CT Innovations


# TSS Installation Efficiency:

## TOUGHTray

TOUGH
SUPPORT SAVINGS

## 1.0 ABSRACT

Improving the efficiency of cable ladder tray installation involves a combination of product innovation, modular solutions, application recommendations, material optimization, and effective work methods.

This paper explores various typical cable ladder tray applications, strategies and innovations aimed at increasing the installation productivity of cable ladder tray systems in industrial and commercial construction environments.

Installation methods that enhance productivity not only reduce project costs but also improve construction schedule timelines, overall quality and the projects profitability.

Analysis, case studies and real-world applications illustrate the efficiency benefits of implementing these methods. This paper presents a series of *"Manufacturer Recommended Methods"* which when applied to a cable ladder tray project, generate approximated installation savings of 260,000 pieces of material and 5,000 hours.

## 2.0 INTRODUCTION

National energy security and environmental concerns are driving the energy transition, while societies adoption of new data technology is driving increased demand for products and services. These combined needs are driving increased demand for new electrical infrastructure which the construction industry must deliver against a backdrop of market constraints such as the availability and cost of product, labor and materials.

In the competitive landscape of industrial and commercial construction projects, the efficiency of cable ladder tray installation methods significantly impacts project success. Increasing installation productivity is crucial for meeting tight completion deadlines, controlling critical path risks and contract costs. This paper examines methods and recommendations that contribute to installation efficiency, higher installation productivity and provides insights into their effectiveness.

It is important that early consideration be given to cable ladder tray installation methods and efficiency. The early selection of a cable ladder tray system that best mitigates installation time, materials and labor is recommended.

This recommendation should ideally be considered and evaluated during project front end engineering design.

## 3.0 INSTALLATION REQUIREMENTS

The following cable ladder tray installation requirements shall be considered. We investigate industry standard practice and manufacturer recommended methods for each requirement, determining their material optimization and installation efficiency potential.

3.1 Tray Jointing
3.2 Cover Restraint
3.3 Thermal Expansion
3.4 Support Structure

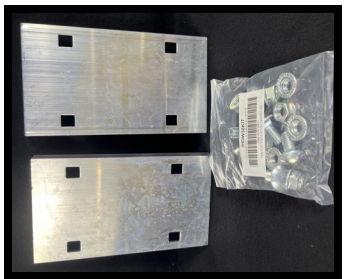
## 3.1 Tray Jointing

Cable ladder tray straight sections and fittings (elbow, tee, cross) must be connected by means of jointing to construct a mechanically continuous tray system. We shall consider two methods of ladder tray jointing:

a) Splicing using loose splice plates.

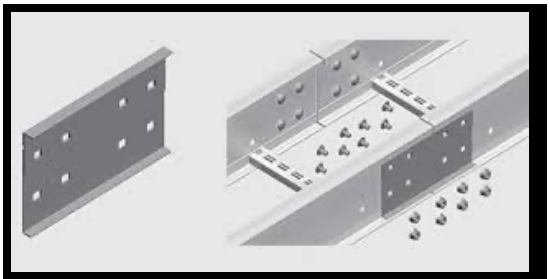
b) Linking using pre-installed link connectors.

a) Splicing: as shown in the below image, the splice plate is supplied as a separate loose item with hardware (bolt, nut, washer) also supplied as loose items. The plate has plain holes, typically square to captivate the bolt to splice (join) the straight sections and fittings.



4-Hole Splice Plate

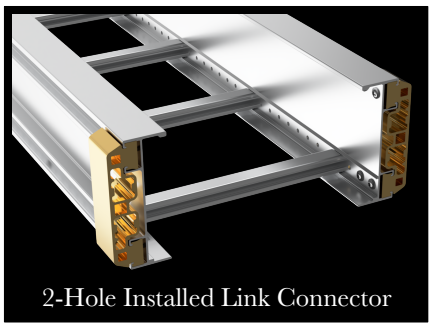
6-Hole Splice Plate



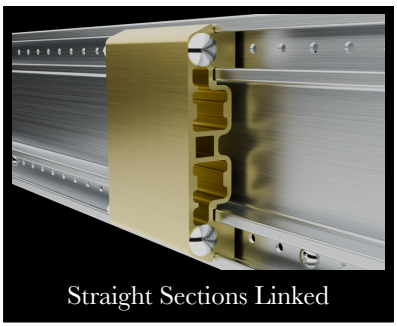
8-Hole Splice Plate

| NEMA® Efficiency | Quantity Pieces | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Industry Standard Practice | 18 | 0.00% | 0.166 | 0.00% |

