GUIDELINE

For Synthetic Slings:

- Flat Web Slings
- Round Slings
- Twin-Path® Slings
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1. OBJECTIVE

- The first objective of this guideline is to provide detailed information regarding the use of synthetic slings and recommend safe rigging practices when working with synthetic slings.

- The second objective of this guideline serves to provide a reference tool to educate a “Designated Rigger” about the essentials of synthetic slings. A Designated Rigger is a person, selected by the Superintendent, responsible for the lift, who:
  
  - Is knowledgeable of the operation for which the lift is being performed.
  
  - Is experienced in the basic fundamentals of rigging and crane lifts related to the heavy construction industry.
  
  - Is capable of identifying existing and predictable hazards during the lift, and who has authorization to take prompt corrective measures to eliminate them.
  
  - Has reviewed this guideline with the Superintendent responsible for the lift.
  
  - Has signed the “Training Record” and has been given a copy of this guideline.

  Refer to Appendix A: Training Record for Designated Rigger.

  - Will be present at all times while synthetic slings are being used during a lift.
2. PREREQUISITE

- This guideline is a supplement to the Pacific Structures Synthetic Sling Policy. It will be important to become familiar with the policy.

  Refer to Appendix D: Copy of the District’s Synthetic Sling Policy.

- Synthetic slings cannot be used for general hoisting purposes. Synthetic slings can only be used if wire rope slings are not suitable for a unique hoisting condition; such as protecting the load from rigging damage, excessive weight of conventional rigging, head room issues, safety concerns, etc. If synthetic slings are used for hoisting, then the use of the synthetic slings will be used in accordance with District policy.

- This guideline only addresses the use of synthetic slings. It does not prescribe the generic fundamentals of rigging and crane lifts such as sling angles, hitch philosophy, crane signals, etc. This guideline assumes the reader has a basic understanding of rigging practices.
3. INTRODUCTION

DIFFERENT SYNTHETIC SLING OPTIONS

Three different synthetic slings are typically used for attachment hitches when rigging a load. They are: flat web slings, round slings, or Twin-Path® slings. A short description of the physical characteristics of each of these slings is provided below:

FLAT WEB SLINGS

➢ Flat web slings are manufactured using either polyester or nylon material.

➢ Flat web slings can be purchased in the following sling configurations:
  o Endless Style Sling
  o Eye & Eye Style Sling:
    - With standard flat eyes
    - With twisted eyes
    - With reverse eyes
    - With metal end fittings (steel or aluminum)
ROUND SLINGS

- Round slings are manufactured with a core yarn using polyester material.
- Round slings are manufactured with an outer cover using polyester or nylon material.

- Round slings can be purchased in the following sling configuration:
  - Endless Style Sling
**TWIN-PATH® SLINGS**

- Twin-Path® slings are manufactured with a core yarn using polyester or K-Spec™ material. K-Spec™ is the manufacturer’s registered trademark for their core yarn, which is an aramid material.

- Twin-Path® slings are manufactured with an inner cover using polyester material and an outer cover using either polyester or nylon material. The Sparkeater version of a Twin-Path® sling is manufactured with an outer cover using Nomex®. Nomex® is the manufacturer’s registered trademark of a flame retardant meta-aramid material.

- Twin-Path slings can be purchased in the following sling configurations.
  - Endless Style Sling
  - Eye & Eye Style Sling:
    - With standard flat eyes
SUMMARY

Table 3-1 is a summary showing the different types of synthetic slings and the various synthetic materials used to manufacture the slings and covers.

Table 3-1

<table>
<thead>
<tr>
<th>Synthetic Sling Material</th>
<th>Synthetic Slings</th>
<th>Flat Web</th>
<th>Round</th>
<th>Twin-Path®</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Core Yarn</td>
<td>Covers</td>
<td>Core Yarn</td>
</tr>
<tr>
<td>Polyester</td>
<td></td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Nylon</td>
<td></td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Aramid (K-Spec®)</td>
<td></td>
<td></td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Meta-Aramid (Nomex®)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. PRE-LIFT PLANNING CONSIDERATIONS

**Chemical Considerations**

- Extensive exposure to ultraviolet light has a damaging effect on synthetic slings and can impact the rated load capacity (working load limit) of the sling. Slings should not be stored in direct sunlight. Slings should be stored in a ventilated, cool, dry, dark place free of any heat sources and chemically active environments.

- Synthetic slings should not be used in the presence of corrosives, acids, caustic liquids or dry powders where the slings can be exposed to fumes, vapors, sprays, mists, or liquids that can be detrimental to the material of the sling. Exposure of a sling to such an environment may have a damaging effect, and may impact the rated load capacity (working load limit) of the sling.

- Never underestimate the risk of chemical exposure to synthetic slings. Most projects use many chemicals in daily activities such as concrete related products, solvents, battery acids, paints, chemicals, etc. Refer to the project MSDS binder(s), Hazardous Material Inventory List, or contact the District Safety Manager for assistance with chemical related questions regarding degradation to the sling. Table 4-1 provides a reference for chemical considerations when using synthetic slings.

