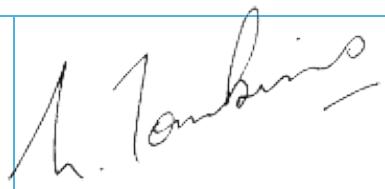
PROCEDURE

Flying Fox Guide - Operations and Construction

Issued with the authority of the Chief Commissioner and Chief Executive Officer of Scouts NSW

Chief Commissioner		CEO signature	
Sponsor	DCC - (Program, Youth Safety & Support)	Originated by	Flying Fox State Advisory Committee
Document type	PROCEDURE	Date of issue	26 March 2021
Document code & no.	PRO5	Version number	V 1.0
Document title	Flying Fox Guide - Operations and Construction	Due for review	March 2024

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Governance and Disclaimer

The information contained in this Flying Fox Guide - Operations and Construction are subject to change from time to time. This manual is intended for use by the Scout Association of Australian for the guidance and training of Scout Association members qualified operators only and gives no warranty that the information is current, correct or complete and is not a definitive statement of procedures for any other purpose.

The Scout Association of Australia, New South Wales Branch advises:

1. This manual form's part of a competency-based assessment course, and as such it can accept no liability for use of this manual, other than in the overall course context.

2. This manual is issued under 'Policy and Rules' and forms part of and is to be read in conjunction with 'Policy and Rules'.

3. There are inherent dangers in flying foxes, and unless qualified no member shall attempt to erect or operate a flying fox. Reliance on the data in this manual, in isolation, is not recommended, and no liability is accepted.

To ensure the current version of Flying Fox Scout Association of Australia, NSW Branch Flying Fox Policy and Manual by referring to the copy found in https://www.nsw.scouts.com.au/members-services/health-and-safety/whspoliciesforms/

1.0 Introduction

1.1 General

Flying fox activities by the Scout Association are part of adventurous activities program offered for its members provides great excitement and adventure for participants.

Flying fox activities involve risks that need be managed by the qualified operators. This is achieved through careful supervision, training, instruction and information. The various equipment and safety devices for protection against falling from a height and collisions of equipment designed for this purpose providing a safe adventurous environment.

These risks should, however, be appropriately managed and minimised by the flying fox operator and team; it should be understood that they cannot be eliminated altogether. Based on a risk assessment, operators should take so far as reasonably practicable measures to ensure the safety of participants and operators.

This Flying Fox Guide - Operations and Construction (from here referred to as "the Flying Fox Guide") is intended to summarise Scouts Australia, NSW policy, qualifications, training and guidance for risk management, planning, equipment, operations and logistics.

Category 1 – Scout Approved Scout Flying Fox Activity Construction

This category covers flying foxes built by 'policy' qualified persons, greater than 20m and up to a maximum span of 100 metres.

Category 2 – Specialised Scout Flying Fox Activity

This covers flying foxes with spans in excess of 100 metres and/or towers not specifically covered by this manual and/or permanent type flying foxes.

This manual, in conjunction with the competency based assessment course, is to assist in the design and erection of category 1).

For the construction of flying foxes under category 2), direct reference must be made to Flying Fox State Advisory Committee ("SAC Fox") as safety considerations may be breached by applying the standards herein to spans in excess of 100 metres.

Where a flying fox is proposed that will exceed a span of 100 metres, it will be necessary to secure a written recommendation from a qualified engineer. If using a tower in excess of details in this manual obtain the appropriate scaffolding high rise work (HRW) license. Submit this to FFSAC for approval and ensuring sufficient time be allowed to obtain such approval.

1.2 Applicable Standards

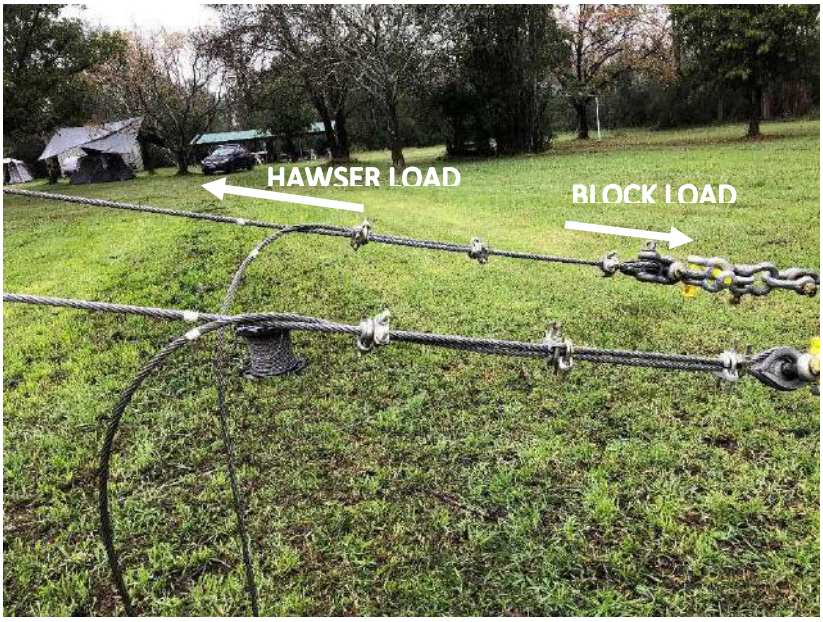
This manual intends to demonstrate compliance to the following standards, Codes and Guidelines as applicable to temporary/mobile structures or permanent installations where operated by Scout Association qualified members.

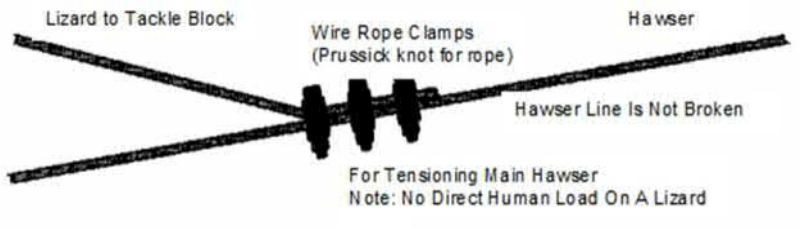
Standard/Codes/Guidelines	Title
AS 2316.2.1-2016	Flying foxes and challenge ropes courses—Construction and safety requirements (EN 15567-1:2007, MOD)
AS 2316.2.2 - 2016	Flying foxes and challenge ropes courses - Operation requirements (EN 15567-2:2007, MOD)
AS 4142.1 - 1993	Fibre ropes Care and safe usage
EN12278 - 2007	Mountaineering Equipment Pulleys
EN 12277	Mountaineering equipment, harnesses
ASTM F887	Standard Specifications for Personal Climbing Equipment
Outdoor Council of Australia	AAAS Australian-Adventure-Activity-Standard-V1.0 Key requirements for preparing and delivering adventure activities.
Outdoor Council of Australia	AAAS Challenge-Courses-GPG-v1.0 Guidance for high and low challenge (ropes) courses and adventure/initiative games.
Outdoor Council of Australia	AAAS Core-Good Practice Guide-v1.0 Guidance for common good practice for all adventure activities.
WHS Regulation 2017	
NSW Work Health and Safety Act 2011.	
NSW Government Code of Practice Safe Design of Structures August 2019	
SafeWork NSW - Scaff Safe 2020	

1.3 Terms and Definitions

For the purposes of this Flying Fox Operators Manual the following terms and definitions shall apply.

Term	Definition
Advanced Fox Guide (Guide – Construction)	Has with sufficient experience in the operation and construction of the Flying Fox to FFSAC and has the Guide – Construction qualification. Refer to Section 8 for details.
Assisted belaying system	Belaying system where the participant is secured by at least one person
Assistant Guide (Fox Guide-operations)	Has Trained Participant skills but has demonstrated sufficient experience in the operation of the Flying Fox to FFSAC. Refer to Section 8 for details.
Bagging	Application of hessian bagging to the shear leg saddle, any point of excessive abrasion, and any green timber anchorage
Catenary	Curve formed by a rope, suspended at two points, hanging under its own weight.
Dead load	Weight of the element when unloaded
Dynamic brake	Braking system operating automatically to reduce the speed of the participant at the end of run
Dynamic load	Load generated by a falling participant
Eye	An enclosed loop
Flying fox	Cable support system in which the participant glides under gravity in a sloping direction
FFSAC	Flying Fox State Advisory Committee (Scout Association of Australia, NSW Branch)
Fox Supervisor	Person supervising the flying fox operations, has Guide-Operations qualification or under the Guide-Operations supervision say for training.
Fox Team	The team of flying fox personnel, made up of Advanced Guide, Guide, Safe Participant and Trained Participant involved in the flying fox construction and operation.

Term	Definition
Guide (Fox Guide - Operations)	Has with sufficient experience in the operation of the Flying Fox to FFSAC and has the Guide – Operations qualification. Refer to Section 8 for details.
Gated eye	An enclosed loop containing a spring-loaded gate.
Hawser	The wire rope over the span that carries the trolley and load
Imposed load	Load corresponding to maximum weight of a participant
In-line eye	A temporary eye placed in the hawser which negates 'flow through 
Kernmantle	A generic term covering a rope of nylon core and braided polyester compliant to AS4142.3
Landing area	Area in which a participant finishing the fox run can land
Level 1 supervision	Situation whereby an instructor can physically intervene (R1 AAAS Challenge-Courses-GPG-v1.0 – Section 7 Leadership)
Level 2 supervision	Situation whereby an instructor can clearly see the participant and intervene verbally (R1 AAAS Challenge-Courses-GPG-v1.0 – Section 7 Leadership)

Term	Definition
Lizard	A method of attaching a temporary load bearing rope in-line for tensioning 
Locked gate eye	A gated eye where the gate locks positively
Maximum fall height	Maximum height that a participant can fall
Mobile flying fox	Flying fox system that is transportable
Moussing	is a secondary securement method used to secure screw pin from rotation or loosening. Annealed iron wire is looped through hole in collar of pin and around adjacent leg of shackle body with wire ends securely twisted together.
Natural fibre rope	Manila or Sisal rope
Operational inspection	Inspection, more detailed than routine visual inspection, to check the operation and stability of the equipment
Operators	The Flying Fox team managing the flying fox activity and operating the system.
Participants	Persons participating in the flying fox activity under the leadership and direction of the operators.
Periodical inspection	Verification, at intervals not exceeding 12 months intended to establish the overall level of safety of equipment, foundations, and surfaces
Permanent flying fox	Flying fox installed for more than 7 days on the same site and primarily for continual usage throughout the year
Pickets (i.e. star pickets)	In ground anchorages
Platform	Flat, practically horizontal raised area in which participants can temporarily stay, before or after the element
Rated	The tested and approved performance characteristic of a component

Term	Definition
Regional Advanced Fox Guide	Is the representative for the Scouts NSW Region responsible for managing flying fox activities and is recognised by FFSAC with the Advanced Fox Guide qualification
Routine visual check	Inspection intended to identify obvious hazards that can result from vandalism, use or weather conditions
Safety Line	Flexible or rigid, horizontal, vertical or sloping, continuous or discontinuous device used as a protection against falling from a height
Safe Participant (Fox Assistant)	Safe Participant may be recruited on the day but are not recognised as regular team members. Refer to Section 8 for details.
Safety system	System used either to arrest or cushion a participant's fall
Self-belaying system	Belaying system that is operated by the participant him-/herself
Shackle	A shackle whose pin performs as a locked gate
Sheave	The wheel within a block which is grooved to take a rope.
Sling	Short length of wire rope or web material used to attach the hawser to the anchor or tree shear leg to support hawser.
Span	The straight-line distance between hawser supports
Spar	Timbers used to make the shear legs or other structures
Spotting	One or more persons working to catch, hold or give physical support to other participants
Static brake	Passive braking system operating automatically
Temporary flying fox	Flying fox that has been installed for up to seven (7) days *[AS 2316.2.1-2016 Cl. 3.3] or periodically longer when approved by FFSAC*
Thimble	An insert in an eye that causes less rope stress and abrasion
Trained Participant (previously known as Basic Foxer)	Flying Fox Team member which has basic outdoor Scout training, has completed the Flying Fox training course and has assisted in several Flying Fox activities with the team. Refer to Section 8 for details.

Term	Definition
Trolley	The mechanical system of carriage along the hawser, previously traveller
Turnbuckle	Rated device which facilitates fine tuning of the catenary length

2.0 Flying Fox Policy

2.1 Currency

This Scout Association of Australia, NSW Branch Flying Fox Policy is current from the latest issue date noted in the Revision History.

2.2 Review

This manual shall be reviewed by FFSAC at least every 3 years but may be more frequent if required. FFSAC shall be formed from the date of endorsement and be comprised of the experienced Flying Fox Advanced Guides/Regional Flying Fox Coordinators from all NSW Scout regions.

2.3 Purpose

To outline the rules of conducting Flying Fox activities by members of Scout Association of Australia, NSW Branch.

The Manual document provides guidelines for the construction and compliance of the apparatus, as well as the rules and guidelines for the operation of this apparatus as an activity.

The Training and Skill Recognition Framework document provides guide-lines for the ongoing skill development and recognition of competencies.

2.4 Philosophy

A Policy for the conduct of Scout activities involving Flying Foxes is required for the following reasons:

- There is inherent risk in these activities.
- Leaders in Scouting need to be aware of risks and apply adequate skills to ensure that activities are conducted safely.

2.5 Principles

Control of all activities described in this Policy shall be vested in the Chief Commissioner of Scout Association of Australia, NSW Branch, and his nominated delegates.

A Flying Fox State Advisory Committee (Scout Association of Australia, NSW Branch) comprising Delegates from each Region shall be established to regularly review the conduct of Flying Fox activities: - FFSAC

The promotion, administration and regulation of Flying Fox activities shall be vested in appropriately qualified Regional Coordinator (Flying Fox), appointed by the Regional Commissioner or Regional Commissioner (Activities).

2.6 Definition

The term "Flying Fox" describes a means of travel along a sloping rope or wire by attaching to it using a free moving pully and being propelled by gravity (R1 AAAS Challenge-Courses-GPG-v1.0 definition).

2.7 Scope

This Policy relates to all Category 1 – qualified Scout Flying Fox activities and associated construction and operation.

Inclusions to this policy:

All Scout Association of Australia, NSW Branch Flying Fox activities and associated construction of spans greater than 20 metres. Flying Fox operation and construction 20m or less are covered by Scouts Australia PRO42 Challenge ropes policy.

Exclusions to this policy:

- Tyrolean and traversing techniques where participants progress under their own power (or teamwork)
- Pioneering structures for flying fox under 20 metres and pioneering type constructed using timber spars and rope (pioneering structures for flying fox under Scout pioneering construction guidelines).
- Commercially conducted activities, run by persons or organisations outside the Scout Association.
- Any specific insurance requirements for publicly run Flying Fox activities.

Before participation in any commercially conducted Flying Fox activity, the policy on Prohibited Activities, and the guidelines for participation in Commercially Run Activities, should be considered.

2.8 Operation

The Flying Fox State Advisory Committee (Scout Association of Australia, NSW Branch) ("SAC Fox") is to:

- Regularly review this Policy, Schedules to the Policy, and other documentation as applicable
- Advise State executive on technical matters relating to this Policy
- Form sub-committees as required to assist with technical standards, safety and training
- Determine and specify minimum standards for all equipment used for these activities
- Provide endorsement of members of Scout Association of Australia, NSW Branch who have the required recognized skill levels to enable them to operate a Flying Fox at a State Activity Centre following local induction.
- Maintain records of qualifications issued and appointments made by the SAC Fox.

The Regional Coordinator (Flying Fox) is to

- Promote, administer and regulate Flying Fox activities within their Region

- Authorise the conduct of Flying Fox activities within the Region
- Maintain regional Flying Fox records of training, completion of workbooks and recommended appointments made within the Region
- Cancel or suspend any qualification pending Region and SAC Fox review if practices are conducted in an unsafe manner or contrary to this Policy
- Recommend to the Regional Commissioner the suspension of any Leader's appointment if practices seriously contravene this Policy or other Scout Code of Practice.

2.9 Authors /Officers

This Scout Association of Australia, NSW Branch Flying Fox Policy and Manual was drafted by members of the Flying Fox Review Committee (Scout Association of Australia, NSW Branch), April-August 2020.