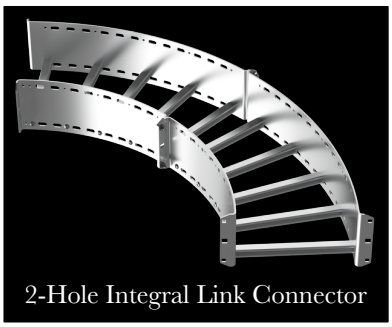
b) Linking: as shown in the below image, the link connector is supplied factory pre-installed to straight sections and integral to fittings with hardware (bolt, nut) supplied as loose items. The link connector has plain square holes to captivate the bolt and to link (join) the straight sections and fittings.



2-Hole Installed Link Connector



Straight Sections Linked



2-Hole Integral Link Connector

| TOUGH SUPPORT SAVINGS Efficiency | Quantity Pieces | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Manufacturer Recommendation | 8 | +55.56% | 0.033 | +80.12% |

## 3.2 Cover Restraint

The cable ladder tray system may require covers to be connected to the tray by a means of restraint suitable to mechanically restrain the covers in service while providing means to easily remove covers for inspection and maintenance. We shall consider two methods of cover restraint:

a) Cover Clamps.

b) Cover Fixings.

a) Clamps: as shown in the below image, the cover clamp is supplied as a separate loose item with hardware (bolt, nut, washer) also supplied as loose items. The cover clamp is supplied in heights and widths to match the tray height and width the cover must be secured too. The cover clamp wraps around the cover and tray, has plain holes for the hardware, tightening of the hardware clamps the cover to the tray.

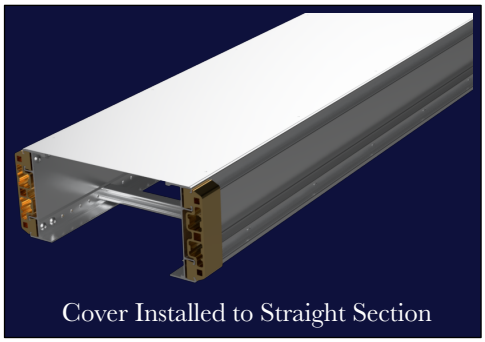
2-Piece Wrap Around Cover Clamp

Installed 2-Piece Wrap Around Cover Clamps

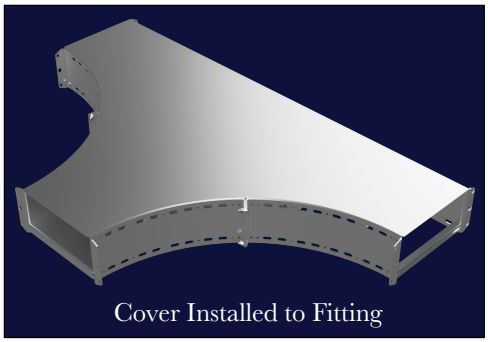
| NEMA® Efficiency | Quantity Pieces | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Industry Standard Practice | 8 | 0.00% | 0.166 | 0.00% |

a) Fixings: as shown in the below image, the cover fixing torx screw is supplied as a loose item. The screw secures all cover widths and cover types. Installing the screw mechanically secures the cover to the tray.

1-Piece Cover Fixing



Cover Installed to Straight Section



Cover Installed to Fitting

| TOUGH SUPPORT SAVINGS Efficiency | Quantity Pieces | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Manufacturer Recommendation | 2 | +55.56% | 0.016 | +90.36% |

## 3.3 Thermal Expansion

Continuous straight tray runs must be provided with expansion joint gaps that allow the continuous straight tray run to thermally expand and contract in service. We shall consider two methods of providing the tray runs with expansion joint gaps:

a) Expansion splice plates.

b) Expansion connector kits.

a) Expansion Splice Plates: as shown in the below image, the expansion splice plate is supplied as a separate loose item with hardware (bolt, nut, washer) also supplied as loose items. The plate has plain holes for the bolt to splice (join) the straight sections while allowing a 1in gap between sections.