### Table 4-1

<table>
<thead>
<tr>
<th>Chemical Considerations</th>
<th>Polyester</th>
<th>Nylon</th>
<th>Aramid (Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid (weak)</td>
<td>OK</td>
<td>NO</td>
<td>OK</td>
</tr>
<tr>
<td>Acid (strong)</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Alcohol</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>NO</td>
<td>OK</td>
<td>NO</td>
</tr>
<tr>
<td>Alkalies (weak)</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Alkalies (strong)</td>
<td>NO</td>
<td>OK</td>
<td>NO</td>
</tr>
<tr>
<td>Bleaching Agents</td>
<td>OK</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Dry Cleaning Solvents</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Ethers</td>
<td>NO</td>
<td>OK</td>
<td>NO</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Ketones</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Oils (crude)</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Oils (Lubricating)</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Soap/Detergent</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Water (fresh)</td>
<td>OK</td>
<td>OK (Note 1)</td>
<td>OK</td>
</tr>
<tr>
<td>Water (sea)</td>
<td>OK</td>
<td>OK (Note 1)</td>
<td>OK</td>
</tr>
</tbody>
</table>

*Note 1:* Nylon slings lose 15% of their rated load capacity (working load limit) as a result of moisture absorption.

*Note 2:* K-Spec™ is the manufacturer’s registered trademark for the core yarn used in Twin-Path® Extra slings.
Table 4-1 contains manufacturer’s recommendations, which include terms that may not be completely understood by everyone. To help determine if these chemicals exist in the presence of synthetic slings on an operation, definitions of the terms used in the table above have been provided in Appendix C of this Guideline.

Some supervisors use magic markers or paint to mark or tag ST&S to aid in ownership identification. Chemicals from the marker or paint can negatively impact the rated load capacity (working load limit) of the sling and should never be used on synthetic slings.

**Performance Characteristics**

Synthetic slings manufactured using polyester and aramid materials do not lose any of their rated load capacity (working load limit) with moisture absorption. However, synthetic slings manufactured using **nylon materials lose 15% of their rated load capacity (working load limit) with moisture absorption.** Slings manufactured using nylon material will regain their rated load capacity (working load limit) once the slings are dry.

Note: It is recommended to purchase synthetic slings manufactured using polyester and/or aramid materials in locations with excessive rain (Washington, Oregon, Alaska, British Columbia, etc.).

Due to the variation in stretch of dissimilar synthetic materials never mix and match slings manufactured from different materials. Slings manufactured using an aramid material stretch approximately 1% at the rated load capacity (working load limit) of the sling. Slings manufactured using polyester material stretch approximately 3% to 7% at the rated load capacity (working load limit) of the sling. Slings manufactured using nylon materials stretch approximately 6% to 10% at the rated load capacity (working load limit) of the sling.

Note: Polyester flat web slings and nylon flat web slings look the same and are similar in color. Refer to the sling label for compatible slings of the same synthetic material.

Note: Twin-Path® slings with K-spec™ core yarn and Twin-Path® slings with polyester core yarn look the same but have different color covers. Refer to the sling label for compatible slings of the same synthetic material.

Table 4-2 provides a reference for performance characteristics when using synthetic slings.
### Table 4-2

<table>
<thead>
<tr>
<th>Performance Characteristics</th>
<th>Polyester</th>
<th>Nylon</th>
<th>Aramid (Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stretch at rated capacity (working load limit)</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Flat web slings – treated</td>
<td>7%</td>
<td>10%</td>
<td>---</td>
</tr>
<tr>
<td>Flat web slings – untreated</td>
<td>3%</td>
<td>6%</td>
<td>---</td>
</tr>
<tr>
<td>Round slings</td>
<td>3%</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Twin-Path® slings</td>
<td>---</td>
<td>---</td>
<td>1%</td>
</tr>
<tr>
<td>Capacity loss when wet</td>
<td>0%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Operating temperatures</td>
<td>-40°F to 180°F</td>
<td>-40°F to 180°F</td>
<td>-40°F to 180°F</td>
</tr>
</tbody>
</table>

**Note 2:** K-Spec™ is the manufacturer’s registered trademark for the core yarn used in Twin-Path® Extra slings.

**Note 3:** The Sparkeater version of Twin-Path® slings have a Nomex® cover. Nomex® is a flame retardant meta-aramid material that has an operating temperature of -40°F to 300°F.

- Hard or brittle spots on a synthetic sling can impact the rated load capacity (working load limit) of a sling, and are usually a result of excessive heat exposure, and must be removed from service and destroyed.

### RIGGING FUNDAMENTALS

- Be safe. Verify that the rigging meets the load requirements.

- The rated load capacity (working load limit) of a synthetic sling shall be specified by the sling manufacturer, using a design safety factor of at least 5:1.

- *Twin-Path® Slings Only:* Each path of a Twin-Path® sling has a 2½:1 safety factor. Both paths combine to give a 5:1 safety factor. It is important to equally load both paths of the sling to achieve the 5:1 safety factor. *(There is a belief within the construction industry that Twin-Path® slings have a 10:1 safety factor as a result of the redundant design of two paths. The redundant design of two paths is true, but the safety factor of 10:1 is not.)*

- When a fast hook (line speed greater than 20 feet per minute) is used for hoisting, such as for rebar, in a rapid production mode, then a best practice is to add a dynamic load factor of 50%. This means the synthetic sling should be designed to 150% due to the dynamic effect of stretch and shock load that can be amplified by a fast hook. The recommended 50% dynamic load factor is over and above the 5:1 safety factor of the sling.

- When a slow hook (line speed less than 20 feet per minute) is used for hoisting, then a good rule is to add a dynamic load factor of 10%. This means the synthetic sling should be designed to 110% due to the dynamic effect of stretch. The recommended 10% dynamic load factor is over and above the 5:1 safety factor of the sling.
For synthetic sling eyes (not including metal fittings), the maximum allowable pin diameter or hook width is not to exceed 50% of the eye length.