The review committee was formed at the behest of the Chief Commissioner's Council and the Chief Commissioner of NSW following attention to a series of incidents on commercial Flying Foxes.

Members were selected on merit within a set of criteria. The Review Committee was convened by the Assistant Chief Commissioner Activities, Bases and Fellowships, and overseen by the Deputy Chief Commissioner Activities and Training, and State Office Safety Officer.

2.10 Flying Fox State Advisory Committee

Role: The purpose of this committee is to utilise the experience of Flying Fox practitioners to monitor changes to applicable standards, review and revise SOP accordingly and provide guidance to Scouts NSW on all matters relating to policy for the operations related to Flying Fox activities undertaken as part of Scouts NSW activities.

Representation: It is recognising that FFSAC members are not professionals in this field but volunteers with extensive practical experience in the operation and construction of Flying Fox activities for Scouts. Where possible this committee is to have representation from as many Scout NSW Regions as possible to ensure sharing of experience and to promote using the latest practises in all Regions.

Procedures:

- The FFSAC should meeting at 6-12 monthly intervals, or more regularly if any actions require.
- FFSAC meetings should, as a minimum, include the following agenda items:
    - Review of any WH&S incidents reported (Check Scouts NSW register plus any commercial Flying Fox incidents publicly reported)
    - Review of recent activities undertaken, any lessons learnt
    - Review any areas within the "Flying Fox Guide - Operations and Construction" requiring amendment
    - Review of training requirements
    - Review of future planned Flying Fox activities

    - Next Meeting date
- Minutes/Notes are to be made each meeting and circulated to all Regions, note not just to Regions represented.

2.11 Authority

Scout Association of Australia, NSW Branch.

2.12 References and Implementation

This statement provides the context for the:

- Flying Fox Guide (Scout Association of Australia, NSW Branch) Version: 01 2021 and
- FF Training and Qualification Framework v2:2020_5_30.

These rules and guidelines take effect from the date of endorsement from NSW Scouts, of this Flying Fox Guide.

3.0 Management of Risk

3.1 General

For over 100 years, Scouting has been an important and successful part of the Australian community providing non-formal educational and recreational programs that help young people to develop emotionally, intellectually, socially spiritually and physically. Awareness of risk has always been a key focus for Scouts Australia in its delivery of programs for young people.

The risk management procedures for Flying Fox activities are to be compliant with Scouts Australia NSW National Risk Management guidelines, refer Scouts NSW PRO18 WHS Risk Management https://www.nsw.scouts.com.au/wp-content/uploads/2020/11/PRO-18-WHS-Risk-Management-v-2.0-signed.pdf *(or check Scout Association of Australia, NSW Branch website for direction if link is inoperable).*

Risk management is critical for Scouts offering Flying Fox activities in a safe environment to all participants, including operators. The management of risk and the development of safety systems must focus on all stages of the design, planning, preparation and delivery of the flying fox activities.

Before any Fox is constructed, during its construction, during its operation, during dismantling and transportation, leaders must be aware of any safety issues. Prior to construction, at least one site visit needs to be carried out to determine any safety issues specific to the site. The observation will be recorded, along with what will be done to reduce or remove that risk.

A competent person will inspect the structure after its construction and prior to its operation. Operational checks will also be performed at regular intervals to check for movement or other changes.

3.2 Management of Risk Overview

The Scouts Australia Risk Management System has been developed in conjunction with Scouts Australia NSW National Risk Management guidelines and in accordance with AS/NZS ISO 31000:2009. It is designed to give assurance that, despite any risk that may be inherent in our activities, the levels of residual risk are acceptable in that effective controls are in place to minimise the potential for harm or loss to Scouts Australia or to its stakeholders. Importantly, the system also provides a planning basis from which to manage potential gains for the organisation through the management of risk.

3.3 Key Flying Fox Risks

It is essential that all risks are identified. Most activities and initiatives of Scouts Australia's will be comparatively straightforward, comprising no more than routine 'core-activities'. Hence, in this Flying Fox Guide we highlight risks specific and key to the safe operation of a flying fox typically. This means that persons responsible for leading the flying fox activity will need to assess their specific activity in detail to see if there are any additional risks that can be identified.

Based on investigation of key past safety risks related to flying foxes are the following:

Equipment:

Equipment is suitable for purpose and being used within the manufacturers' recommendations

Equipment is inspected by experienced operators on the Scout Association of Australia, NSW Branch Flying Fox team prior to use and is in GOOD condition.

Construction Practices:

Construction practices must be in accordance with the guidelines set out in this Operating Manual

Avoid any single points of failure which can result in persons falling

Any use of trees or other natural features shall be suitable for the forces imposed with a large safety margin

Construction set up must be planned to provide fall protection

PPE must be used during set up, operation and dismantling to minimise risk of injury

Load Rating:

All equipment must be used within the manufacturers installation method and stamped/published load rating.

Hawser Termination:

The load tension support for the hawser must be in accordance with the guidelines set out in this Scout Association of Australia, NSW Branch Flying Fox Policy and Manual

Hawser terminations must be regularly inspected during flying fox operation to confirm no movement or slippage occurs

Inspections:

The whole operating system/construction must be regularly checked during the operation of the flying fox

The inspections must be undertaken by experienced operators on the Scout Association of Australia, NSW Branch Flying Fox team.

Communications:

Ensure all participants can communicate during operation so as flying fox runs are only initiated when safe to do so.

Ensure participants are briefed and understand the use of the flying fox and any actions not permitted

3.4 Monitor, Review and Communication

Procedures and networks for monitoring, reviewing, and communication about risk management must be established as part of the overall risk management framework. Scout Association of Australia, NSW Branch have established a Flying Fox State Advisory Committee (Scout Association of Australia, NSW Branch) and this group should review annually any accidents, injuries and near misses to ensure safety risk management is continually improved.

3.5 Guidance on Flying Fox Operational Risk

Refer to Scouts NSW PRO18 WHS Risk Management https://www.nsw.scouts.com.au/wp-content/uploads/2020/11/PRO-18-WHS-Risk-Management-v-2.0-signed.pdf *(or check Scout Association of Australia, NSW Branch website for direction if link is inoperable).*

Risk review and analysis does need to be undertaken on each Flying Fox activity, despite that perhaps that a risk review may have been undertaken previously. This is necessary as operating condition, users, equipment and Flying Fox personnel could have changed.

Likelihood descriptors for risk practitioners

Likelihood	Description
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances.
Possible	The event might (or should) occur at some time
Unlikely	The event could occur at some time
Rare	The event may only occur in exceptional circumstances.

Consequence descriptors for risk practitioners

Descriptor	Example Detail Description
Insignificant	Most likely, no injury would result. Low level impact with negligible consequences on the Branch aim or activity objectives that can be controlled by routine management procedures (no injuries, negligible financial loss or disruption to non-essential infrastructure/data)
Minor	First Aid would likely be needed. The consequences would threaten the efficiency or effectiveness of achieving some aspects of Scouts Australia's aim or activity objectives, requiring management effort to minimise impact (minimal financial loss, injuries requiring first aid only, minor "reputational" impact or disruption to non-essential infrastructure/data)
Moderate	Medical Treatment and/or time off work would likely be required. A significant/medium potential of affecting the achievement of Scouts Australia's aim or activity objectives (moderate financial loss or "reputational" impact, injuries requiring medical treatments only, medium term loss of some essential infrastructure/data
Major	Extensive or serious injuries requiring hospitalisation or specialist treatment. A very high potential to impair the achievement of Scouts Australia's aim or activity objectives (major financial loss or "reputational" impact, significant work, health and safety incidents, long term loss or some critical infrastructure/data)
Catastrophic	Death, permanent disability or multiple serious injuries. An extreme potential to threaten the sustainability of the organisation or its aims and activities (huge financial loss or "reputational" impact, very serious work, health safety and welfare incident/s permanent loss of critical infrastructure/data.

Impact table for risk practitioners

Consequence / Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Significant	Significant	High	High	High
Likely	Moderate	Significant	Significant	High	High
Possible	Low	Moderate	Significant	High	High
Unlikely	Low	Low	Moderate	Significant	High
Rare	Low	Low	Moderate	Significant	Significant

The outcome of this ranking exercise is the subjective ranking of significance for each identified risk. Action needs to be considered in direct relation to the ranked significance of risk. As well as an individual risk score, each risk is also placed within one of the four broad categories as detailed in the Level of Risk Matrix.

Risk Priority for Employed Staff, Leaders of Adults or Risk Practitioners

Priority	Action
High	A high risk is one that must be dealt with immediately and will require a detailed action plan. The Regional Commissioner (or equivalent) normally monitors high risks.
Medium	A medium risk is one that should be dealt with after attending to high level risks and will require an action plan. The Group Leader normally monitors medium risks.
Low	A low risk is one that can be treated by applying routine procedures at the lowest (Section) level.

Note that the example below only highlights specific risks which may impact the Flying Fox and it does not include the usual slip, trips and fall risks which may be encountered on Scout camps or similar activities.

BASE RISK ASSESSMENT

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	**List of Hazards / Risks**	**Likelihood**	**Consequence**	**Rating**	**Current Controls**	**Additional Control Means**	**Residual rating**	**Person**
Storage	Storage - Water damage - Rodent damage - Unauthorised equipment use - Chemical damage/corrosion	Possible	Moderate	Significant	Equipment stored fully enclosed in trailers and/or stored in halls locked to prevent unauthorised access.	Refer Section 7.3.3 Equipment Storage	Moderate	Regional Advanced Fox Guide
Transport	Transport - Heavy load - Unsecure lead leading to impact damage to breakage - Driver fatigue	Possible	Moderate	Significant	Fox gear is transported either in dedicated trailers or suitable trailers for the load to be transported. PR020 Vehicle and Driver Safety policy	Transportation planned so as not to call for long, early or late travel or multiple drivers are available.	Moderate	Regional Advanced Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	List of Hazards / Risks	Likelihood	Consequence	Rating	Current Controls	Additional Control Means	Residual rating	Person
Site Inspection	Site inspection - Poor location for run, too steep, too close to obstacles, insufficient height - Poor location of anchors - Poor location of shear legs - Poor location for take-off - Poor location for landing - Poor route for participant assembly & movement	Possible	Minor	Moderate	Discuss location with the Fox Team who have previously run in this location. The arrangement should be agreed to by several members of the Flying Fox team so that there is consensus on the location suitability.	Refer Section 4.0 Planning and Section 5.0 Flying Fox Design	Moderate	Advanced Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	List of Hazards / Risks	Likelihood	Consequence	Rating	Current Controls	Additional Control Means	Residual rating	Person
Environmental	Weather conditions - strong winds - Lightning - Heavy rain - Icy conditions - Change in conditions - Darkness	Possible	Major	High	Stop fox operations during high winds and/or storm events. The Flying Fox should NOT be run at night as communications between the team and movement around the site could lead to additional Hazards. If a special activity is proposed, then this should eb raised with FFSAC for special approval based on adequate risk mitigation measures being in place.	Monitor weather conditions Figure 59 Running System Safety Checklist. Training highlights weather risks, refer Section 8.0 Recognition of Scout Skills and Training.	Significant	Advanced Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	List of Hazards / Risks	Likelihood	Consequence	Rating	Current Controls	Additional Control Means	Residual rating	Person
Construction	Construction - Inadequate space for gear set-up - Movement of heavy equip top/bottom of tun - Fall from height - Impact from falling objects - Star picket or pegs damaging electrical of other underground services	Possible	Moderate	Significant	Proper PPE for fall/impact protection. Discuss location with the Fox Team who have previously set up in this location to minimise manual lifting. Discuss with property care taker or authorities to ensure no underground services in the vicinity. If any risk, undertake detailed services search. Belay team during all work at height, establish belay points early during construction. No unauthorised access in the construction area apart from the fox team. Ensure star pickets have caps and any other sharp objects are protected from causing injury.	Refer Section 7.3 Fox Construction. Refer Appendix A – Engineers Report.	Moderate	Advanced Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	List of Hazards / Risks	Likelihood	Consequence	Rating	Current Controls	Additional Control Means	Residual rating	Person
Operations - **Movement**	- Collision of person travelling down the fox and people walking across the path of the flying fox run - Route from assembly area up to take off zone too steep, close to cliffs or dead trees -	Possible	Minor	Moderate	Mark out run zone, provide hazard tape marking. Run in existing locations with established routes. Guide / Activity Leaders to participant ratios dependent on activity in accordance with this Flying Fox Manual	Refer Section 7.3 Fox Construction. Refer Section 7.4.4 Participant Briefing. Refer Section 7.6 Participant movement	Moderate	Advanced Fox Guide
Operations - **General Construction**	- Failure of shear leg/s - Failure of brake causing impact to bottom shear leg	Possible	Moderate	Significant	Experienced Fox team constructing the flying fox. Discuss with Fox Team who have previously set up in this location to get feedback of past fox construction on this site.	Refer Section 7.3 Fox Construction. Monitor construction elements, refer Figure 59 Running System Safety Checklist.	Significant	Advanced Fox Guide
Operations - **Equipment Failure**	- Running gear axial breakage - Dropper crimp failure - Harness failure - Hair/clothing catch in running gear	Possible	Moderate	Significant	Inspection of components (Detailed inspection min. every 3 years, refer Section 7.9) Rigging in accordance with this Flying Fox Manual Checking participant prior to run for loose hair/loose clothing	Refer Section 6.0 Equipment.		Advanced Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	List of Hazards / Risks	Likelihood	Consequence	Rating	Current Controls	Additional Control Means	Residual rating	Person
Operations - **Hawser Failure**	- Failure of hawser anchor/s - Slippage of inline eye/s or rope clamps - Failure of Hawser rope	Possible	Catastrophic	High	Care of the Hawser. Experienced fox team installation anchors. Hawser rope double clamps used. Experienced team carrying out inspections.	Refer Section 7.3 Fox Construction. Refer Section 6.16.2 Wire rope inspection Refer Section 7.9.3 Explanation of System Checks Refer Appendix A – Engineers Report.	Significant	Advanced Fox Guide
Operations - **Take Off**	- Fall from top take-off platform - Letting participant go before team ready to receive possible impact with persons or equipment	Possible	Moderate	Significant	Top fox team member fastens safety line on scout and only unfastens when secure on running gear drop line. Fox operators to be belayed. Communications protocol between landing team and take of team	Refer Section 7.2.2 Fox Team Roles Refer Section 7.3.1 Fox Set-up Refer Section 7.4.4 Fox Team Communications	Moderate	Advanced Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	List of Hazards / Risks	Likelihood	Consequence	Rating	Current Controls	Additional Control Means	Residual rating	Person
Operations - **Equipment Landing**	- Hawser too low leading to impact on ground - Equipment in path of travel leading to impact	Possible	Moderate	Significant	Experienced fox team setting hawser tension. Experienced team carrying out inspections. Communications protocol between landing team and take of team	Refer Section 7.4.1 Hawser Tensioning Refer Section 7.9.3 Explanation of System Checks Refer Section 7.4.4 Fox Team Communications	Moderate	Advanced Fox Guide
Operations - **PPE Fitting**	- Incorrect fitting PPE leading to fall - Failure of harness leading to fall	Possible	Moderate	Significant	Experienced team carrying out final checks of PPE fitting. Second check off PPE just prior to take-off	Refer Section 6.14 Personal Protection Equipment Refer Section 7.5 PPE Supervision Refer Section 7.2.2 Fox Team Roles	Moderate	Fox Guide
Operations - **Run Inspections**	- Operations leading to equipment slippage leading to hawser falling - Operations leading to equipment slippage leading to brake ineffectiveness and impact	Possible	Moderate	Significant	Experienced team carrying out inspections.	Refer Section 6.16 Gear Inspection, including having multiple Fox Team members carry out the inspection and not just one person	Moderate	Advanced Fox Guide /Fox Guide

Identify the hazards [a]		Assess the risk			Mitigate the risk	Re-assess the risk		Responsibility
						Control Measures Required		
Activity (Task / Location)	**List of Hazards / Risks**	**Likelihood**	**Consequence**	**Rating**	**Current Controls**	**Additional Control Means**	**Residual rating**	**Person**
Short break from operation	- Unsupervised fox usage and possible incorrect usage leading to fall or impact	Possible	Moderate	Significant	Flying fox access blocked off Trolley removed At least one from fox team left to supervise	Refer Section 7.2 Fox Team	Moderate	Fox Guide
Overnight out of operations	- Flying fox used when Fox Team supervision is not present, risk of fall from height or impact	Possible	Moderate	Significant	Flying Fox are de-rigged at end of day Access to Flying Fox is restricted between scheduled activity sessions. Ladder is locked. Warning signs placed at Flying fox	Refer Section 7.2 Fox Team	Moderate	Advanced Fox Guide
De-construction	Construction - Inadequate space for gear pack-up - Movement of heavy equip top/bottom of tun - Fall from height - Impact from falling objects	Possible	Moderate	Significant	Experienced Fox team dismantling the flying fox. Discuss with Fox Team who have previously set up in this location to get feedback of past fox dismantling on this site.	Refer Section 7.3.2 Dismantling	Moderate	Advanced Fox Guide

Table 1 SAMPLE Flying Fox Risk Assessment Form

3.6 Incident Reporting

Note: All flying fox incidents are reportable.