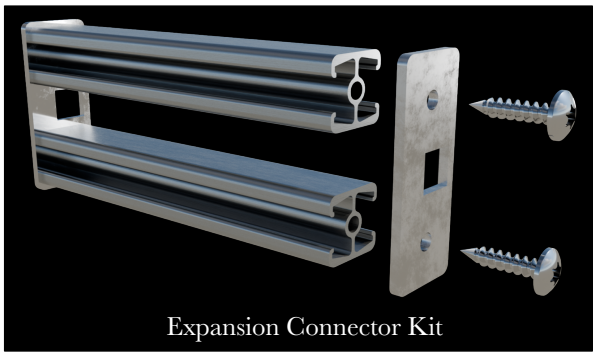
4-Bolt Expansion Plate

6-Bolt Expansion Splice Plate

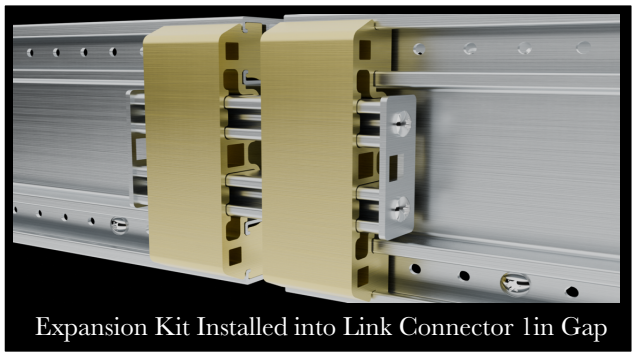
Installed Expansion Splice Plate 1in Gap

| NEMA® Efficiency | Quantity Pieces | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Industry Standard Practice | 26 | 0.00% | 0.199 | 0.00% |

b) Expansion Connector Kits: as shown in the below image, the expansion splice plate is supplied as a separate loose item with hardware (bolt, nut, washer) also supplied as loose items. The plate has plain holes for the bolt to splice (join) the straight sections while allowing a 1in gap between sections.



Expansion Connector Kit



Expansion Kit Installed into Link Connector 1in Gap

| TOUGH SUPPORT SAVINGS Efficiency | Quantity Pieces | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Manufacturer Recommendation | 8 | +69.23% | 0.033 | +83.42% |

## 3.4 Support Structure

The cable ladder tray must be supported by means of a structural support system. Structural support types range from I-beam sections to strut channel and all-thread rod to wire rope. For the optimization of tray support structure and its installation time we shall consider two methods:

a) Industry Standard Practice (NEMA VE 2) Method.

b) Manufacturer Recommended (TOUGH Support Savings) Method.

a) Industry Standard Practice: as shown in the below images, cable ladder tray structural support locations and support quantities are detailed for a range of tray fittings. The support locations and quantities are as recommended by industry standard practice NEMA VE 2