For example: A sling manufactured with a 6-inch long eye should not be used with a pin diameter or hook width in excess of 3-inches across. Refer to the diagram below:

Synthetic slings should never pass over themselves when used as a double wrap. This can cause sling damage.

Synthetic slings should never be twisted or tied in a knot. This can cause concentrated stresses resulting in sling failure.

Synthetic slings equipped with metal fittings or shackles attached should never be dropped to the ground. This can cause sling damage.

Synthetic slings should never have objects dropped on them or run over with a vehicle/equipment. This can cause sling damage.

Synthetic slings should never be dragged or drawn across the floor, ground or abrasive surfaces. This can cause sling damage.

*Twin-Path® Slings Only: Twin-Path® slings can be purchased with a fiber optic option, which allows the condition of the internal yarn to be inspected by checking the continuity of the fiber optics cable. If heat, chemicals, crushing or cutting has occurred then damage to the fiber optics cable will eliminate its ability to transmit light from one end to the other. It is recommended to purchase Twin-Path® slings with this option.

COMPATIBLE HARDWARE

When terminating synthetic slings at a connection point, the use of “sling saver” shackles/hardware and/or “wide body” shackles to prevent sling damage is strongly recommended.

Refer to Section 8 – Shackles & Hardware for additional detailed information.
GUIDELINE FOR SYNTHETIC SLINGS

- When choking a load using synthetic slings, always use a hook or shackle where the sling connects back to itself to prevent sling damage.
  - The hook or shackle used at the choker hitch should be compatible with synthetic slings.
  
  Refer to **Section 8 – Shackles & Hardware** for additional detailed information.

- When terminating a synthetic sling at a shackle, never attach the sling to the pin area of the shackle. This can cause a cut/damage resulting in sling failure.
  - If a synthetic sling must attach to the pin area of a shackle, the shackle pin must be padded.
  
  Refer to **Section 8 – Shackles & Hardware** for additional detailed information.

**STRESSES AT BENDING POINTS**

- When using synthetic slings, the proper selection and implementation of padding and/or softeners on the corners/edges of the load is crucial.
  - Refer to **Section 7 – Padding & Softeners** for additional detailed information.

- The **D/d ratio calculation is not applicable for use with synthetic slings** for determining if high stress is introduced at the bend point of the sling.

- The following D/d ratio information for wire rope is presented to illustrate the significance of bending stress on a sling.
  - The D over d ratio (D/d) is the diameter of curvature around which wire rope is bent (D), over the diameter of the wire rope (d).
  
  The D/d ratio is a simple calculation used to ensure high stress is not introduced at the bend points of a wire rope. For wire rope a D/d ratio should be 25:1, if this cannot be achieved then the capacity of the wire rope needs to be appropriately reduced for the reduction in efficiency or de-rated to 50%. See Table 4-3.
Table 4-3

Reduction in efficiency of wire rope when bent over curved surfaces of various sizes (static loads only).

For example: A wire rope bent around a pin or corner/edge of equal diameter will have a D/d ratio of 1:1. The efficiency will be 50%. The wire rope will only have 50% of its load rated capacity (working load limit).

The following information is provided to serve as a D/d ratio type of rule for synthetic slings.

Flat web slings have no D/d ratio type of rules. Nylon and polyester fibers are assumed to be so flexible that the bending stresses are negligible, particularly when used with padding for protection from cutting.
Round slings have no D/d ratio type of rules. Nylon and polyester fibers are assumed to be so flexible that the bending stresses are negligible, particularly when used with padding for protection from cutting.

Twin-Path slings have a D/d ratio type of rule of ½ the sling width. For example: A 4-inch wide Twin-Path sling would need a minimum pin or corner diameter of 2-inches.
5. PRE-LIFT INSPECTION

FREQUENCY OF INSPECTION

- Inspection of synthetic slings should be performed as follows:
  - Before use – (mandatory).
  - During use – (at a minimum once daily).
  - After use – (inspect and appropriately handle any damaged slings).

- Annual certification tags are required for some synthetic slings.
  - Flat web slings (polyester and nylon) do not require annual certification tags.
  - Round slings (polyester) do not require annual certification tags.
  - Twin-Path slings (polyester and aramid) require an annual inspection that is recorded and maintained for each individual sling. Slings have serial numbers on the tags, which help in documenting the sling’s inspection record.

INSPECTION BASICS

- If any doubt exists as to the slings condition, the sling shall not be used.

- If the label on the synthetic sling is illegible or is missing from the sling, then the sling must be removed from service immediately.

- The “Designated Rigger” will perform a hand-over-hand inspection while checking the sling for evidence of damage. If the sling does not pass inspection remove the sling from service or discard (if appropriate) any damaged slings.

  Note: Destroy all slings before discarding in a dumpster.

  Note: Never allow employees to take home any synthetic slings removed from service.

HOW TO PERFORM AN INSPECTION

- When inspecting a synthetic sling, ensure all of the following information on the tag is legible:
  1. Name and/or trademark of the manufacturer.
  2. Manufacturer’s product code or stock number.
  3. Rated load for the type of hitch (vertical, choker and basket).
4. Type of material (polyester, nylon or aramid/K-spec™).
5. Sling length – bearing point to bearing point.

In cases where the tag is missing or non-readable it is possible to return the sling to the vendor to be re-labeled. If it is not practical for the vendor to re-label the sling then the sling must be removed from service and destroyed.