Incident reporting is in line with Scout Association of Australia, NSW Branch WHS procedures, specifically via the Scouts NSW WHS Incident Report Form.

In addition, the SAC Fox require all incidents, near misses, and novel situations requiring response to be reported so that improvements can be made to Fox processes.

AS 3533 requires that any accident occurring on a flying fox is 'reportable'. Where necessary, this manual will be updated with necessary information to ensure that such accidents do not reoccur.

It is mandatory that there be an emergency plan in force, and known by all operators, prior to the running of the flying fox, which will cover all likely 'accidents' that may occur. This is the operator's responsibility.

As a First Aider must be present when a flying fox is run, we will assume that general emergency procedures are known.

Terms to consider:

Hazard: something that could hurt you, could cost money, cause damage, loss of equipment, injury, loss of earnings etc.

Risk: the chances of the hazard impacting on the activity: probability and potential severity.

Incident: Sometimes known as an accident. An event or chain of events, which has, or could have caused injury, Illness, financial loss or reputational loss to people or assets. Incidents include: injury, illness and near miss.

Near Miss: An event which, although it did not result in personal injury/disease or damage to people, property or the environment, it had the potential to do so.

Accident: An event which has resulted in bodily injury or property damage.

4.0 Planning

4.1 General

Whether preparing for one, or a series of activities, the management, design and delivery of Flying Fox activities requires good planning. Planning allows the Fox Team to

To meet our objectives to provide an enjoyable experience safely; and

Achieve the personal goals for activity leaders and participant.

There must be a process in place for the development of an activity plans for each activity that suit the context and purpose.

4.2 Participants

Differing people will require different provisions in line with age/ physical ability/ fitness/ confidence and other considerations to ensure their safe enjoyment of a Flying Fox activity.

Joey and Cub Scouts will need closer assistance regarding harness fitment and attaching and detaching from the Fox. Follow Scout Guidelines in relation to physical assistance and Youth Protection. Less assistance may be required for Scouts and older age groups.

Another consideration would be for older non- Scouts who may need as much assistance as a Joey Scout. Additional support and instruction may be required for the take-off and landing zones, and access routes, especially with a dual runway in use.

4.3 Pre-Activity Checks

The following Pre-Activity Checks should be undertaken:

- If the Flying Fox activity is part of a larger activity, ensure the organisation group is aware of the fox spatial requirements, participants/parents have been notified and given consent to participate in the Flying Fox and any necessary approvals have been obtained.
- If the Flying Fox activity is part of a larger activity, ensure the first aid and incident reporting structure is understood.
- Where the site is new for the flying fox or has been a long time since the last Fox activity there, then a site visit and planned construction should be undertaken prior to the activity to be sure it can be safely run and that no recent environmental changes could compromise that safety.
- Check the Weather forecast, including for set up and pack up.

4.4 Site Arrangement

It is preferable to use only those sites, trees, anchors known well to the team. A walk through the site/ potential site a week or so prior to the 'planned' activity helps reduce the possibility that the site will not be suitable due to changed conditions or lack of understanding of the activity requirements. At the preparatory visit, all aspects of safe Fox operations, from working at heights to exit from landing zone, need to be considered.

The possibility of finding two identical or similar sites is remote, and it is this large variety of sites which makes the formulation of a standard policy difficult.

Some general rules are:

- Use the lay of the land to your best advantage.
- Shear Legs can be trees or structures, pioneering type or fabricated type.
- Anchorages may be natural features, i.e. tree trunks or constructed anchorages such as log and picket, triple picket and dead man anchors.

The following figures indicate some options:

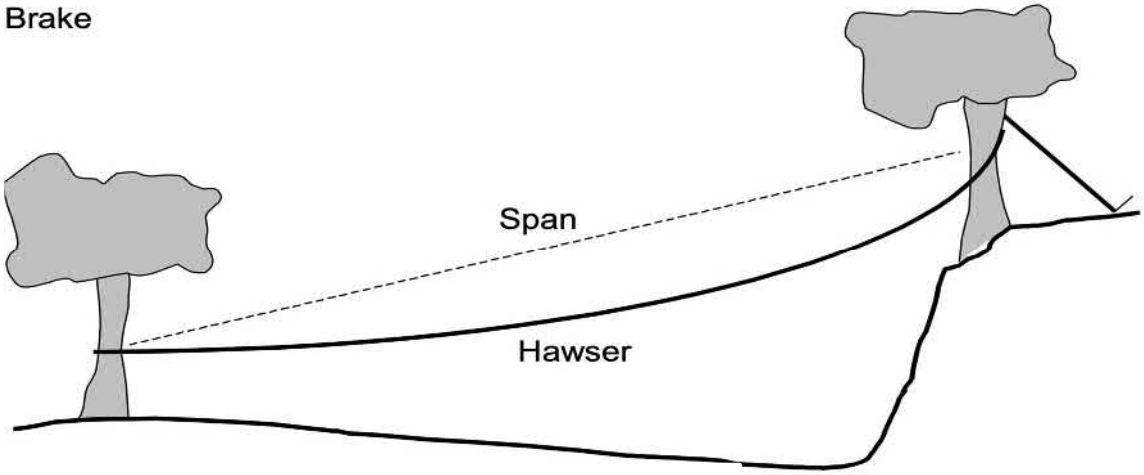


Figure 1 Tree Shear to Tree Shear Legs with Fall

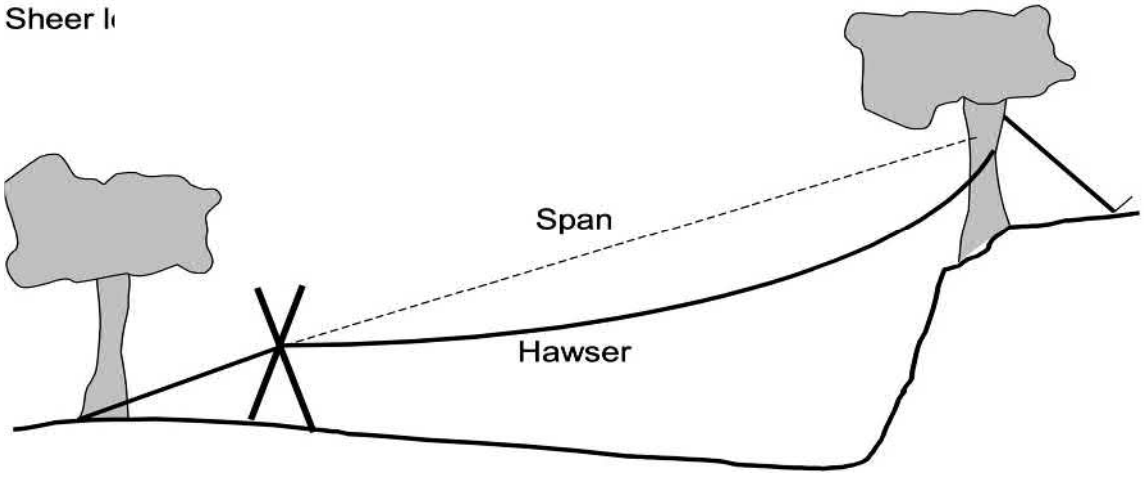


Figure 2 Upper Tree Shear Leg & Picket Anchors and Lower Shear Leg Structure with Tree Anchor

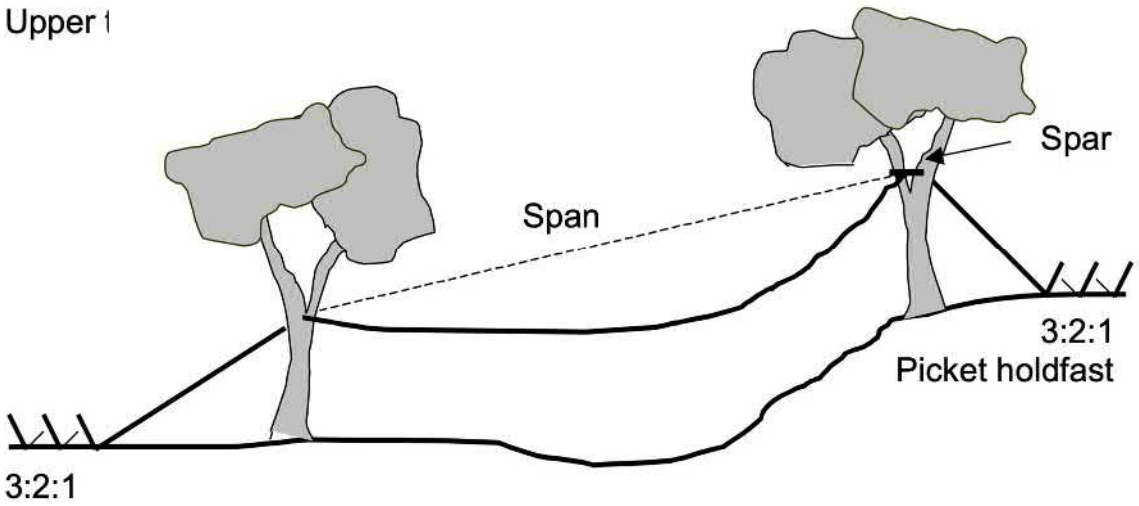


Figure 3 Upper and Lower Tree Shear Legs with Log & Picket Anchors

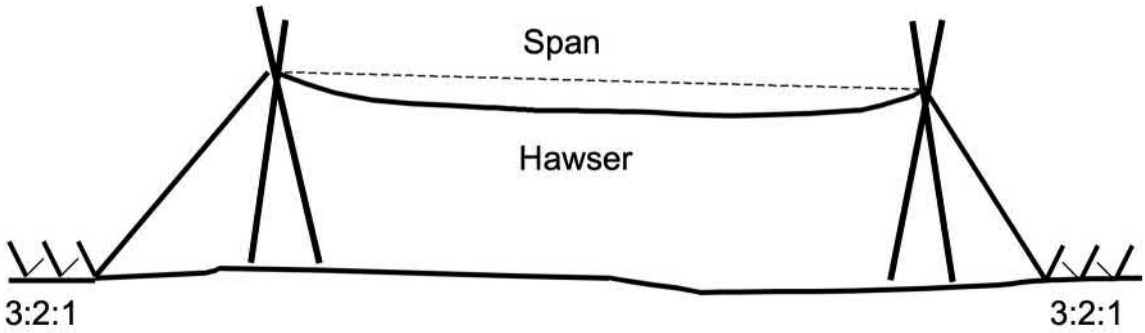


Figure 4 Flat Ground Double Shear Leg Structures & Picket Anchors

But we must look at some basic criteria so we can assess if the chosen method is secure, given the potential large loading stress that applies to flying foxes.

For the purpose of developing our 'model' we will assume a tree to shear leg configuration. Each step with its rules is interchangeable for another step, provided the rules remain matched to each step.

The location will determine your span length which will not exceed 100 metres.

Your options are then basically one of two designs:

Turnbuckle and Shackles 'in line'

The hawser carrying capacity terminates at an eye with a shackle connection to full load rated turnbuckle/s connected to the hawser 'in line' and the bottom anchor.

Block and tackle 'lizard'

The hawser runs from anchorage to anchorage, and the block and tackle is lizarded to the hawser. This in effect gives a double roping over the block and tackle length. *This can only be used for raising/lowering the hawser and at no time must the human load be carried directly by a lizard line, apart for exceptional circumstances where it has been set up as part of the emergency rescue plan but then it should be tested with a dead load for that purpose.*

Both the above methods can lead to hawser damage if correct care is not taken with what is being done.

4.5 Slope of Runway

The tighter the rope the faster the run, but the greater the tension and associated forces on the hawser.

Subject to the provision of appropriate braking, the *maximum average angle of descent should not exceed 45 degrees*. (This requires that span height must be equal to or less than span width).

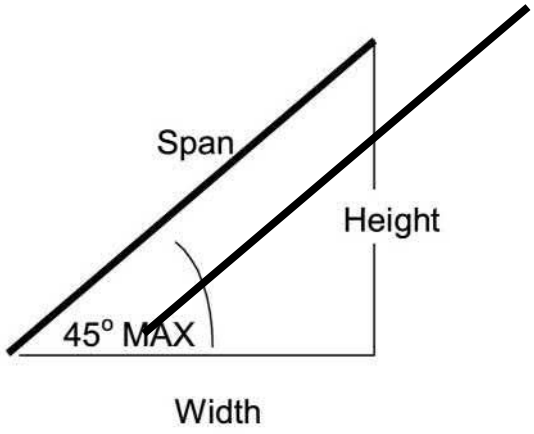


Figure 5 Maximum Hawser Slope

By slackening the rope, the end tangent angle of descent may increase, so at any given point the end tangent *angle of descent should not exceed 65 degrees*.

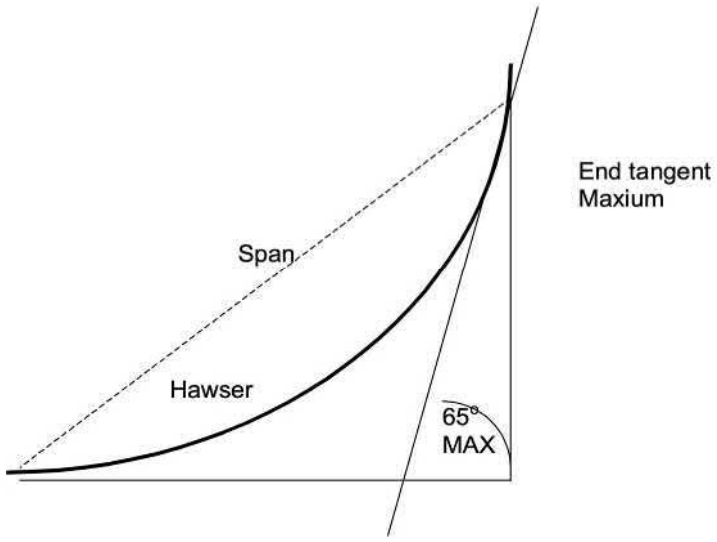


Figure 6 Maximum Take-off Angle

4.6 Slope of Runway - Safety Considerations

The design criteria in Figure 5 and Figure 6 are to be considered maximum and in isolation. These are maximums and must be considered in relation to the location.

In most instances, if these were combined on a more conventional location, these could lead to serious injury as the high degree of ascent combined with a slack rope could result in a catenary at or near conclusion of the run that would drive the passenger into the ground. Always remember that the catenary will tend to triangulate at the ends of the span.

The conventional recommendations for flying fox rope alignment are that the horizontal angle of the span line does *not exceed 10 degrees and that the unloaded rope angle does not exceed 15 degrees*. 10 degrees equates to a 1 in 5.5 fall, while 15 degrees equates to a 1 in 3.5 fall.