VE2

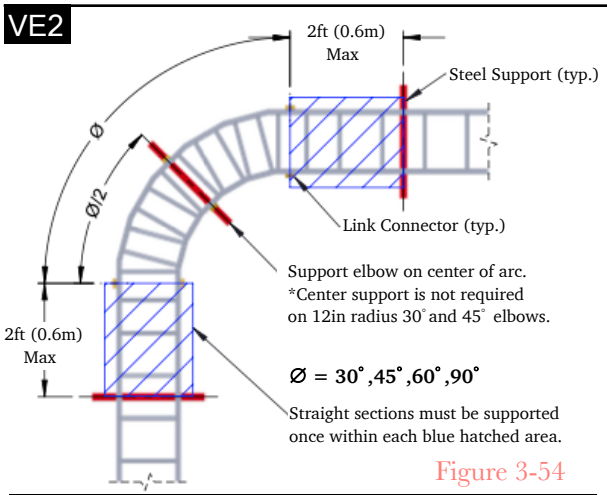



Figure 3-54

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 3 | 0.00% | 1.5 | 0.00% |

VE2

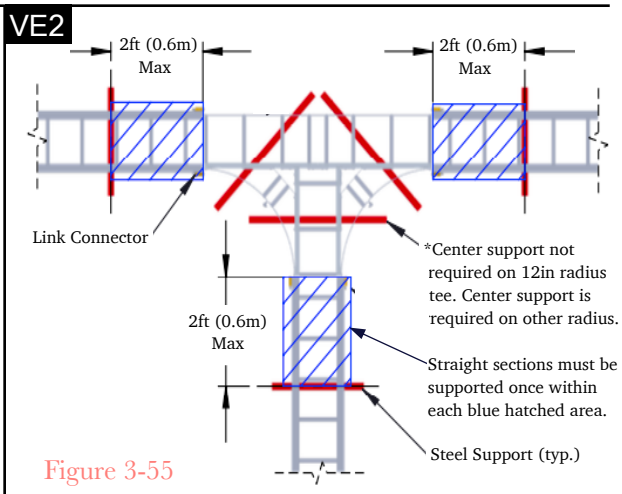



Figure 3-55

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 6 | 0.00% | 3.0 | 0.00% |

VE2

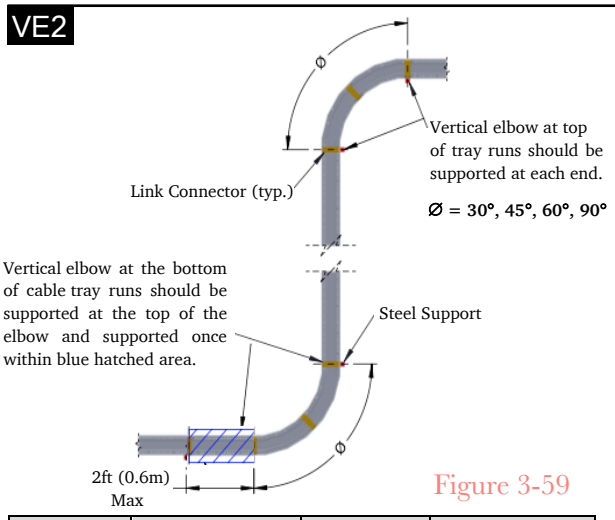



Figure 3-59

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 4 | 0.00% | 2.0 | 0.00% |

VE2

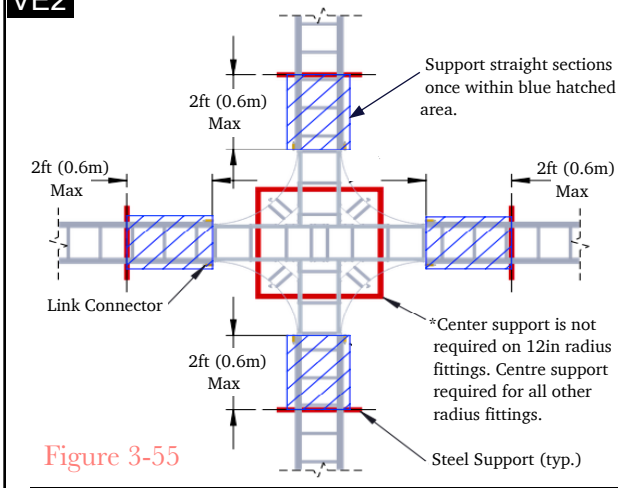



Figure 3-55

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 8 | 0.00% | 4.0 | 0.00% |

b) Manufacturer Recommendations: as shown in the below images, the cable ladder tray structural support locations and support quantities are detailed for a range of tray fittings. Support locations and quantities are as recommended by the manufacturer TOUGH Support Savings.