**INSPECTION CRITERIA**

The synthetic sling has:

3. No twists or knots.
4. No excessive wear due to abrasion.
5. No snags, punctures, tears, cuts or embedded items.
6. No burns from chemicals such as acids or caustics.
7. No melting or charring from weld or torch splatter.
8. No hard or brittle spots.
9. No distorted end fittings; if equipped with metal end fittings.
10. **Nylon Slings Only:** The sling is dry. This is very important because nylon slings lose 15% of their rated load capacity (working load limit) with moisture absorption.
11. **Flat Web Slings Only:** The sling has no exposed red fiber. It should be noted that not all manufacturers of flat web slings use the “red is dead” method in the stitching.
12. **Flat Web Sling Only:** The sling has no split between the selvage edge and its woven width.
13. **Flat Web Slings Only:** The sling has no broken or worn stitches.
14. **Flat Web or Round Slings Only:** The sling has no evidence of elongation. A brand new sling of the same original size may be used to compare for elongation.
15. **Eye and Eye Style Slings Only:** The sling has no broken stitches at the eye.
16. **Twin-Path® Slings Only:** The sling has no exposed red inner cover. If the red inner cover is exposed the sling should be removed from service and sent to the manufacturer for repair. It should be noted that Twin-Path® slings in most cases
can be repaired by the manufacturer if the inner red cover or the core yarn is exposed.

17. *Twin-Path® Slings Only*: The sling has no repairs other than the manufacturers repairs.

18. *Twin-Path® Slings Only*: The sling has tell-tails that extend ½-inch past the tag area. If both tell-tails are not ½-inch long, then remove the sling from service. If the tell-tails show evidence of chemical degradation, remove the sling from service. Send the sling to manufacturer for repair or evaluation.
6. OPERATING PRACTICE

- The hazard analysis and rigging plan will be reviewed and followed at all times.

RIGGING AND HOISTING THE LOAD

- Always check to ensure synthetic slings are used in the conditions shown on the Rigging Plan.

  - Refer to Appendix B – Example of a Rigging Plan for Synthetic Slings.

Ensure the following items are in accordance with the Rigging Plan:

- The correct synthetic sling is used (type of sling, type of sling material, capacity, and length).

- The correct attachment hitch is used (vertical, choker, or basket).

- The sling path on the load is free of sharp edges that could cause damage to the slings. If padding is specified in the Rigging Plan, then assure the padding is properly placed and is adequate.

- The sling path on the load does not create excess bending stresses on the slings. If softeners are specified in the Rigging Plan, then assure the softeners are properly placed and are adequate.

- Always check the path of synthetic slings for interference from accessory items on the load; such as bolts, stiffeners, splice plates, pipes, protrusions, etc. These could damage the sling resulting in sling failure. Accessory items on the load may not always be included in the Rigging Plan.

- Always use synthetic slings without crossing or twisting the slings. This can cause concentrated stresses resulting in overloading and potential sling failure. It may be necessary to stop and adjust the slings once the load is applied to the rigging.

  - Note: Be aware of stored energy and pinch points if attempting to reposition a synthetic sling that is load bearing.

- Always check the connection between the synthetic sling and the shackle for proper seating of the sling within the shackle. It may be necessary to stop and adjust the shackle connection once the load is applied to the rigging.

  - Note: Be aware of stored energy and pinch points if attempting to reposition a synthetic sling that is load bearing.
Always terminate a synthetic sling on the bow of a shackle. Never attach a synthetic sling to the pin area of the shackle. This can cause the sling to be cut resulting in sling failure.

If a synthetic sling must attach to the pin area of a shackle, the shackle pin must be padded.

Refer to Section 8 – Shackles & Hardware for additional detailed information.

*Twin-Path® Slings Only:* When feasible, position slings in a manner where the tell-tails on the sling can be seen and monitored during the initial lift.

Never abruptly load a synthetic sling. This causes a shock load to the sling. Shock loading a hitch utilizing synthetic slings greatly increases the chance of a synthetic sling failure.

Never hoist a load using synthetic slings that is not balanced and level within reason. A load which slips within a hitch utilizing synthetic slings will most likely cut the sling, resulting in sling failure.

Always secure padding and/or softeners with a positive attachment to the slings. Padding and/or softeners can create a falling object hazard to members of the crew in the area when slings are slacked and/or while unrigging the load.

**LIFT AND HOLD TEST**

Always perform a “lift and hold” test before hoisting the load. The “lift and hold” test can take a couple of seconds or several minutes depending on the detail of the rigging required for the lift. The “lift and hold” test should be performed as follows:

- Lift the load enough for the rigging to take all of the weight, but keep the load as close to the ground as possible.

- Hold the load long enough to inspect the loading condition of the synthetic slings and padding and/or softeners. Ensure the load is stable before proceeding with final hoisting.

Always pay attention and listen for noises during the “lift and hold” test. A popping noise indicates potential sling failure and requires the load to be placed back down in a safe condition as soon as possible.

It may be necessary to place the load back down after the “lift and hold” test when using padding and/or softeners to ensure no damage has occurred to the padding and/or softeners before final hoisting.
*Twin-Path® Sling Only: Tell-tails on the sling should be monitored during the “lift and hold” test. Any reduction in tell-tail length indicates potential internal failure, and requires the load to be placed in a safe condition as soon as possible.