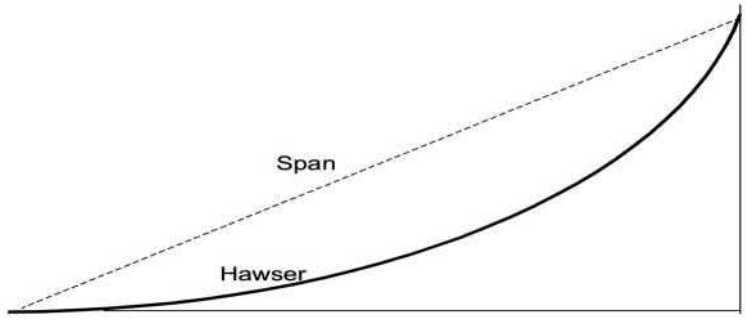


Figure 7 Hawser Speed

Whilst exceeding these parameters may increase the 'thrill', all care must be taken to ensure the overall safety of the passenger.

The maximum effective speed (velocity) is 11 km/h average (3.055 m/sec.) in accordance to AS2555.

5.0 Flying Fox Design

5.1 Anchors

Initial and timely inspection will afford the best possible anchors. If in doubt, 'don't'.

Note in general the minimum SWL limit adopted by Scout Association of Australia, NSW Branch is a minimum of 4T SWL for the Hawser and all associated in line fixtures, fastenings and anchors.

Note: Due to the diversity of conditions, anchorages are potentially the weakest link in the design. Therefore, during hawser tensioning, design testing, and full running, continuous inspection must be directed to all anchorages.

Any signs of movement in the soil around the pickets or other anchorages, or persistent loosening during operation, implying movement of anchorages, signify a weakness and hence all operations must be discontinued.

Low strength soils, such as swamps and mud flats, are to be avoided.

At the first indication of a problem, stop use of the fox, and correct the fault. If it cannot be remedied, discontinue the entire activity.

5.1.1 Tree Anchors

The tree should be a mature tree, free from termites, living, well rooted (not on rock shelf), be of a type that is 'good burning' (avoid banksia etc), and be of a minimum 600 mm diameter (2 feet) 1200-1500mm above its base. Hug the tree and if more than fingers meet, in the case of an adult, find a bigger tree.

Securing should be as close to the base as is practical, but where securing is attempted at a height exceeding 2 metres above the ground, safety lines must be used to secure the people involved. Where the tree is at a cliff edge, or other safety concerns apply, guying the tree is considered essential.

Where securing to a tree fork, select a suitably safe fork, and if necessary, treat it as a shear leg, and secure the rope lower down the tree to the trunk or another suitable limb, or to another anchorage. Alternatively, square lash a spar above the fork, and draw the hawser over the spar. If the fork is used directly, it should be bagged to avoid damage to the tree, and to allow easy hawser 'slip' as tension is applied.

Figure 8 Sling Anchor Using Tree

The tree must be 'bagged' if using wire slings. A sling with thimble eyes at each end can be centred around the tree. The hawser (with thimble eye end) is attached to the sling using a rated moussed shackle.

The sling and hawser must be either steel or equivalent rated webbing sling.

To avoid undue stress on the sling by installing it in a chocked configuration which will de-rate the SWL. The sling should lay parallel to the hawser exit lay in a loop configuration as illustrated in Figure 9.

The angle between the sling tails should never exceed 120 degrees, as beyond this the effective strength of the Sling is below the rating of the hawser. As 90 degrees is easier to visualise, this should be the targeted minimum induced angle, refer Figure 9.

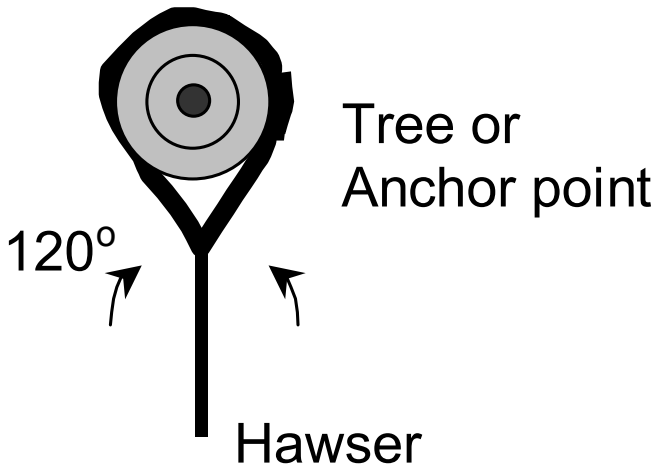


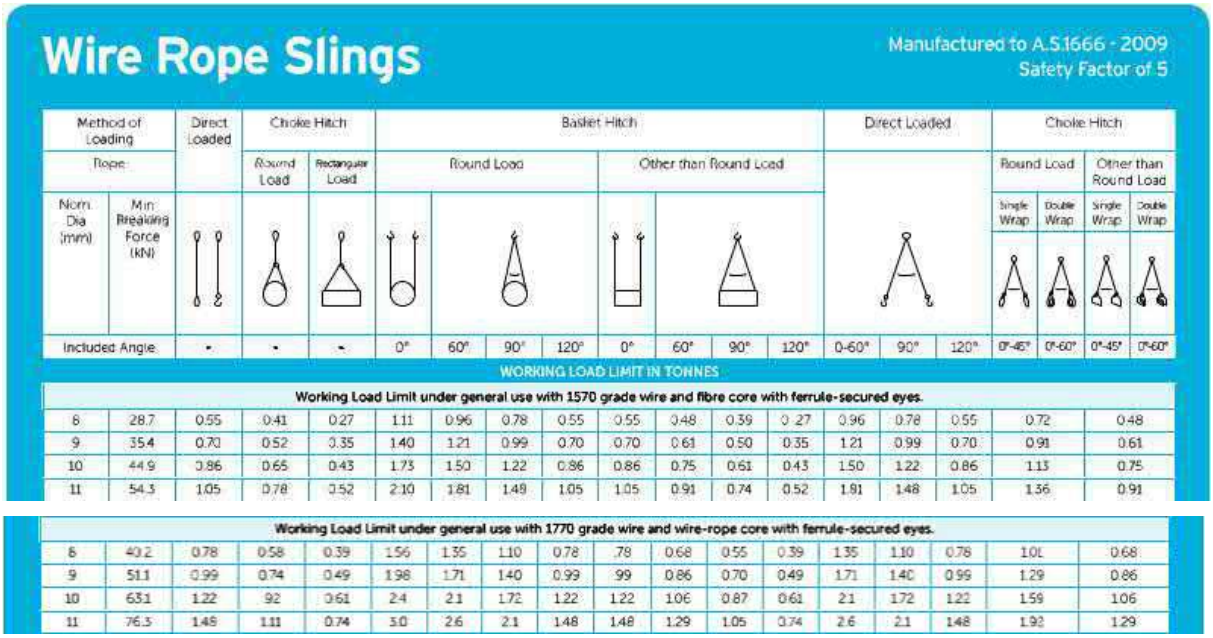
Figure 9 Sling Loop Configuration on Tree

The ideal sling arrangement above is in a basket configuration which is the recommended method as 3T slings will support a load up to 5.1T. Note that increasing the angle of the sling to the hawser greatly reduces the sling rating.

Note that choking a sling greatly reduces the rating, refer to the Figure 10 derating chart.

Figure 10 Flat Webbing & Round Sling Working Load Limit

(EnergySafe Victoria for slings manufactured to AS1353.1, AS1353.2 and AS4497.1)



Wire Rope Slings

Manufactured to A.S.1666 - 2009
Safety Factor of 5

Method of Loading		Direct Loaded	Choke Hitch		Basket Hitch								Direct Loaded			Choke Hitch			
Rope			Round Load	Rectangular Load	Round Load				Other than Round Load							Round Load		Other than Round Load	
Nom. Dia (mm)	Min. Breaking Force (kN)															Single Wrap	Double Wrap	Single Wrap	Double Wrap
Included Angle		-	-	-	0°	60°	90°	120°	0°	60°	90°	120°	0-60°	90°	120°	0°-45°	0°-60°	0°-45°	0°-60°
WORKING LOAD LIMIT IN TONNES																			
Working Load Limit under general use with 1570 grade wire and fibre core with ferrule-secured eyes.																			
8	28.7	0.55	0.41	0.27	1.11	0.96	0.78	0.55	0.55	0.48	0.39	0.27	0.96	0.78	0.55	0.72		0.48	
9	35.4	0.70	0.52	0.35	1.40	1.21	0.99	0.70	0.70	0.61	0.50	0.35	1.21	0.99	0.70	0.91		0.61	
10	44.9	0.86	0.65	0.43	1.73	1.50	1.22	0.86	0.86	0.75	0.61	0.43	1.50	1.22	0.86	1.13		0.75	
11	54.3	1.05	0.78	0.52	2.10	1.81	1.49	1.05	1.05	0.91	0.74	0.52	1.81	1.48	1.05	1.36		0.91	
Working Load Limit under general use with 1770 grade wire and wire-rope core with ferrule-secured eyes.																			
8	40.2	0.78	0.58	0.39	1.56	1.35	1.10	0.78	.78	0.68	0.55	0.39	1.35	1.10	0.78	1.01		0.68	
9	51.1	0.99	0.74	0.49	1.98	1.71	1.40	0.99	99	0.86	0.70	0.49	1.71	1.40	0.99	1.29		0.86	
10	63.1	1.22	.92	0.61	2.4	2.1	1.72	1.22	1.22	1.06	0.87	0.61	2.1	1.72	1.22	1.59		1.06	
11	76.3	1.48	1.11	0.74	3.0	2.6	2.1	1.48	1.48	1.29	1.05	0.74	2.6	2.1	1.48	1.92		1.29	

Figure 11 Wire Rope Sling Working Load Limit

(EnergySafe Victoria for slings manufactured to AS1666)

The tail of the hawser is then passed over the shear legs (not yet erected), and the positioning of the anchorage is then determined. The distance from the anchorage to the shear leg base shall be twice the distance from the shear leg base to the saddle.

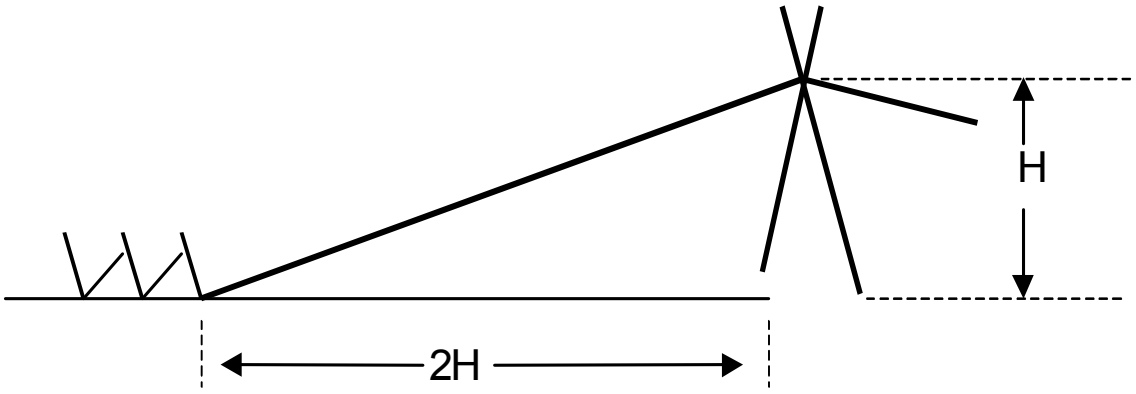


Figure 12 Attachment to Tree

5.1.2 Picketing

There is a large variation in soil types in Australia, ranging from rock through clay and sand, and for this reason the picketing method selected must best suit the soil type, and allow for maximum safety.

'Traditional' soil types consist of a 'topsoil' which on average is to a depth of 200 mm. The sub soil, may be clay etc, is what gives the picket its 'holding power', and it is where the levels meet that we will refer to as the 'PIVOT POINT'. (where it bends when overstressed), refer to Figure 13.

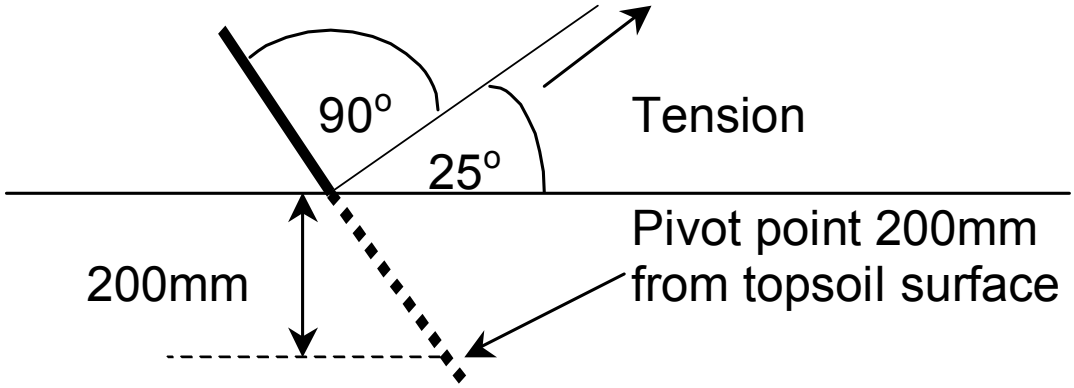


Figure 13 Picket Pivot Point

When driving pickets, if no 'resistance' is met by 200 mm of penetration, a Dead Man anchorage must be used. 'Pivot points' deeper than 200 mm can-not effectively be corrected by driving the picket deeper.

5.1.3 Log and picket

The log must be no less than 150 mm in diameter, and no less than 1 metre in length. 5 sets of pickets is a minimum, with each set evenly spaced and bearing an equal load, and the hawser line being evenly centred on the log refer to Figure 15 and Figure 15. The star pickets shall be 900 mm in length, *embedded to a minimum of 500mm*.

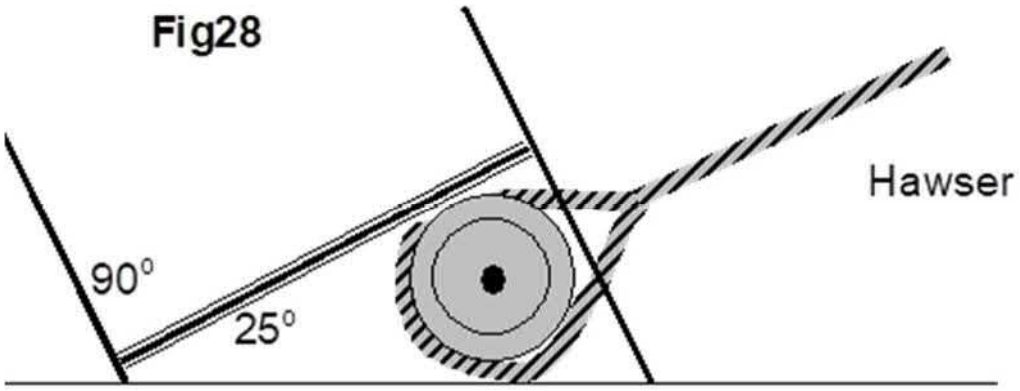


Figure 14 Log and Picket Angles

Figure 15 Log and Picket Anchor

5.1.4 Triple pickets

These shall be ganged in a 3.2.3 configuration, shall be star pickets of at *least 900 mm in length, embedded to 600 mm, at an angle of 65 degrees, with all ropes at 90 degrees*.

Where star pickets are used, the leading picket (No 1) shall be ganged as a minimum of two, but preferably three, and shall be bound using a multiple strand, tight banjo lashings, to the rearward pickets.

