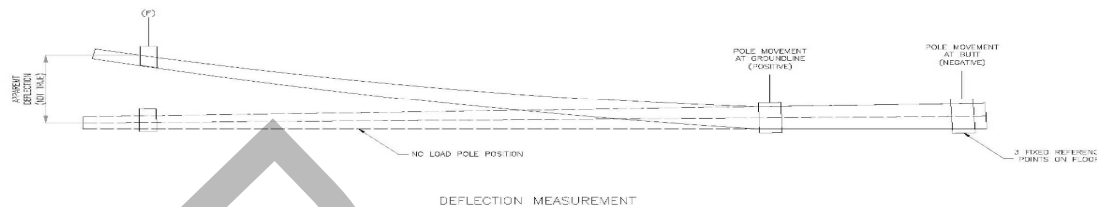


Fig (3)

7.3. Type tests:

- 7.3.1 These tests done to have the actual mechanical and electrical result for the design.
- 7.3.2 These results taken in calculation sheet.

7.4. Routine TEST:

The following tests shall be carried out on the representative sample
Withdrawn in accordance with table 4:

- 7.4.1 One third of the sample shall be taken for carrying out acceptance tests with a minimum of two poles.
- 7.4.2 Two third of the sample shall be taken for retesting in case any of the poles in the sample specified in table 4 fails in the test.

7.5 Visual inspection:

The pole shall be visually inspected to ensure that it is free from any damage or apparent defect in manufacture and to ensure conformity of labelled information with the relevant requirements.

7.6 Dimensions measurements:

- 7.6.1 All dimensions of the pole shall be measured by length measuring instruments to check their compliance with the specified dimensions in accordance with the design calculations.

7.6.2 The internal and external diameters of the pole shall be measured at different positions from the pole top and bottom using a suitable method of measurement.

7.6.3 The thickness of the pole shall be measured at different positions along its length using a micrometer or any other means of suitable accuracy.

7.6.4 The different specified lengths of the pole shall be measured by tape measures and graduated scales of suitable accuracy.

7.6.5 Determination of pole weight

The pole shall be placed on a platform scale with the result record.

7.6.6 Weathering

The product must pass the weathering test according to standard in 2.18.

8. TRANSPORT AND STORAGE

8.1 The poles shall be transported and stored in such a manner that ensures the protection from stresses and traumas.

8.2 Each consignment of poles shall be divided into groups of the same type and dimensions

9. LABELLING AND MARKING

Each pole shall be legibly and indelibly marked in Arabic and/or English with the following information:

9.1 Manufacturer's name and/or trademark.

9.2 Production serial number.

9.3 Country of origin.

9.4 Total length of pole.

9.5 Mounting height.

9.6 Dimensions of the sign, arm (if any) or mentioned barcode for its

REFERENCES:

- **ASSHTO Sixth Edition 2013**, Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
- **GOS 265(SASO 533)**, Fiberglass Reinforced Polyester Poles (FRP) and Methods of testing
- **Scientific Research Publishing**, GFRP Poles for Traffic Signs and Signal Poles: A Case Study in Saudi Arabia (<https://www.scirp.org/journal/paperinformation?paperid=121819>)
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