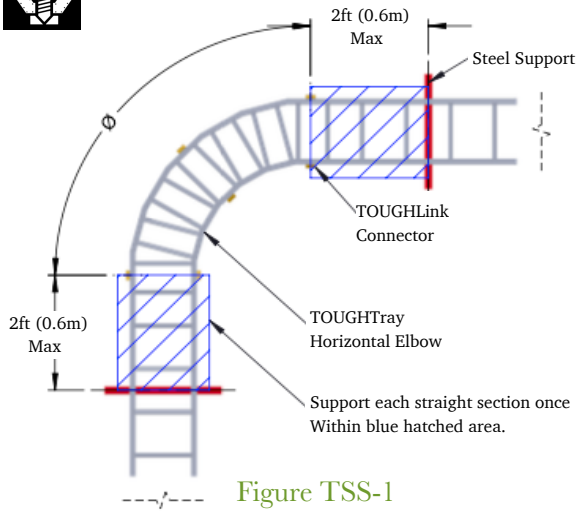



Figure TSS-1

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 2 | +33.33% | 1.0 | +33.33% |

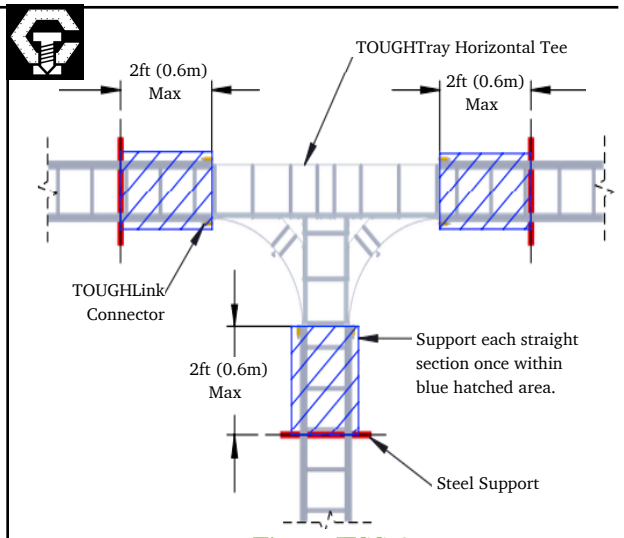



Figure TSS-2

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 3 | +50.00% | 1.5 | +50.00% |

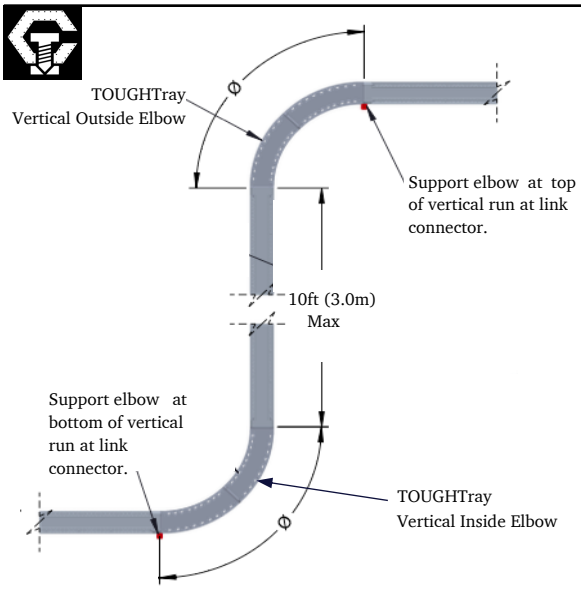



Figure TSS-3

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 2 | +50.00% | 1.0 | +50.00% |

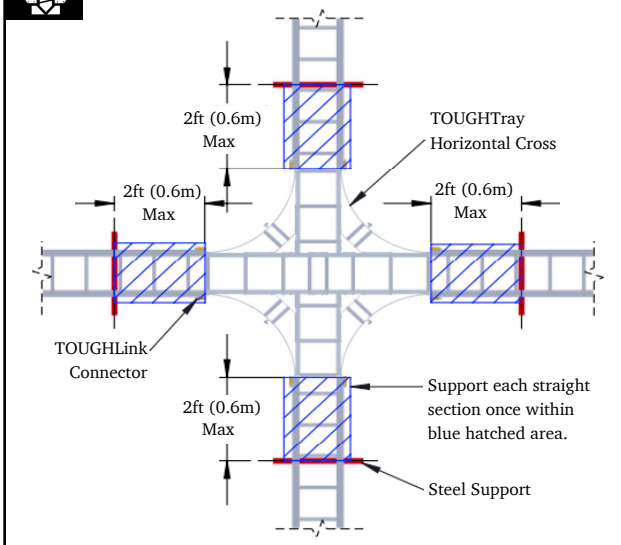



Figure TSS-4

| Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|
| 4 | +50.00% | 2.0 | +50.00% |

a) Industry Standard Practice: as shown in the below images, cable ladder tray structural support locations and support quantities are detailed for a continuous straight tray run expansion joint. The joint, support locations and quantities are as recommended by industry standard practice NEMA VE 2.