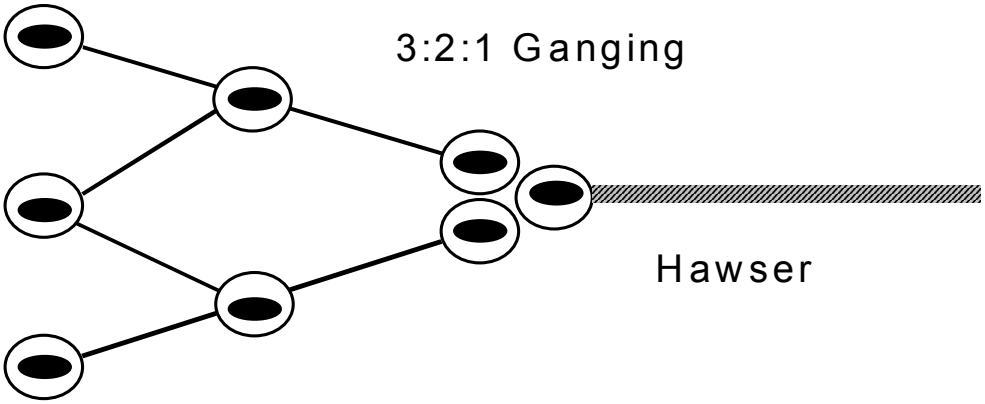


Figure 16 Triple Picket Plan

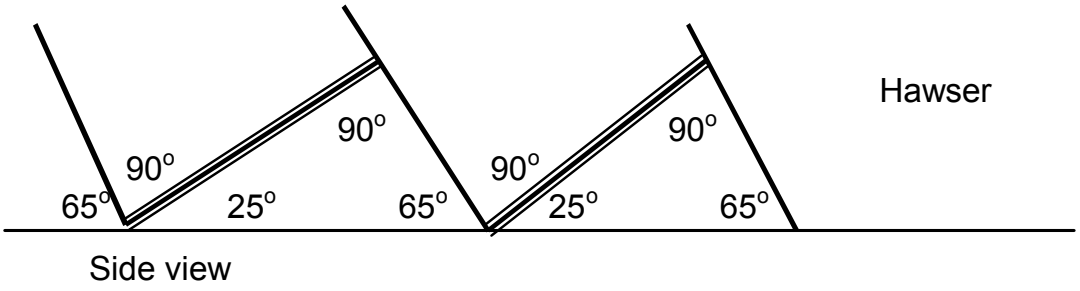


Figure 17 Triple Pickets Section

It is important that the forward picket lashing be as close as is practically possible to the 'pivot point', but retaining the critical picket and rope angles as this reduces stress in the picketing refer Figure 16 and Figure 17.

5.1.5 Dead Man anchor

The log must be a minimum of 150 mm in diameter and 1 metre in length. It must be *buried at a depth of at least three times its diameter* and lay at right angles to the hawser. A narrow channel is to be cut to allow a tail rope (11 mm steel) to pass to the block and tackle. The angle of exit of the tail rope and hawser should be no greater than 25 degrees to the horizontal.

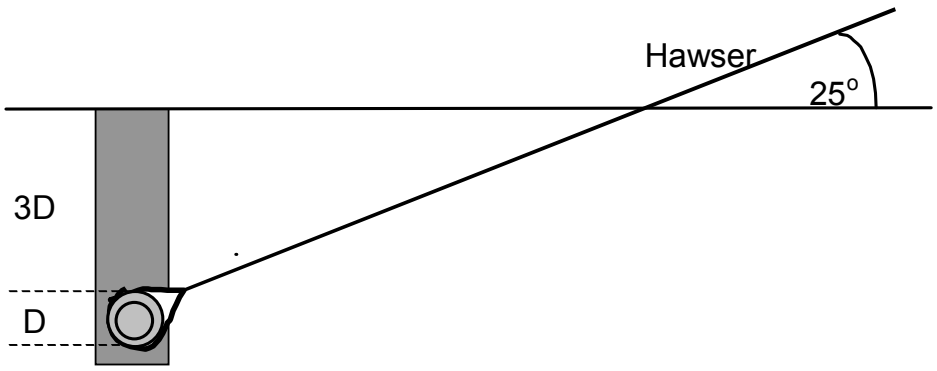


Figure 18 Deadman Anchor

5.1.6 Ground Plates

Flat to ground plates, as singles, doubles, V's etc. using offset pegs (as used by Fire Rescue) are banned.

Any design that addresses the 'lifting' effect of the hawser on the leading plate, can be submitted to FFSAC for evaluation.

5.1.7 Other Man Made Anchorages

Care must be taken in assessing potential man made anchors. Light poles (not telegraph), fence posts etc. would be unlikely to be able to meet the Hawser SWL of a flying fox.

In the event no suitable anchorage is available, a vehicle whose weight exceeds 6 tonnes, may be used as an anchor.

Figure 19 Truck Anchorage

Rules that would apply include:

- It is an anchor, not a tensioning device
- Ideally it should be heavier than 6 tonnes (say 9 tonnes)
- It must be parked side on to the direction of tension
- It must be in first gear or reverse
- Hand brakes must be applied, and the wheels chocked
- The cab must be locked, with all keys in the operator's care.

Attachment must be to the chassis or at worst an axle, and as close to the ground as possible (use bagging, thimbles etc. as appropriate).

5.2 Shear Legs and Towers

5.2.1 Single Hawser Shear Leg

Generally, use spars either made or purchased specifically for use in a Fox's shear legs. If an additional spar was required, bear in mind that dead timber in a forest, by the time it lands on earth, is likely more brittle than longitudinally robust. All such spars would need to be soundly 'rung' against a rock, hard ground or a bigger spar/ branch etc to determine if it was 'true' for use as a spar. *Spars shall be minimum of 125mm diameter*.

The *lashing ropes shall be 12mm diameter natural fibre rope*, as shall the guys.

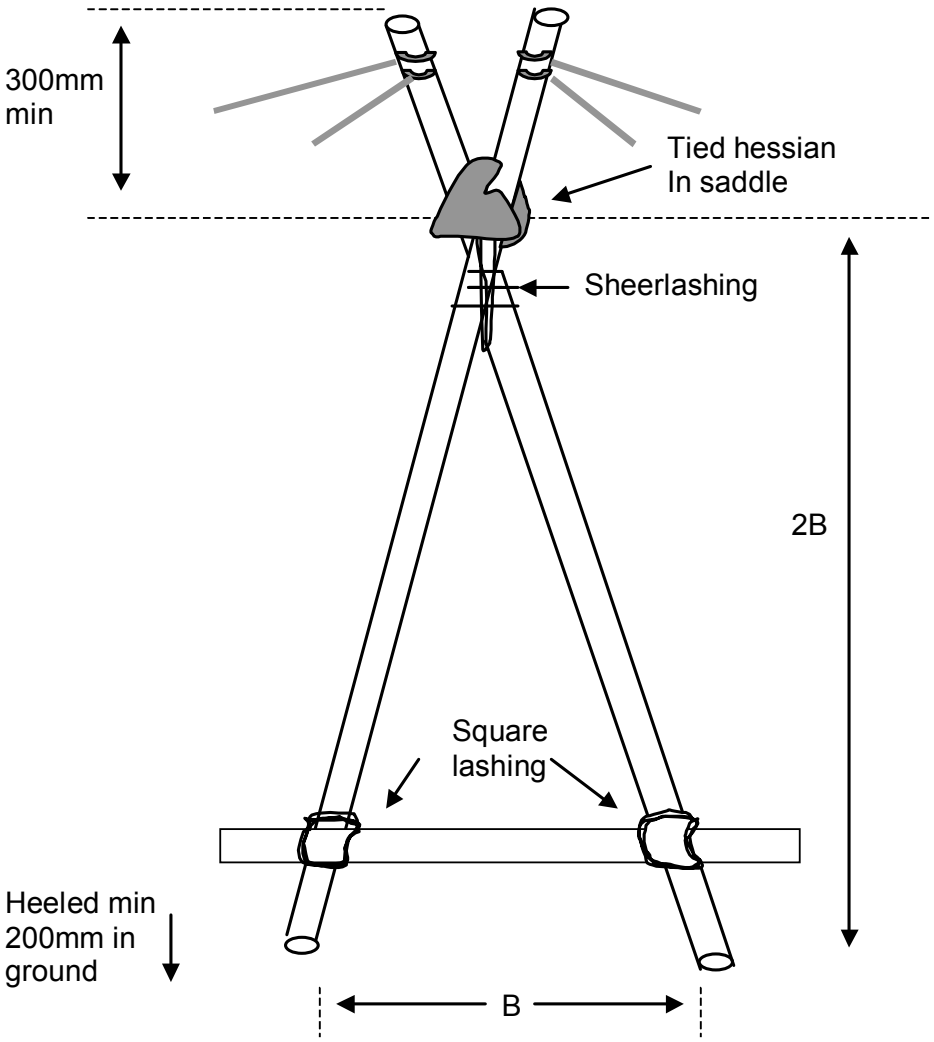


Figure 20 Single Hawser Shear Leg Construction

To avoid toppling, the shear legs must be positioned so that they are directly in line with the natural lay of the hawser between the anchorages.

If of benefit, additional cross stays may be added to form a ladder to facilitate access to the flying fox.

5.2.2 Dual Hawser Shear Leg

'Squared' shear legs are required for dual hawser foxes. *Spars shall be minimum of 125mm diameter. A diagonal brace, 90 mm minimum, is required within the frame.*

Care must be taken to erect the shear legs with the load supporting cross spar on the anchor side of the frame. This minimises stress in the system and results in less load on the square lashings.

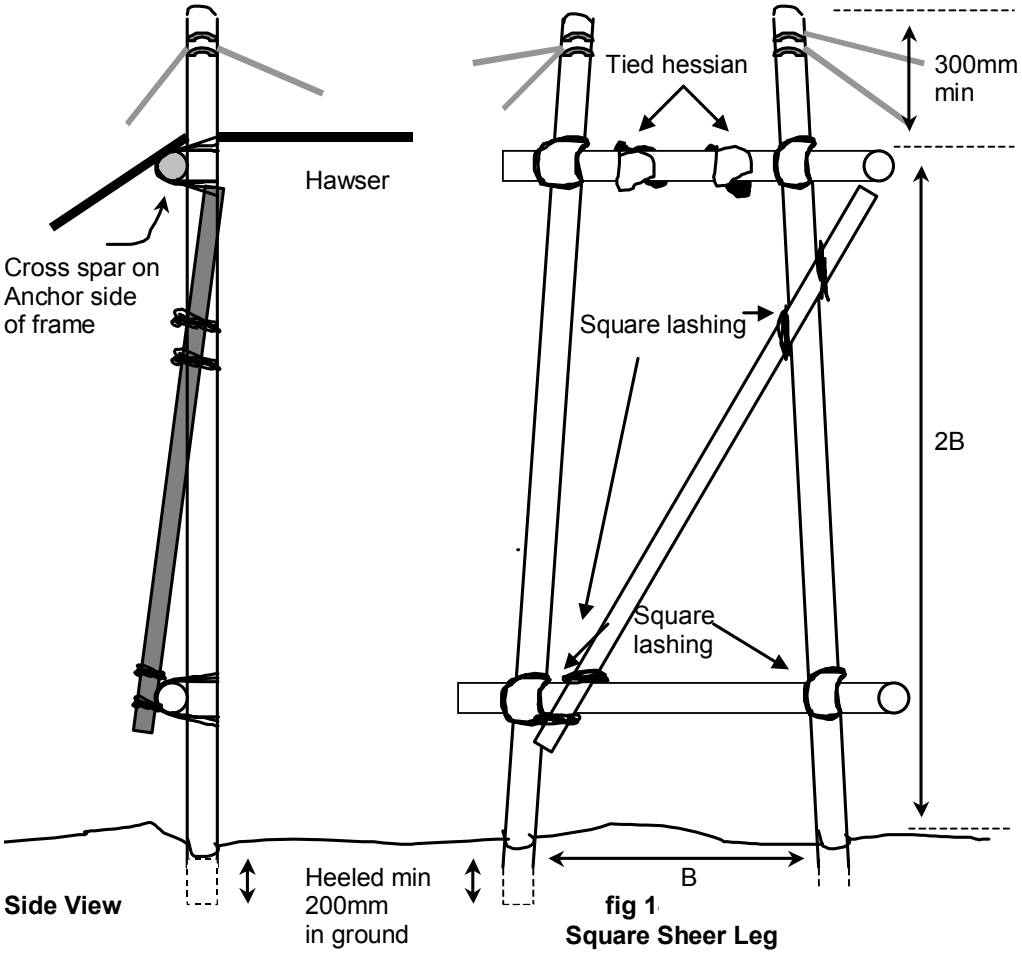


Figure 21 Dual Hawser Shear Leg Construction

The shear legs are to be suitably guyed in the vertical position to prevent falling forward or backwards. It should be noted that there will be slight movement in the shear leg structure with a dual hawser as only one hawser will be fully loaded at a time during operation.

Single picket anchor support for each guy usually suffices if there are reasonable soil conditions, however the same checks apply as per the anchor picket movement. Use the guys anchorage angles as illustrated in Figure 23.

Consideration should be given to providing protection to the fibre rope as it is looped around the picket, i.e. with short PVC pipe lengths, ensuring that it will not lead to the rope moving up the picket when loaded.

Figure 22 Picket Fibre Rope Protection

Guys should be tied off using a rolling hitch to allow repeated tensioning if required during inspections. Consider also making a double turn on the rolling hitch to increase the tension provided on the hitch.

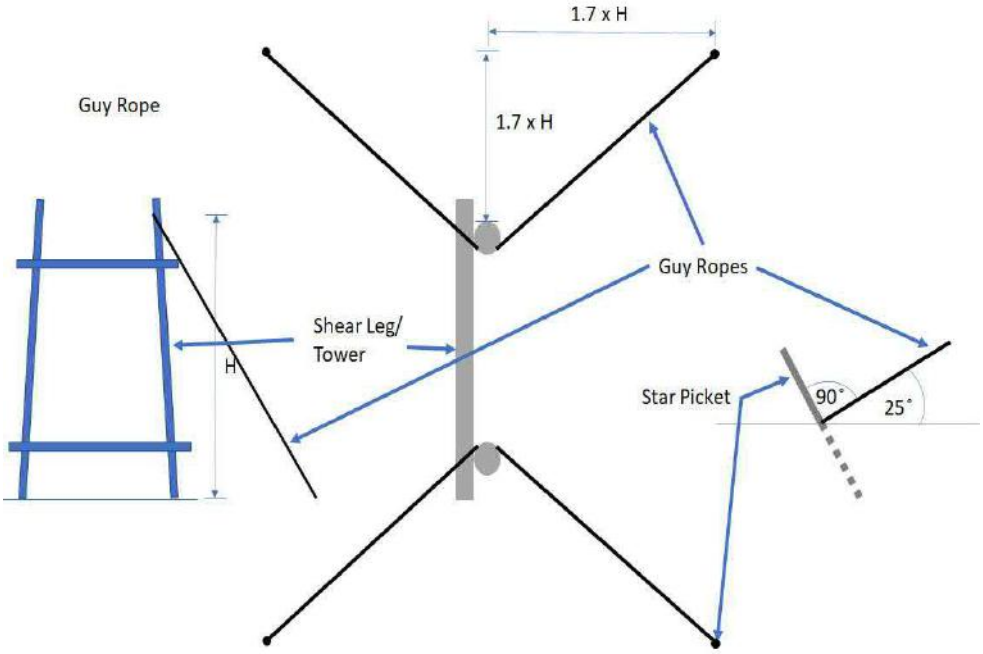


Figure 23 Shear Leg Construction Guy Ropes

At no time should the hawsers (on a tower) pass over any cantilevered construction as illustrated in Figure 24.

Figure 24 Cantilevered Hawser Structure (Non-compliant)

Cantilevered braces must be set outside the hawser as shown by the dotted line. Inside will cause a see-saw effect on an otherwise stable tower.

5.2.3 Scaffold Tower Shear Leg

Finding the right natural location often proves difficult, and with our desire to take foxes to the public at displays etc. The major 'upside' is flexibility, the 'downside' is cost.

FFSAC have developed a scaffold system described in this manual. However, note that this is an arrangement design brief for efficient operation only and that the scaffold does need to be designed and erected under the supervision of the qualified rigger who holds a scaffolding high risk work (HRW) licence and all work undertaken to comply with WorkSafe NSW requirements and notifications.

Design and erection must comply with the following requirements:

- All construction to be carried out as per AS 1576.1 and to standard practice.
- All pipe to be 48 mm dia. x 3.0.
- Scaffold clamp to have a safe working capacity of 6.7kn shear.
- Standard 150 x 150 footplate on min 600 long x 250 x 250 hardwood seating plate excavated to firm level seating in soil.