If any uncertainty exists, or damage appears to the sling or to the padding and/or softeners, during the “lift and hold” test, stop the lift, place the load down and notify the Superintendent. It will be necessary to re-evaluate the use of a different type of padding, softener or sling to prevent future damage and the possibility of dropping the load.

Landing the Load and Unrigging

Always ensure the area is clear of obstructions that can trap and/or damage a synthetic sling.

Always disconnect and remove synthetic slings from the load in a manner that will not cause damage to the slings.

Never use the crane to pull a trapped synthetic sling out from under the load. This can overload the sling, damage the sling, and/or cause personal injury to members of the crew.

Never fly empty rigging with padding and/or softeners attached to the slings unless they are positively secured to the slings. Padding and/or softeners can create a falling object hazard to members of the crew.

Never throw a sling with metal fittings, or shackles attached to the sling, to the ground. This can cause damage to the sling.

After the slings are disconnected, inspect the sling prior to placing in storage. Remove from service any slings, padding, or softeners that are damaged. Handle and/or dispose of appropriately.

Always prepare the sling for proper storage out of sunlight. Clean rigging (with rags and/or water only) of any debris such as mud or grease. If slings are wet, hang them in a manner to dry.

It is the responsibility of everyone involved in the lift to notify the Designated Rigger, Foreman and/or Superintendent if they have knowledge of damage that has occurred to the rigging.
7. PADDING & SOFTENERS

INTRODUCTION

- Proper use and selection of padding and softeners is crucial. Always use manufactured or job built softeners, or equivalent, for synthetic sling protection, unless the edge of the load has a sufficient radius not to cause sling damage, such as a pipe, shaft, etc.

- **Padding**: Padding is a manufactured or job built piece of reinforced rubber, leather, nylon, wood, fire hose, or similar device to cushion sharp edges or abrasive areas of the load to prevent sling damage.

- **Softeners**: Softeners are manufactured or job built devices used to increase the bending diameter or decrease the angle (soften the angle) on the corner of the load so that the sling capacity is not lost at the bend.

![Diagram showing Padding protects the sling from a sharp edge and Softener increases the bending diameter on the sling.]

MANUFACTURED PRODUCTS

This section provides information for off-the-shelf products that rigging manufacturers produce. SlingMax® and Lift-All® are two companies who manufacture padding/softener products that most rigging vendors carry. Information about SlingMax® and Lift-All® padding/softeners will be discussed in this section; however there may be other similar manufactured products that exist; check with your local rigging vendor.
SlingMax® Products

➤ CornerMax™:

The following series of photos show a product called CornerMax™. This padding/softener product creates a tunnel located at the corner of the load. The tunnel protects the pad and sling from contacting the edge of the load, which prevents damage to the sling, as well as softens the bending radius. This product also has Velcro loops to help hold it in place on the sling.
Tunnel
Synthetic Armor™:

The following series of photos show padding products called Synthetic Armor™. They can be used to protect synthetic slings from abrasion damage, which can be caused by contact with rough surfaces, such as concrete beams and structures.

Synthetic Armor™ can also be used to protect finished or painted loads from marring. They can be made to fit any length or width of sling, and can also be made in long lengths that allow custom cutting to desired length in the field. Double or triple thickness can be applied to provide resistance for the more severe conditions.

The padding is removable with various styles of Velcro attachments and/or sewn edge(s) and can be slid up or down the sling for the best position to protect the sling.

These products are primarily padding and provide little, if any, softening of the bending radius.
Lift-All® Products

Wear Pads:

The following photos show padding products called Wear Pads. They can be used to protect synthetic slings from abrasion damage, which can be caused by contact with rough surfaces such as concrete beams and structures, and can also be used to protect finished or painted loads from marring.

Various types and thicknesses of materials are used for each type of Wear Pad to provide resistance for different conditions. Some of the Wear Pads are removable with various styles of Velcro attachments and/or sewn edge(s) and can be slid up or down the sling for the best position to protect the sling. Other types of Wear Pads are sewn on and are fixed to the sling. These products are primarily for padding and provide little, if any, softening of the bending radius.
Wear Pad “A” is called “Tubular Quick Fix”. It is a tubular sleeve manufactured from any of the materials listed in Table 7-1.

Wear Pad “B” is called “Flat Quick Fix”. It is a flat sleeve manufactured from any of the materials listed in Table 7-1.

Wear Pad “C” is called “Flat Sewn Sleeve”. It is a flat sleeve manufactured from any of the materials listed in Table 7-1.

Wear Pad “D” is called “Sewn-On Wear Pad”. It is physically sewn to a sling and is manufactured from any of the materials listed in Table 7-1.

Wear Pad “E” is called “Edge Guard”. It is physically sewn to a sling and is only manufactured from Texturized Webbing or Light Duty Leather material.

Wear Pad “F” is called “Poly Pad”. It is a flat pad and is only manufactured from woven polyester fabric impregnated and coated with PVC.