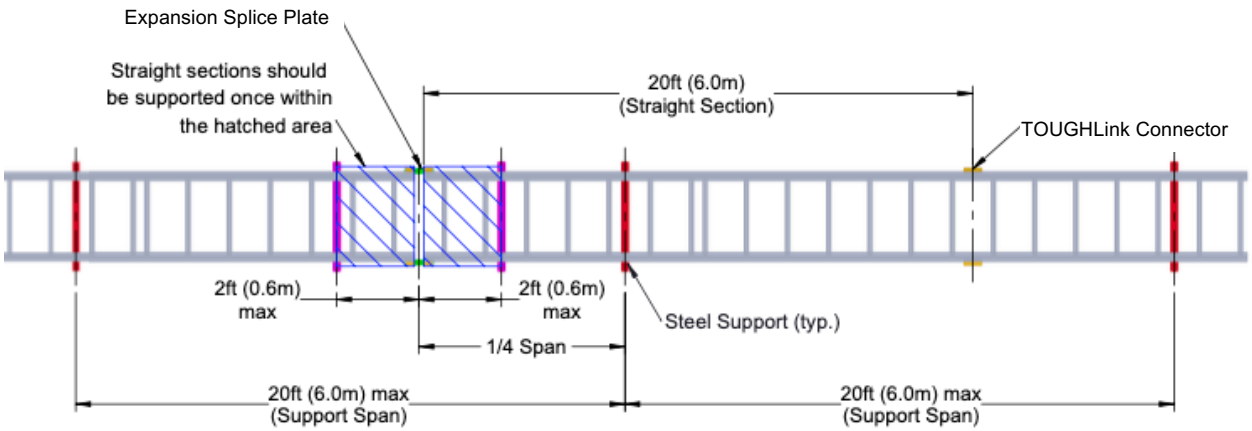



Figure 3-34

| NEMA® Efficiency | Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Industry Standard Practice | 2 | 0.00% | 1.0 | 0.00% |

b) Industry Standard Practice: as shown in the below images, cable ladder tray structural support locations and support quantities are detailed for a continuous straight tray run expansion joint. The joint, support locations and quantities are as recommended by manufacturer TOUGH Support Savings.

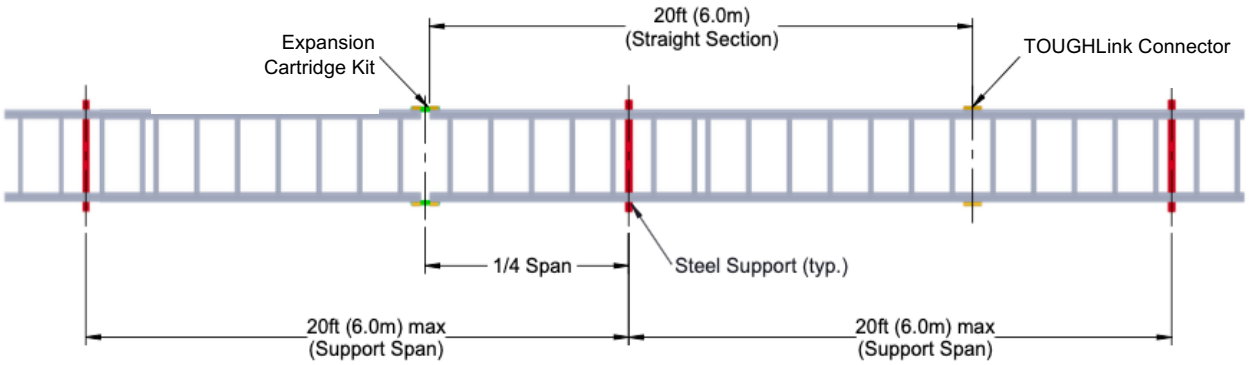



Figure TSS-5

| TOUGH Support Savings Efficiency | Support Qty (pcs) | Material Optimization | Install Time (hrs) | Installation Efficiency (%) |
|---|---|---|---|---|
| Manufacturer Recommendation | 0 | +100.00% | 0.0 | +100.00% |