- The frame is to be guyed as shown, to suitable ground connections in accordance with anchorages defined in Section 5.
- Guy ropes are to be a minimum of 12 mm dia. and a min of 14m long from anchor to top scaffold tower.

The scaffold frame supports must be founded in all cases on firm natural undisturbed soil having a minimum bearing capacity of 150 kPa (normal firm dry topsoil overlaying clay or compact sand in the Sydney region would easily have this capacity, but where in doubt professional advice should be sought). Areas of concern would be uncompacted fill, loose sand, waterlogged soil etc.

Scaffold frame and other ropeway supports will be located on essentially level ground. (i.e. on a slope of no more than one in ten in any direction).

The scaffold frame is to be constructed using standard components of certified capacity, that are in good and serviceable condition.

The frame must be constructed in a manner which meets Workcover Authority and other statutory requirements.

The hawsers will not be connected to the ledger bearer but must be free to slide along the bearer in the direction of their span.

The hawsers are to be suitably restrained against damage due to sideways movement against the scaffolding components by means of fabric restraints such as sacking laid around the bearer or similar.

The operation of the ropeway must always be supervised by a qualified Scout Association of Australia, NSW Branch Flying Fox ‘Advanced Guide’, or ‘Supervisor’, the latter where members of the public are participating.

The above aspects are critical for the scaffold structure described in this section to meet the design performance criteria.

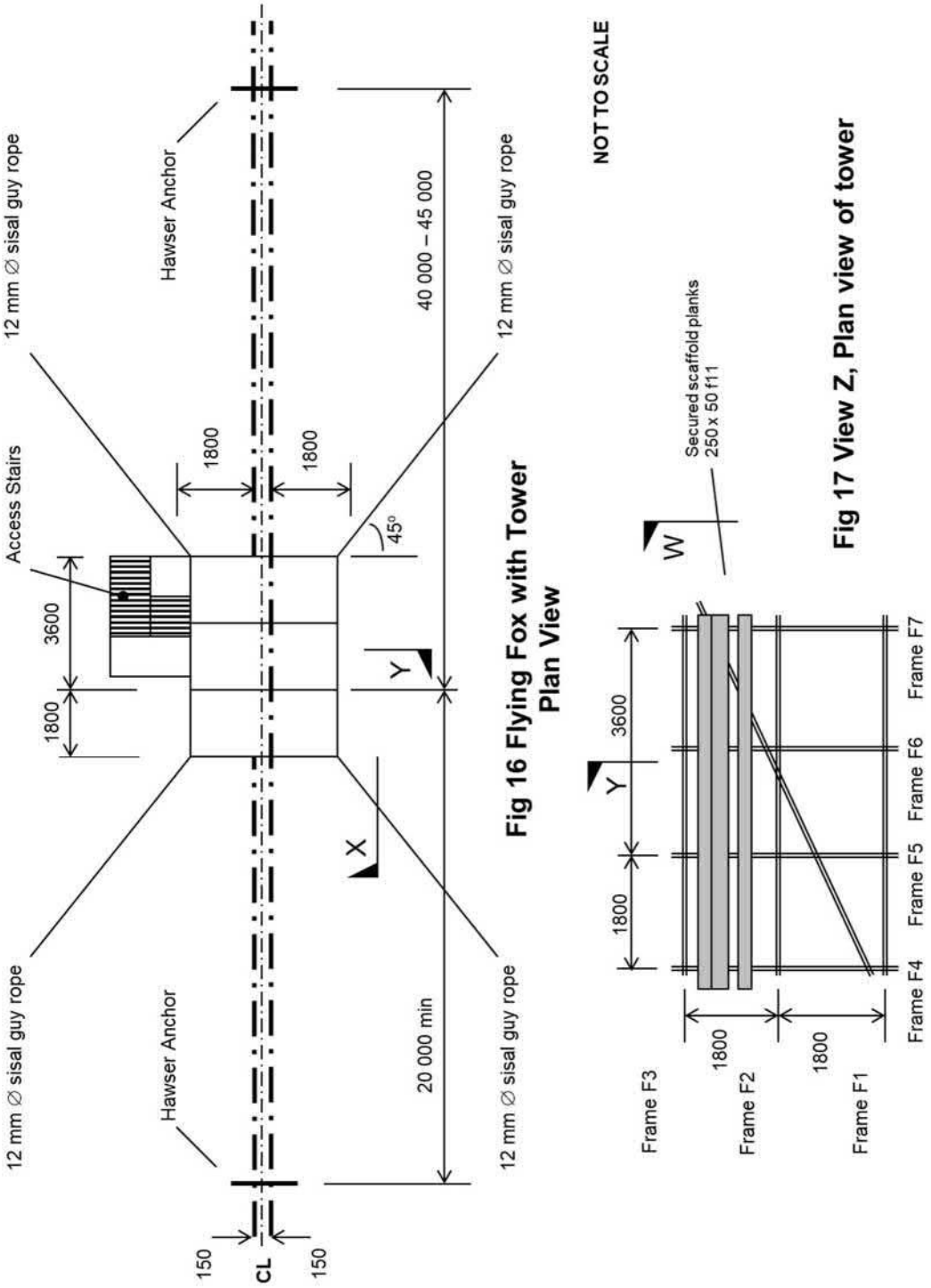


Figure 25 Scaffold Tower

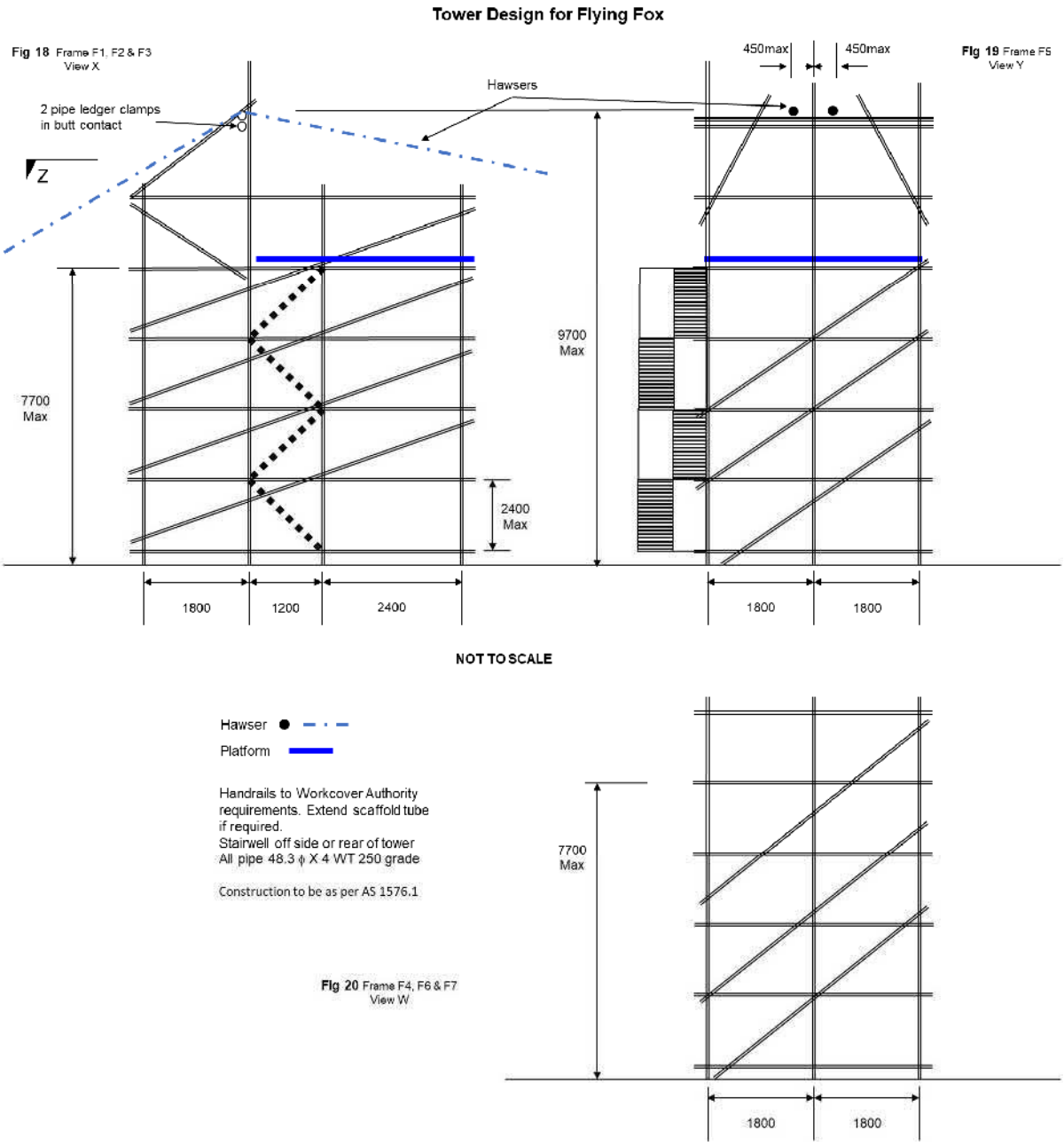
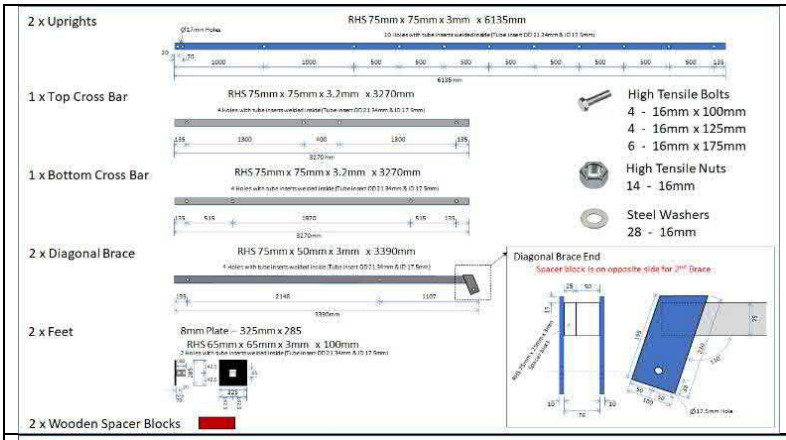
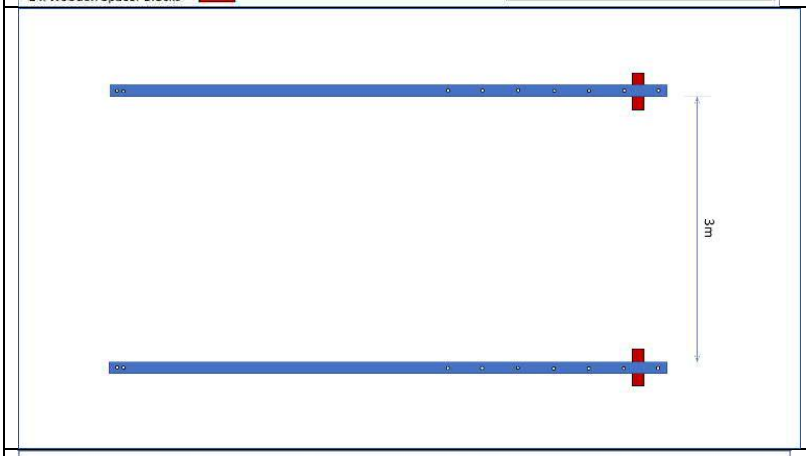
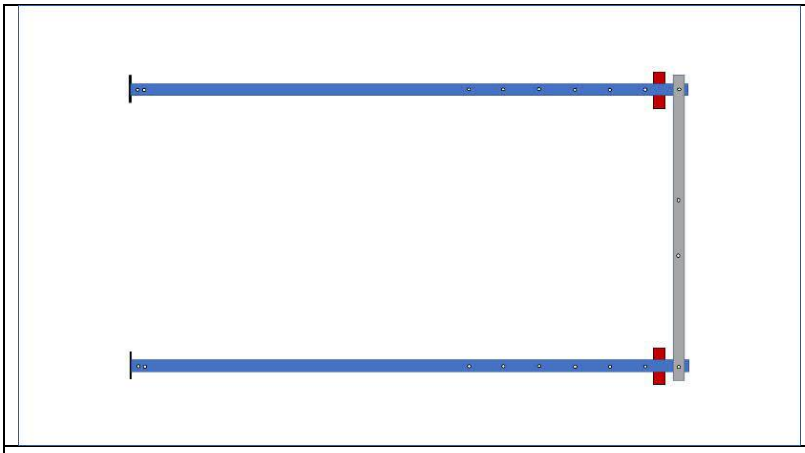
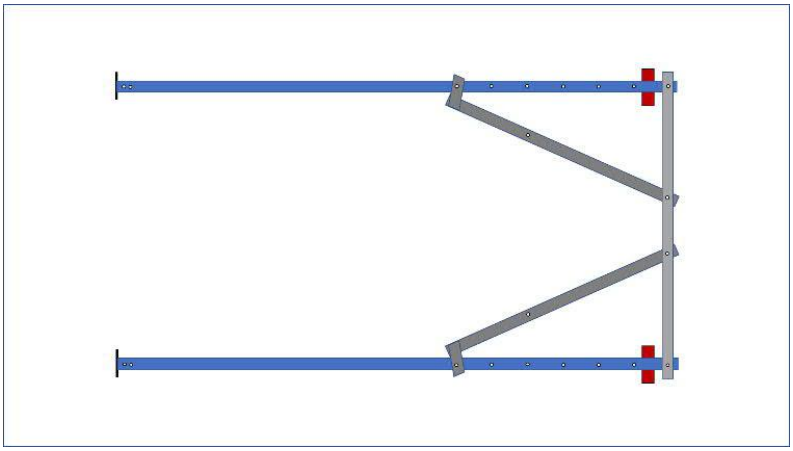
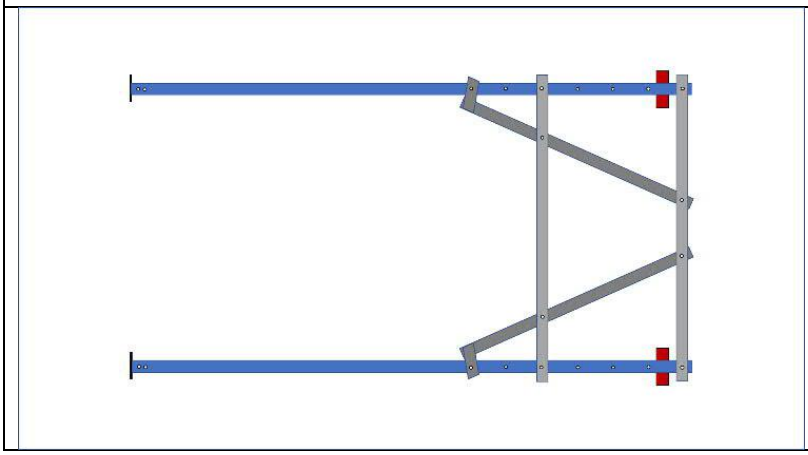
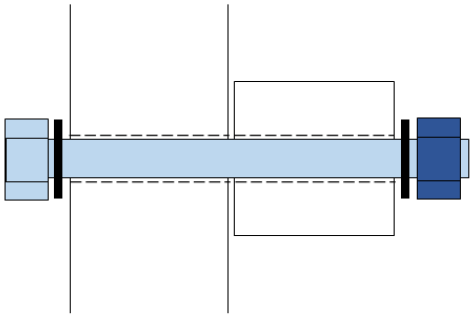