### Table 7-1

<table>
<thead>
<tr>
<th>Lift-All® Name</th>
<th>Thickness</th>
<th>Wear Pad Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pukka-Pads:</td>
<td>5/16”</td>
<td>High density, synthetic felt</td>
</tr>
<tr>
<td>Webmaster 1600:</td>
<td>3/16”</td>
<td>Heavy nylon sling webbing w/ red core warning yarn</td>
</tr>
<tr>
<td>Heavy Leather:</td>
<td>5/32”</td>
<td>Genuine top grain cowhide</td>
</tr>
<tr>
<td>PVC Belting:</td>
<td>1/8”</td>
<td>Non-absorbent conveyor belting</td>
</tr>
<tr>
<td>Texturized Webbing:</td>
<td>3/32”</td>
<td>Bulked nylon fiber</td>
</tr>
<tr>
<td>Ballistic Nylon:</td>
<td>1/16”</td>
<td>2-ply wear resistant fabric made of bulked nylon fibers</td>
</tr>
</tbody>
</table>
**JOB BUILT PRODUCTS**

This section provides information on a style of job built padding/softener that is typically used. The following series of photos show a job built padding/softener made from a piece of pipe and angle welded together. The pipe is notched to receive the piece of angle iron and flanges are welded on each end to prevent the sling from slipping off. Note the tie wire in the photo. It is very important to positively secure the softener to the sling so it can not fall when the slings are slacked and/or unrigged from the load.
8. SHACKLES & HARDWARE

INTRODUCTION

- Synthetic slings shall not be constricted or bunched between the ears of a shackle or in a hook. The opening of the fittings shall be the proper shape and size to ensure that the fitting will seat properly on the synthetic sling.

- Bunching or pinching of a synthetic sling, which occurs when used with conventional shackles, hooks or other hardware, will reduce the rated load capacity (working load limit) of the sling by 15%.

COMPATIBLE PRODUCTS

Always use hardware that is compatible with synthetic slings. Hardware used with synthetic slings must meet the requirements for minimum stock diameter or thickness, and have effective contact width recommendation for synthetic slings. Crosby manufactures a line of shackle and hook products that are compatible with synthetic slings by allowing the synthetic fibers to spread out flat instead of bunching and pinching.

- “Sling Saver” Shackles:

  The photos below show “Sling Saver” shackles manufactured by Crosby. These shackles are designed to connect synthetic slings to eyebolts, pad eyes, lifting lugs etc. “Sling Saver” shackles have an increased radius on the bow of the shackle, which provides a wider sling bearing surface resulting in an increased area for load distribution. By providing better load distribution for the synthetic sling, efficiency is increased by 15%, as compared to standard shackle bows. This allows 100% of the slings rated capacity to be achieved. Be sure these types of shackles are specified in the rigging plan, if required.

Model S-281 3¼ ton – 8½ ton  
Model S-252 3¼ ton – 50 ton  
Model S253
“Wide Body” Shackles:

The photo below shows a “Wide Body” shackle manufactured by Crosby. These shackles are designed to connect synthetic slings to eyebolts, pad eyes, lifting lugs etc. “Wide Body” shackles have an increased radius on the bow of the shackle, which provides a wider sling bearing surface resulting in an increased area for load distribution. By providing better load distribution for the synthetic sling, efficiency is increased by 15%, as compared to standard shackle bows. This allows 100% of the slings rated capacity to be achieved. Be sure these types of shackles are specified in the rigging plan, if required.

Model G-2160
30 ton – 1,000 ton

“Sling Saver” Choker Hook:

“Sling Saver” choker hooks are designed to reduce friction, abrasion, and fraying in the choked area. “Sling Saver” choker hooks have an increased radius on the hook, which provides a wider sling bearing surface resulting in an increased area for load distribution. By providing better load distribution for the synthetic sling, efficiency is increased by 15%, as compared to standard shackle bows or hooks. This allows 100% of the slings rated capacity to be achieved. Be sure these types of choker hooks are specified in the rigging plan, if required.

Model S-287
3½ ton – 4½ ton
**SHACKLE PIN PROTECTION**

Never place a synthetic sling on the pin area of a shackle. If a synthetic sling is exposed to the pin area of a shackle it can be cut, resulting in sling failure. Even a new shackle can have a sharp edge where the threaded pin goes through the shackle ear. If a synthetic sling must attach to the pin area of a shackle, the shackle pin must be padded.

- **“Shackle Pin Pad” Protection:**

  The photos below show a “Shackle Pin Pad” manufactured by SlingMax®. This product can be used to protect a synthetic sling from damage caused by the sharp edge where the threaded pin goes through the shackle. There are three connection points where the pad is secured to the shackle and can be installed and removed in seconds.
APPENDIX A

Training Record for Designated Rigger
TRAINING RECORD

“DESIGNATED RIGGER”

of

SYNTHETIC SLINGS

DESIGNATED RIGGER:

Please Print Name

The undersigned company supervisor or representative acknowledges, on behalf of the company, that the “Guideline for Synthetic Slings” has been reviewed with the above referenced “Designated Rigger”.

<table>
<thead>
<tr>
<th>Superintendent Signature</th>
<th>Job Name</th>
<th>Job Number</th>
</tr>
</thead>
</table>

I, the undersigned “Designated Rigger,” have read the “Guideline for Synthetic Slings” and understand them fully.