## 4.0 TABULATION OF INSTALLATION METHODS

This tabulation provides a summary of the installation methods detailed within Section 3.0. The below data will show each methods efficiency in optimizing materials and installation productivity. Green colored cells indicate the method is highly efficient. Red colored cells indicate the method is not efficient.

| Productivity | Section 3.1 Tray Jointing | | Section 3.2 Cover Restraint | | Section 3.3 Thermal Expansion | | Section 3.4 Support Structure | |
|---|---|---|---|---|---|---|---|---|
| | I.S.P. | M.R. | I.S.P. | M.R. | I.S.P. | M.R. | I.S.P. | M.R. |
| Material Optimization | 0.00% | +55.56% | 0.00% | +55.56% | 0.00% | +69.23% | 0.00% | +52.17% |
| Installation Time (hrs) | 0.166 | 0.033 | 0.166 | 0.016 | 0.199% | 0.033 | 11.50 | 5.50 |
| Installation Efficiency | 0.00% | +80.12% | 0.00% | +90.36% | 0.00% | +83.42% | 0.00% | +52.17% |

*I.S.P. = Industry Standard Practice NEMA VE 2 | M.R. = Manufacturer Recommendation TOUGH Support Savings

## 5.0 PROJECT EXAMPLE OF WORKED METHODS

We now evaluate the installation methods when applied to a cable tray project. Based on the below Table 5.1 cable tray material take-off, we will calculate the installation methods material optimization and installation efficiency which are summarized in the following Table 5.2

The calculations and comparisons will consider the following:

a) Material Optimization (%).
b) Installation Time (Hrs.).
c) Installation Efficiency (%).

Table 5.1 : Cable Tray System Material Take-Off

| Item # | Quantity | UoM | Cable Tray Description | NEMA VE 1 |
|---|---|---|---|---|
| 1.0 | 4500 | 1-Piece | Straight Section 36”W 20ft L | 20C |
| 1.1 | 9000 | 1-Piece | Cover Straight Section 36”W 10ft L | - |
| 2.0 | 400 | 1-Piece | Horizontal Elbow 36”W 36”R | 20C |
| 2.1 | 400 | 1-Piece | Cover Horizontal Elbow 36”W 36”R | - |
| 3.0 | 150 | 1-Piece | Horizontal Tee 36”W 36”R | 20C |
| 3.1 | 150 | 1-Piece | Cover Horizontal Tee 36”W 36”R | - |
| 4.0 | 100 | 1-Piece | Horizontal Cross 36”W 36”R | 20C |
| 4.1 | 100 | 1-Piece | Cover Horizontal Cross 36”W 36”R | - |
| 5.0 | 400 | 1-Piece | Vertical Inside Elbow 36”W 36”R | 20C |
| 5.1 | 400 | 1-Piece | Cover Vertical Inside Elbow 36”W 36”R | - |
| 6.0 | 400 | 1-Piece | Vertical Outside Elbow 36”W 36”R | 20C |
| 6.1 | 400 | 1-Piece | Cover Vertical Outside Elbow 36”W 36”R | - |
| 7.0 | 1500 | 1-Pair | Expansion Joint Kit 36”W | 20C |