Figure 26 Scaffold Tower

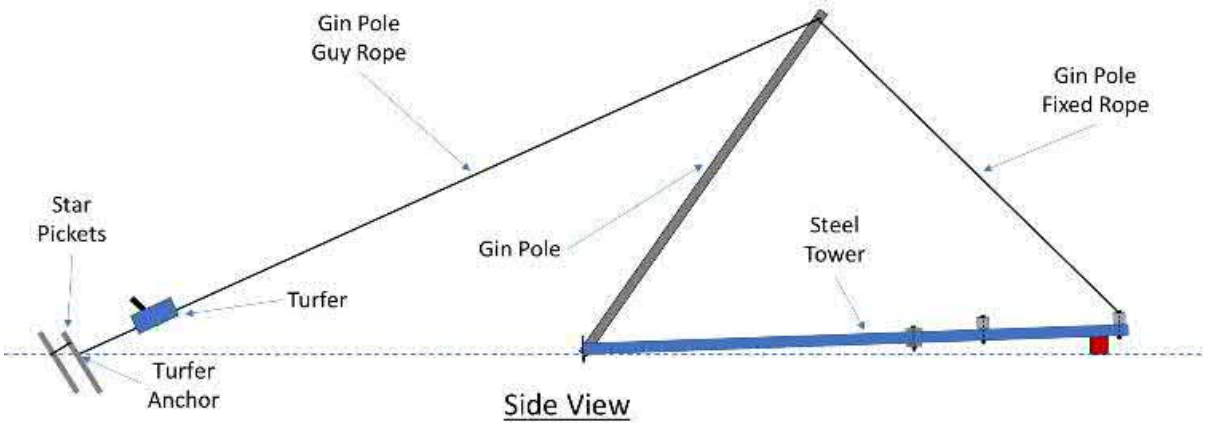
5.2.4 Fabricated Steel Tower Shear Leg

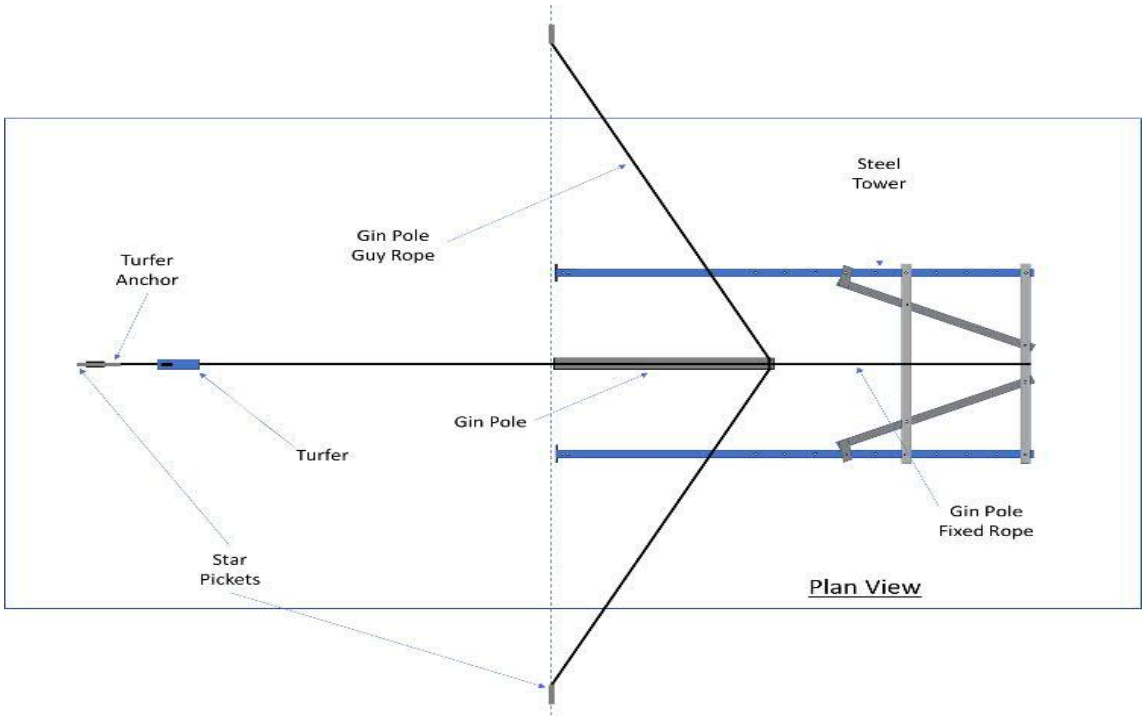
		1) Ensure all parts are available 2 x Uprights 1 x Top Cross Bar 1 x Bottom Cross Bar 2 x Diagonal Braces 2 x Upright Feet 2 x Wooden Spacer Blocks 14 x High Tensile Bolts 14 x High Tensile Nuts 28 x Steel Washers
		2) Uprights Lay out two Uprights approx. 3 m apart Place Wooden Spacer Blocks under each end
		3) Feet Insert Feet Plates into bottom of each Upright Insert four, 12mm x 100mm, High Tensile Bolts, Washers and Nuts Tighten all four Bolts

	4) Top Cross Bar Place Top Cross Bar (two holes closer to centre) on top of Uprights over top set of holes Insert two, 12mm x 175mm, High Tensile Bolts, Washers and Nuts Do bolts up loosely
	5) Diagonal Braces Select Diagonal Brace (steel with plates welded to each side at one end) and bolt to Top Cross Bar Place plain under top Cross Bar and bolt into the two holes in the centre of Top Bar Slide side plates on other ends over uprights on each side (should line up with 6th hole below Top Bar) Insert bolts and do up loosely
	6) Bottom Cross Bar Lay Bottom Cross Bar on top of Uprights and Diagonal Braces (should line up with 4th hole below Top Bar) Place bolts through Uprights and Diagonal Braces Insert four, 12mm x 175mm, High Tensile Bolts, Washers and Nuts Do bolts up loosely

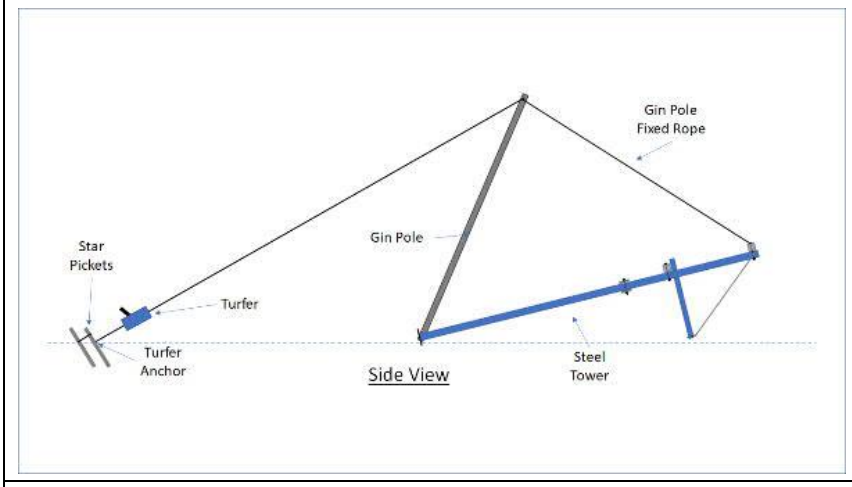


7) Tension Bolts
Tighten all Bolts securely





8) Set up Gin Pole
Set up and construction of the Gin Pole must comply with the following requirements:
The height of the Gin Pole is equal to the height of the shear leg being raised.
The base of the Gin Pole is placed at the mid-point between the base of the two shear legs and 150mm in the ground
The Gin Pole Fixed rope must be secured to the top of the Gin Pole with a Pipe Hitch containing no less 8 full turns.
The Gin Pole Fixed rope must be a minimum of 2900kg Tensile Strength e.g. 12mm diameter static kernmantle rope.
The knot securing the Gin Pole Fixed rope to the mid-point of the top of the shear legs should a rethreaded double Figure 8 or running Bowline.
The length of the Gin Pole Fixed rope between the Pipe Hitch and the top of the shear leg must be equal to the height of the shear leg.
The star pickets supporting the Gin pole must be 1.5 times the height of the shear leg from the base of the Gin pole. The star pickets, Gin Pole base and the shear leg base must form a straight line.
The guy ropes supporting the Gin Pole are secured to the top of the Gin Pole using a pipe hitch or similar knot that will not slip down.
A Turfer cable winch must be used to raise the Gin pole.
The anchors for the Turfer are 2 off star pickets joined with a Banjo Lashing. This anchor is to be placed 1.5 times the height of the shear leg from the base of Gin Pole and on centre line of the shear leg and Gin Pole.
The hook on the Turfer is connected to the Gin Pole using an appropriate sling. e.g. 2 tonne sling.
Double check the guy ropes are installed on the shear legs as well as string line, hawsers, return ropes and pulleys, safety ropes and other hardware for the shear leg.
Ensure the star pickets are installed ready for the shear leg guy ropes.
Use the Turfer to raise the shear leg to the limit of the Gin Pole. Operators to take control of the shear leg using the guy ropes to fully raise the tower into correct position.
Once the shear leg is secured with the guy ropes the Gin Pole, Gin Pole fixed rope, Gin Pole guy ropes, turfer and turfer anchoring star pickets can be removed.



9) Attach Platform to Tower
Raise tower enough to attach platform
Attach platform with u bolts and cables
10) Raise Tower

Figure 27 Fabricated Steel Tower Erection

5.3 Braking Systems

5.3.1 Static Brake Setout

The running end of the ropes are secured to steel pickets so that If the participant hits the static brake and it moves to the limit of its travel they cannot Swing up and hit the shear leg, refer Figure 28.

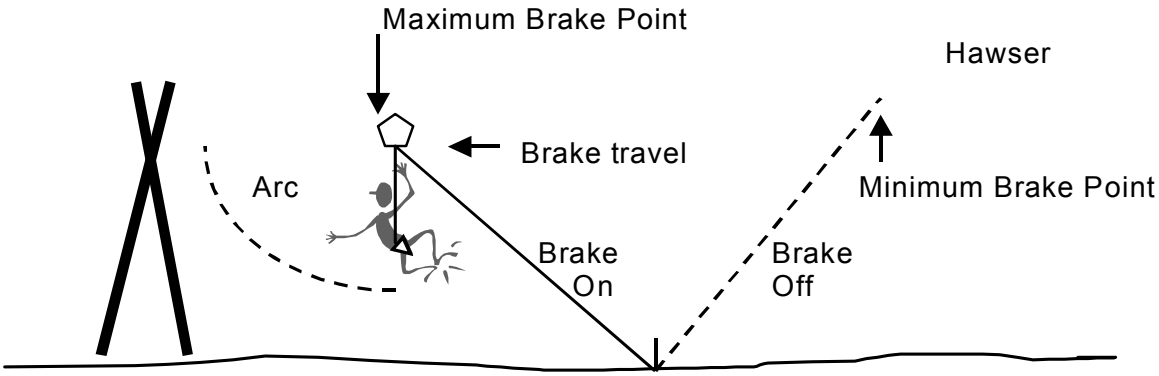


Figure 28 Static Brake Setout

A convenient but safe knot must be used on the anchorages, i.e. rolling hitches, alpine butterfly and figure loops are considered appropriate, but will depend on design, and the lay of the rope.

Consideration should be given to providing protection to the rope as it is looped around the picket, i.e. with short PVC pipe lengths of using shackles over the star pickets, ensuring that it will not lead to the rope moving up the picket when loaded.

5.3.2 Static Brake

The static brake is secondary braking system with the aim to prevent the participant hitting the shear leg if the primary braking system, which must be a dynamic braking system, fails. It is made using dynamic kernmantle rope with a fixed length to achieve the set out as described in Section 5.3.1.

Note: AS 2316.2.1 stipulates the maximum imposed load on the participant shall not exceed 0.8kN (approx. 81.6kg) and the maximum dynamic load is 6kN (approx. 611.8kg).

Figure 29 Static Brake Arrangement

For a Dual hawser system tie two alpine butterfly knots close to the middle of the rope and at the width of the hawsers. Install either on each hawser nylon blocks and rated bow shackles connected to the alpine butterfly knots.

5.3.3 Gravity Brake

A gravity brake is a passive braking system which allows for slow deceleration. It is where 1/3 of the span (or more) is uphill as per Figure 30.

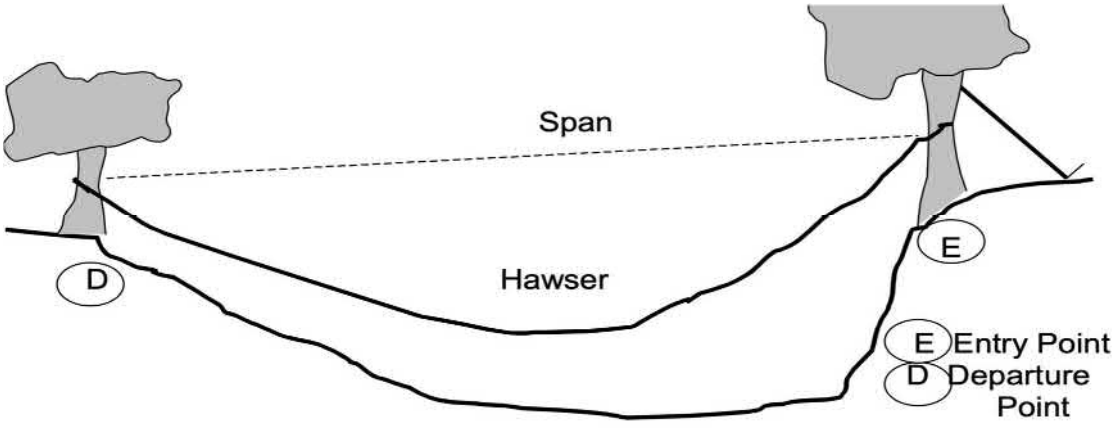


Figure 30 Tree Shear to Tree Shear Legs with Natural Brake

5.3.4 Dynamic Brake

The maximum effective speed (velocity) is 11 km/h average (3.055 m/sec.) in accordance to AS2555.

This is calculated when initially testing the system. To determine maximum speed:

Measure the distance from the launch platform to the 'final stop' position.

Place a mass equivalent to the maximum rider weight on the trolley. e.g. 120kg

With a stop-watch time the distance from launch to final stop.

Calculate the velocity of the mass.

Example I (Acceptable velocity)

If the distance travelled is 50m and the duration was 17.5 seconds.

Velocity = 50m / 17.5 seconds

Velocity = 2.85m/s

This is less than 3.055m/s and is acceptable

Example II (Maximum velocity)

If the distance travelled is 50m and the duration was 15.5 seconds.

Velocity = 50m / 16.366 seconds

Velocity = 3.055m/s

This is the maximum velocity acceptable

Example III (Unacceptable velocity)

If the distance travelled is 50m and the duration was 13.5 seconds.

Velocity = 50m / 17.5 seconds

Velocity = 3.7m/s

This is greater than 3.055m/s and is unacceptable

According to Australian Standard AS 2316.2.1:2016, Artificial climbing structures and challenge courses, Part 2.1: Flying foxes and challenge ropes courses Construction and safety requirements, the maximum Imposed Load per person shall not exceed 0.8kN 81.55kg) and the maximum Dynamic Load is 6kN (611.6 kg). If the maximum velocity of 3.055m/s is not exceeded and a gradual deceleration (described in this section) is used e.g. tyre, chain or bungee brakes, the maximum force imposed the participant is subject to should not exceed 0.8kN (81.5kg) and a Dynamic Load of 6kN (611.6 kg).

Each flying fox is required to have a minimum of two braking systems.

If the towing rope is used as part of a braking system, the rope capacity will need to be increased to compensate for the additional load.

5.3.5 Dual Hawser Dynamic Brakes

Dual hawser Flying Foxes are ideal for high volume throughput of 'trolleys', as the recovery of the trolley is done automatically, and manual recovery is overcome.

'Bottom end' brakes can be modifications of previously discussed systems, such as bungee, in line, tyres in line, etc., but where stacked tyres are used, the tow line is not available for braking, as it is used for trolley recovery through a system of pulleys, or a single pulley.

A dedicated braking rope is required and can be constructed as per Figure 31.

The brake line is tensioned by using a stabiliser rope, tied to the bottom shear leg, which lifts the first tyre. The tension is necessary to stop the brake rope dragging to the ground. The loop system to the brake blocks allows only the active block to action the brake, and the length of the loop will determine when the non-active block is brought into play. The stabilised distance must be greater than the total draw of the balance of the tyre brake.

It has been found a length of shock cord will negate any slack in the stabiliser rope, at the point of brake block impact. This shock cord must be secured under tension. The shock cord is best fitted approximately halving the distance of travel between the shear leg and brake blocks and can be run through a pulley to de-crease wear on the cord. The shock cord should not be used in place of the stabiliser rope.