<table>
<thead>
<tr>
<th>Designated Rigger Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
APPENDIX B
Example Rigging Plan for Synthetic Slings
## Rigging Plan for Synthetic Sling(s)

<table>
<thead>
<tr>
<th>Project:</th>
<th>Superintendent:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of Lift:</td>
<td>Engineer:</td>
</tr>
<tr>
<td>Prepared By:</td>
<td>Foreman:</td>
</tr>
<tr>
<td>Date:</td>
<td>Designated Rigger:</td>
</tr>
</tbody>
</table>

1. Why is wire rope not being used?

2. Rigging Sketch: *(Use an attached drawing if necessary.)*

   ![Rigging Sketch](image)

3. The material of the sling, *(polyester, nylon or aramid/K-Spec™ core yarn)*: ____________

4. The type of sling, *(flat web, round or Twin-Path®)*: ________________________________

5. The type of hitch, *(vertical, choked or basket)*: ________________________________

6. The product code or stock number for the sling: ________________________________

7. The rated capacity of the sling, *(hitch specific)*: ____________________ lbs

8. The load/force the sling will see during the lift: ____________________ lbs

9. The percent of capacity *(Line 7 ÷ Line 6 × 100)*: ____________________ %

10. Is padding and/or softeners needed *(show on above sketch)*: ________________________________

**APPROVED:**

<table>
<thead>
<tr>
<th>Job Superintendent (print)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________________</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job Superintendent (sign)</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________________________</td>
</tr>
</tbody>
</table>

---

PAGE 36 OF 44
Rigging Plan for Synthetic Sling(s)

Project: BENICIA
Description of Lift: MENCK HOSES
Prepared By: J. RILEY
Date: 11-5-02
Superintendent: J. STOGS
Engineer: D. SVICK
Forman: M. STEPHANS
Designated Rigger: M. STEPHANS

1. Rigging Sketch: (Use an attached drawing if necessary)

2. The material of the sling, (polyester, nylon or aramid/K-Spec™ core yarn): K-SPEC
3. The type of sling, (flat web, round or Twin-Path®): TWIN-PATH
4. The type of hitch, (vertical, choked or basket): CHOKED
5. The product code or stock number for the sling: TPXC 7500
6. The rated capacity of the sling, (hitch specific): CHOKED = 60,000 lbs
7. The load/force the sling will see during the lift: 4,982 lbs
8. The percent of capacity (Line 7 ÷ Line 6 x 100): 8.34%
9. Is padding and/or softeners needed (show on above sketch): NO - HOSE BUNDLE IN ROW
10. Why is wire rope not being used? IT WILL CUT & DAMAGE HOSES

OVER TIME

APPROVED

Job Superintendent: JEFF RILEY
Date: 11-5-02
APPENDIX C
Definition of Terms
Acids:
An acid is traditionally considered any chemical compound that when dissolved in water, gives a solution with a pH of less than 7. Common examples include acetic acid (in vinegar) and sulfuric acid (used in car batteries).

Alcohol:
In general usage, alcohol refers almost always to ethanol, also known as grain alcohol; a colorless, volatile liquid with a strong smell formed by the fermentation of sugars. It also often refers to any liquid that contains ethanol.

Aldehydes:
An aldehyde is an organic compound containing a terminal carbonyl group. This functional group, which consists of a carbon atom which is bonded to a hydrogen atom and double-bonded to an oxygen atom (chemical formula -CHO), is called the aldehyde group.

Alkalis:
In chemistry, an alkali is a specific type of base, formed as a carbonate, hydroxide or other basic (pH greater than 7) ionic salt of an alkali metal or alkali earth metal element.

Aramid:
Aramid fiber (1961) is a fire-resistant and strong synthetic fiber. It is used in aerospace and military applications, for "bullet-proof" body armor fabric, and as an asbestos substitute. The term is a shortened form of "aromatic polyamide". A well-known type of aramid fiber (a para-aramid nylon) is commonly known by its DuPont trade name, Kevlar, or Teijin trade name Twaron. An especially fireproof meta variant is Nomex.

Bleaching Agents:
To bleach something is to remove or lighten its color. Common chemical bleaches include sodium hypochlorite, or "chlorine bleach," and "oxygen bleach," which contains hydrogen peroxide or a peroxide-releasing compound such as sodium perborate or sodium percarbonate. "Bleaching powder" is calcium hypochlorite.

Dry Cleaning Solvents:
Tetrachloroethylene is a manufactured chemical compound that is widely used for the dry cleaning of fabrics and for metal-degreasing. It is also used to make other chemicals and is used in some consumer products. Other names for tetrachloroethylene include perchloroethylene, perc, PCE, and tetrachloroethene. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell tetrachloroethylene when it is present in the air at a concentration of 1 part per million (1 ppm), although some can smell it at even lower levels.

Hydrocarbons:
In chemistry, a hydrocarbon is any chemical compound that consists only of the elements carbon (C) and hydrogen (H). They all contain a carbon backbone, called a carbon skeleton, and have hydrogen atoms attached to that backbone. (Often the term is
used as a shortened form of the term aliphatic hydrocarbon.) Most hydrocarbons are combustible.

The simplest hydrocarbon is methane (swamp/marsh gas), a hydrocarbon with one carbon atom and four hydrogen atoms: CH₄. Ethane is a hydrocarbon (more specifically, an alkane) consisting of two carbon atoms held together with a single bond, each with three hydrogen atoms bonded: C₂H₆. Propane has three carbon atoms (C₃H₈) and butane has four carbons (C₄H₁₀).

Ketones:
A ketone is either the functional group characterized by a carbonyl group linked to two other carbon atoms or a chemical compound that contains this functional group.

A carbonyl carbon bonded to two carbon atoms distinguishes ketones from carboxylic acids, aldehydes, esters, amides, and other oxygen-containing compounds. The double-bond of the carbonyl group distinguishes ketones from alcohols and ethers. The simplest ketone is acetone (also called propanone).

Nomex:
Nomex is the registered brand name of a flame retardant meta-aramid material marketed and first discovered by DuPont in the 1970s. It is sold in both fiber and sheet forms and is used as a fabric wherever resistance from heat and flame is required.