| Table 6.2 : Material Take-Off Installation Methods Analysis | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Tray Description | UoM | Qty | Material Quantity (pcs) | | Material Optimization (%) | | Installation Time (hrs) | | Installation Efficiency (%) | |
| | | | | I.S.P. | M.R. | I.S.P. | M.R. | I.S.P. | M.R. | I.S.P. | M.R. |
| 1.0 | Straight Section 36"W 20ft L | 1-Piece | 4500 | 54,000 | 24,000 | 0.00 | +55.56 | 498.0 | 99.0 | 0.00 | +80.12 |
| 1.1 | Cover Straight 36"W 10ft L | 1-Piece | 9000 | 216,000 | 54,000 | 0.00 | +75.00 | 4,482.0 | 432.0 | 0.00 | +90.36 |
| 2.0 | Horizontal Elbow 36"W 36"R | 1-Piece | 400 | 8,400 | 4,000 | 0.00 | +52.38 | 66.4 | 13.2 | 0.00 | +65.73 |
| 2.1 | Cover Elbow 36"W 36"R | 1-Piece | 400 | 6,400 | 1,600 | 0.00 | +75.00 | 132.8 | 12.8 | 0.00 | +90.36 |
| 3.0 | Horizontal Tee 36"W 36"R | 1-Piece | 150 | 6,300 | 1,650 | 0.00 | +73.81 | 24.9 | 4.9 | 0.00 | +65.06 |
| 3.1 | Cover Tee 36"W 36"R | 1-Piece | 150 | 3,600 | 900 | 0.00 | +75.00 | 74.7 | 7.2 | 0.00 | +90.36 |
| 4.0 | Horizontal Cross 36"W 36"R | 1-Piece | 100 | 6,200 | 1,200 | 0.00 | +80.65 | 16.6 | 3.3 | 0.00 | +65.06 |
| 4.1 | Cover Cross 36"W 36"R | 1-Piece | 100 | 3,200 | 800 | 0.00 | +75.00 | 66.4 | 6.4 | 0.00 | +90.36 |
| 5.0 | Vertical IS Elbow 36"W 36"R | 1-Piece | 400 | 8,000 | 2,000 | 0.00 | +75.00 | 66.4 | 13.2 | 0.00 | +65.06 |
| 3.1 | Cover IS Elbow 36"W 36"R | 1-Piece | 400 | 6,400 | 1,600 | 0.00 | +75.00 | 132.8 | 12.8 | 0.00 | +90.36 |
| 6.0 | Vertical OS Elbow 36"W 36"R | 1-Piece | 400 | 8,000 | 2,000 | 0.00 | +75.00 | 66.4 | 13.2 | 0.00 | +65.06 |
| 6.1 | Cover OS Elbow 36"W 36"R | 1-Piece | 400 | 6,400 | 1,600 | 0.00 | +75.00 | 132.8 | 12.8 | 0.00 | +90.36 |
| 7.0 | Expansion Joint Kit 36"W | 1-Pair | 1500 | 39,000 | 12,000 | 0.00 | +69.23 | 298.5 | 49.5 | 0.00 | +90.06 |
| | | Table Totals: | | **372000** | **107350** | | | **6058.7** | **680.3** | | |

## 7.0 SUMMARY

With consideration to the data presented within Table 6.2, we can summarize the available cable tray installation methods material optimization and installation efficiencies:

a) Industry Standard Practice Installation Methods.

Industry Standard Practice does not optimize cable tray materials or reduce cable tray installation time. It demonstrates installation inefficiency, resulting in high cable tray material content and installation time.

b) Manufacturer Recommended Installation Methods.

Manufacturer Recommendations optimize cable tray materials and reduce the cable tray installation time. It demonstrates installation efficiency, optimizing cable tray materials by 264,650pcs and reducing the cable tray installation time by 5,378.4 Hours. Resulting in cable tray installation productivity gains of up to 90%.

## 8.0 CONCLUSIONS

Cable ladder tray industry standard practices and installation methods present efficiency challenges which can be easily mitigated by the selection and implementation of alternate manufacturer recommendations. Based on the findings of this paper, we recommend:

a. Cable tray selection should consider the impact of the installation methods at the earliest possible stage of a project. This is recommended to be during project FEED.

b. Selecting a cable ladder tray system designed to optimize materials and reduce installation time, that delivers quantifiable efficiency and productivity gains.

## 9.0 REFERENCES & TOOLS

To aid in the evaluation of cable ladder tray installation efficiency, the following technical papers and quantification tools are available to the reader and recommended by the author.

a. TOUGH Support Savings Calculator

b. TT-W005: Structural Design Efficiency

c. TT-W004: Mitigating Critical Path Risks

Visit, view and download from: https://www.toughinnovations.com/resources

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