Nylon:
Nylon represents a family of synthetic polymers, a thermoplastic material, first produced in 1935. It is made of repeating units linked by peptide bonds (another name for amide bonds) and is frequently referred to as polyamide (PA). Nylon was the first commercially successful polymer and the first synthetic fiber to be made entirely from coal, water and air. These are formed into monomers of intermediate molecular weight, which are then reacted to form long polymer chains. Nylon fibers are used in fabrics and ropes, and solid nylon is used for mechanical parts and as an engineering material. Engineering grade Nylon is processed by extrusion, casting & injection molding. Type 6/6 Nylon 101 is the most common commercial grade of Nylon, and Nylon 6 is the most common commercial grade of cast Nylon.

Oils (Lubricating):
Lubricants are an essential part of modern machinery.

A lubricant is a substance (usually a liquid) introduced between two moving surfaces to reduce the friction and wear between them. A lubricant provides a protective film which allows for two touching surfaces to be separated, thus lessening the friction between them.

Typically lubricants contain 90% base oil (most often petroleum fractions, called mineral oils) and less than 10% additives. Vegetable oils or synthetic liquids such as hydrogenated polyolefins, esters, silicone, fluorocarbons and many others are sometimes
used as base oils. Additives deliver reduced friction and wear, increased viscosity, resistance to corrosion and oxidation, aging or contamination, etc.

Non-liquid lubricants include grease, powders (dry graphite, PTFE, Molybdenum disulfide, etc.), teflon tape used in plumbing, air cushion and others.

**Grease** is a lubricant of higher initial viscosity than oil, consisting originally of a calcium, sodium or lithium soap jelly emulsified with mineral oil.

**Water (Sea Water):**
**Seawater** is water from a sea or ocean. On average, seawater in the world's oceans has a salinity of ~3.5%. This means that for every 1 litre (1000 mL) of seawater there are 35 grams of salts (mostly, but not entirely, sodium chloride) dissolved in it.

The density of seawater is between 1020 and 1030 kg/m$^3$. Seawater pH is limited to the range 7.5 to 8.4.

**Water (Fresh Water):**
**Fresh water** is water with less than 0.5 parts per thousand dissolved salts. Fresh water may be found in lakes, rivers, and bodies of groundwater. The ultimate source of fresh water is rain.
APPENDIX D

Copy of the District’s Synthetic Sling Policy

Section 2.16
SECTION 2.16 SYNTHETIC SLINGS

Synthetic slings cannot be used for general hoisting purposes. Synthetic slings can only be used if wire rope slings are not suitable for a unique hoisting condition and Job Superintendent approval is obtained as outlined below. If synthetic slings are used for hoisting, then the following procedure shall be followed.

1. A detailed HAZARD ANALYSIS will be prepared specifically for the lift utilizing synthetic slings.

2. A detailed RIGGING PLAN will be prepared specifically for the lift utilizing synthetic slings. The rigging plan will include the following information regarding the synthetic slings:
   (a) Why wire rope is not being used?
   (b) A rigging sketch showing the position of slings for the lift.
   (c) The material of the slings, (polyester, nylon or aramid/K-Spec™).
   (d) The type of sling, (flat web, round or Twin-Path®).
   (e) The type of hitch, (vertical, chocker or basket).
   (f) The product code or stock number for the sling.
   (g) The rated capacity of the sling, (hitch specific).
   (h) The load/force the sling will see during the lift.
   (i) The percent capacity (the load/force in the sling ÷ rated capacity of the sling × 100).
   (j) Is padding and/or softeners needed, (show on sketch).

Note: Refer to the District’s “Guideline for Synthetic Slings” Appendix B: Example of a Rigging Plan for Synthetic Slings

3. A DESIGNATED RIGGER will be specified by name for the lift utilizing synthetic slings. The Designated Rigger is a person, selected by the Superintendent responsible for the lift, who:
   (a) Is knowledgeable of the operation for which the lift is being performed.
   (b) Is experienced in the basic fundamentals of rigging and crane lifts related to the heavy construction industry.
   (c) Has the authority and the capability to make prudent and safe decisions during the lift.
   (d) Has been provided a copy of the District’s “Guideline for Synthetic Slings” and reviewed it in its entirety with the Superintendent responsible for the lift.
   (e) Has signed the “Training Record”.
   (f) Will be present at all times while synthetic slings are being used.

Note: Refer to the District’s “Guideline for Synthetic Slings” Appendix A: Training Record for Designated Rigger

4. JOB SUPERINTENDENT APPROVAL will be obtained prior to a lift utilizing synthetic slings. The Job Superintendent will be provided a copy of the following for his/her review and approval:
   (a) The Hazard Analysis.
   (b) The Rigging Plan.
   (c) The Designated Riggers name and the signed copy of the “Training Record”.


**WARNING:** The proper selection and use of *padding* and/or *softeners* when using synthetic slings to make a lift is crucial. Several incidents within Kiewit have occurred where loads were dropped due to inadequate protection of synthetic slings.

(a) All sharp edges or abrasive areas of the load that come in contact with synthetic slings are to be *padded* to prevent damage to the sling when making a lift.

(b) All sharp bends of the load that come in contact with synthetic slings are to be *softened* to increase the radius or decrease the angle (soften the angle) on the corner of the load so that the sling capacity is not significantly reduced when making a lift.

*Note:* Refer to the District’s “Guideline for Synthetic Slings”
Section 7: Padding and Softeners

**Administration**

The Job Superintendent is responsible for the administration of this policy.