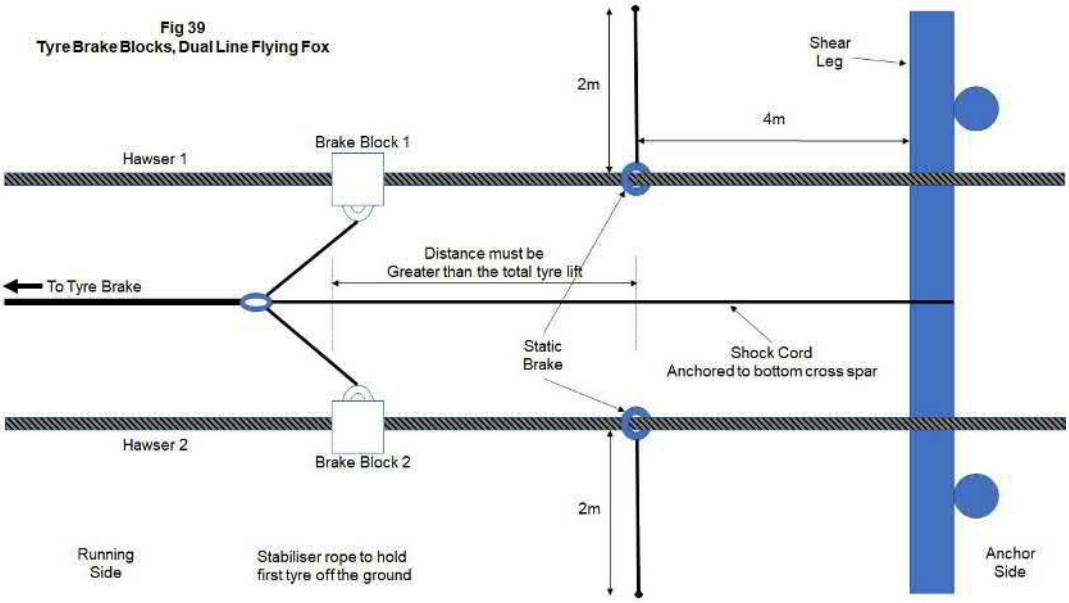


Figure 31 Dual Hawser Dynamic Brake Layout

Figure 32 Double Hawser Dynamic Brake

Consideration should be given to providing protection to the rope as it is looped around the picket, i.e. with short PVC pipe lengths of using shackles over the star pickets, ensuring that it will not lead to the rope moving up the picket when loaded.

Brakes can be applied through the tow line. By using a 12 mm diameter natural fibre rope, run the tow line back through a pulley located near the span end, but not to foul the hawser, and then run the pulley to ground. Attach to this a minimum of 3 car tyres, the configuration of which will be determined by the design of the flying fox, speed and weight of participants. This is one of the preferred methods.

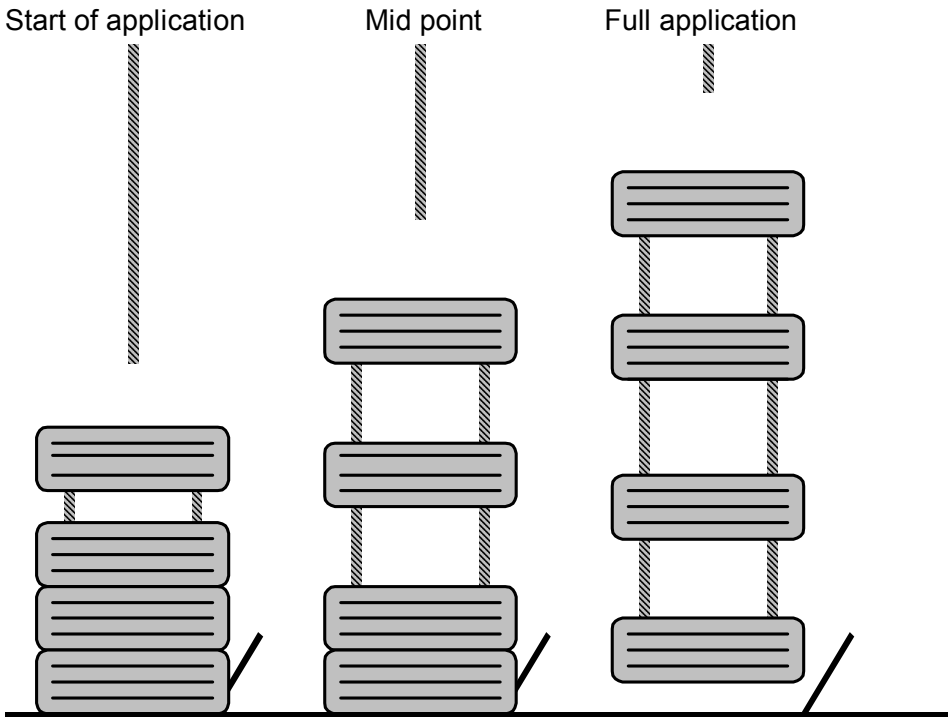


Figure 33 Dynamic Brake - Tyre Weight

The spacing between the tyres is determined by the length on the hawser over which braking is applied.

If the space required for tyres, when transporting or where the brakes are physically installed, heavy large link chains can be applied through the tow line. By using a 12 mm diameter natural fibre rope, run the tow line back through a pulley located near the span end leg, but not to foul the hawser, and then run the pulley to ground. Alternatively, the tow line can be run through a block system to bring it back to the lower shear leg. This has the advantage of not having to carry the weights up a steep incline.

The chains should be grouped in separate weight configurations and attached on the other chains to suit the weight take up required, which can be added or removed to suit the design of the flying fox, speed and weight of participants. This is another one of the preferred methods.

Figure 34 Dynamic Brake - Chain Weight

Where such brakes are used, care must be taken to ensure that the brake mechanism cannot be fouled, and that it is a danger to no one.

The brake design for the heaviest load will be ‘over efficient’ on lighter loads, but as always safety will be the first consideration.

In a dual hawser set up the brake needs to be under tension, and a fifth tyre maybe recommended.

5.3.6 Bungee Dynamic Brakes

A length of 10 mm shock cord is selected that will give the required deceleration. For safety reasons four minimum are required for each side of the nylon block. These lines must be fitted with nylon thimbles and are recommended to be secured with a figure of eight knot or whipped fastening securing thimble.

The anchor end must be secured in a manner that will not ride off the anchor, and if necessary, a 12 mm sisal rope extension can be included at the anchor end to extend the total length of the anchor line. If such a brake is used in combination with an in-line brake as described above the maximum draw out length of both brakes can be identical, but the initial location on the hawser may differ. Obviously load weight will vary the final resting place of the bungee brake.

Care should be taken to reduce any 'slingshot' effect.

5.3.7 In-Line Tyre Braking System

Alternatively, the static brake can be made up of inline tyre arrangement indicated in Figure 35. The tyres are pierced, and the hawser passes through them).

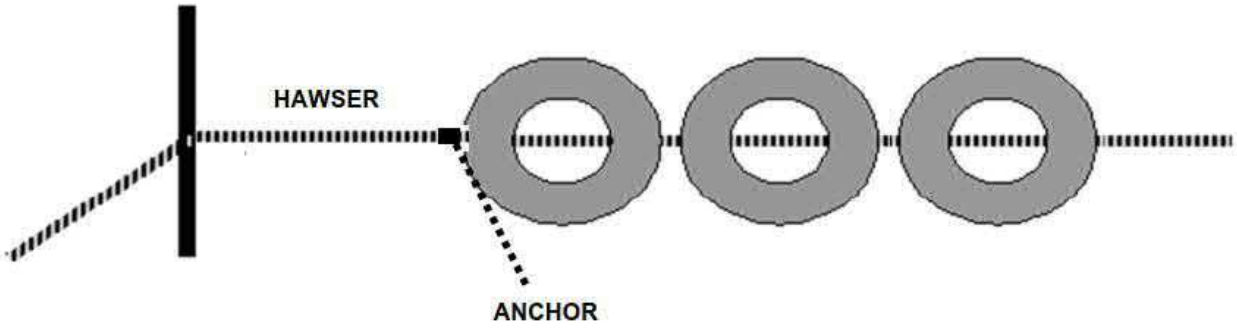


Figure 35 Hawser In-Line Tyre Brake

The tyres under maximum compression, must keep the arced passenger free of the shear legs, or similar. The negative of this design is weight on the hawser and difficulty installing safely at high level. (Beware!)

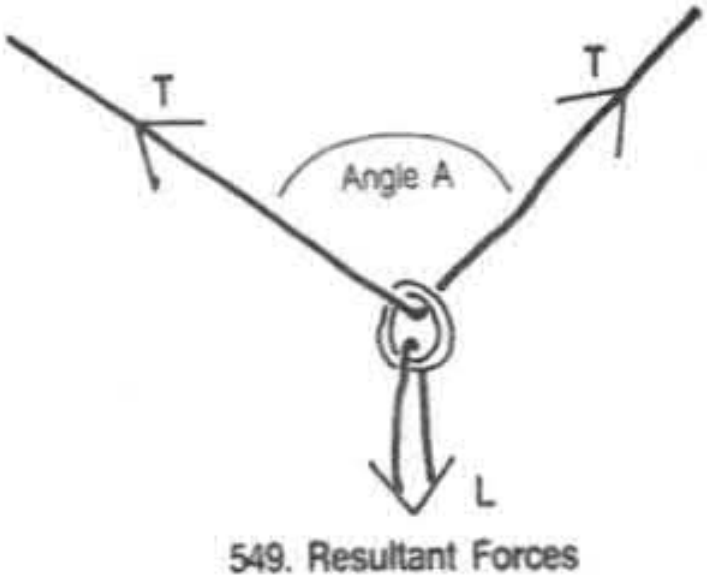
5.4 Hawser and Tension System

5.4.1 Hawser Loading Theory

The relationship between participant weight, hawser included angle (% of catenary) and system loads (Resultant Forces) is critical. According to (Warner C, 1992, A Fresh Approach to Knotting and Ropework, National Library of Australia), Resultant Force changes with different angles. See below copy of that text.

Note that these forces apply to the hawser and all in line components, including shackles, turnbuckles, anchors and associated slings. FFSAC are recommending a minimum 4T components be used for flying foxes less than 100m, 5% sag in the hawser and maximum participant weight of 120kg.

If your weak anchor points are well spread out sideways, you must make your linkages sufficiently long to allow for the resultant forces at various angles (549). If a load "L" is shared between two leg of a rope forming an angle "A", then the load "T" in the legs is not far from approximately 1/2L if the angle "A" is less than about 75°, but then increases rapidly with increasing angle, so that it is 3/4L at 90°, L at 120°, 2L at 150°, 4L at 165° and 12L at 175° (this assumes that the legs are straight, with no sag). You should therefore never exceed 120° between legs of a self-equalising anchor.



549. Resultant Forces

Figure 36 Hawser Forces

It is the same principles which apply to the relation between the weight of a person crossing a rope bridge and loading int eh rope. That is why such rope bridges must sag quite a bit, or else have very strong rope.

The minimum catenary is 5% = 168.57 degrees (calculated using trigonometry). Applying interpolation Warner's text above, the Resultant Forces "T" on the system and anchors is approximately 6.75 x Load. If we have a 120kg maximum participant weight the Resultant Forces on the system: 6.75 x 120kg = 810kg.

This does not take into consideration the mass of the hawser itself or dynamic loads. i.e. the participant takes a running start onto the flying fox. At 164 degrees included angle in the hawser the Resultant Forces on the system reduces to less than 4 x Load.

Resultant Forces on the system: <4 x 120kg = <480kg.

At 175 degrees included angle in the hawser the Resultant Forces on the system increases to 12 x Load.

Resultant Forces on the system = 12 x 120kg = 1440kg.

To keep system loads to a minimum to 5% minimum catenary must be enforced. Participant mass should not exceed 120kg and participants to be launched from a static position i.e. NO running launches.

5.4.2 Hawser Tensioning

Once secured, the tensioning of the hawser may take place. Any “block and tackle”, “chain block”/”cum-along” or ‘turfer’ used, while not being required to be rated, needs to be in good condition to avoid accidents – this especially applies to the rope used on the block and the rope attaching to the hawser via a ‘lizard’ or other method. Measuring of the catenary formed with a known weight (at the suggested limit or lesser) in the middle of the hawser is required. Notation of data obtained is a requisite of any Fox construction.

The minimum catenary of the Hawser shall be 5% or an included angle on the hawser at midpoint of 168 degrees. This ensures the resultant forces applied to the system do not exponentially increase above rated system loads.

5.4.3 Block and tackle ‘in line’

An ‘in line’ eye should be placed in the hawser on the non-traverse side of the shear legs. This can be achieved by using a correctly installed appropriately rated wedge socket or eye and double turnbuckle clamps.

The hawser is then attached to the block and tackle (triple sheave end) with a moussed shackle of minimum 3.1 tonne capacity. The double sheave block is attached to the anchorage selected by using a sling, rope and or shackle for triple picket, or a tail rope for log and picket, or dead man anchorage.

If required a suitable tail rope can be paralleled to the block and tackle.

Identical fixings are used where the hawser is to flow through, and the double sheaved end of the block and tackle will need to be ‘lizarded’ to the hawser, however, the lizard is not to be the main load support connection.

5.4.4 Turnbuckles

A single or tow inline 24 mm turnbuckle Rated at 4T (minimum) may be inserted on an ‘in line eye’ configuration, to facilitate minor tensioning and catenary adjustments. These turnbuckle and associated shackles are to be moussed to avoid the potential for it to unwind under load.

Figure 37 Turnbuckle Hawser Base Clamp Tensioning

In an 'in line eye' configuration the thimble eye in the hawser should be set and secured by double base clamps See Figure 43 and Figure 44. *A minimum of three (3) steel hawser double base clamps shall be used to secure the thimble steel eye in the hawser, refer* Figure 37*. Note that these are critical and must be inspected regularly for any movement.*

Figure 38 Hawser Double Base Clamp Fixing

It is recommended to install tape markers adjacent to eye or one the lead side and tail end of the first base clamps to check on any movement, refer Figure 58.

Remember wire rope grips are banned in any human load carrying situation.

Wire rope grips maybe used to secure the lizards to the hawser with non-human load, for setting up hawser tension. Wire rope grips should be tensioned to 24 Nm, 18 pound-foot, 2.45 kg.m. Set the tail rope long and adjust single base clamps (6 nuts) as you adjust the tension.

5.4.5 Raising the Hawser

Raising the hawser and applying the approximate tension tensioning can be achieved using either "Chain block"/"Cum-along" or 'Turfer' can be used as a versatile tensioning system which has more flexibility than a block and tackle. Note this can then also be available and set ready for rescues if required.

Figure 39 Cum-along Tensioning System

5.4.6 Hawser Catenary Tension vs Sag

Assuming a 120kg load, over a 40m span, with:

ROPE LENGTH	CREATES CENTRAL SAG	AND GIVES RISE TO A HAWSER TENSION OF
42 m	6.4 m	1.6 tonnes
41 m	4.5 m	2.3 tonnes
40.25m	2.2 m	4.5 tonnes

Table 2 Hawser Tension vs. Sag

It can be seen from this that a tight rope gives a fast trip, but may overstress the rope and endanger life, so we have devised a three-level safety check on rope tension.

Step 1:

We must establish the span which may be done by:

'Stretching' a bricklayer' line to minimise it's catenary and then measuring the line length. The danger is that the 'stretching' may be significant, and the determined measure may cause an unsafe underestimation of the span.

Preferably we should use a high quality 'non stretch' tape measure. This will cause minor overestimation of span (safe), due to tape catenary.

Step 2:

Refer to Table 3 Schedule of Required Sag – No Load where by taking the length of the span you can determine the required catenary. On a light pole place a sturdy nail at the determined distance from the pole end. At mid span point (not mid ground point) locate the nail just above the hawser. The top of the gauge must not exceed the span line height, whilst the gauge is vertical to the ground (not 90 degrees to span line).

Thirdly refer to Table 4 Schedule of Required Sag – Under Load where by taking the length of the span you can determine the required sag under load. Apply a second nail to the gauge at this stated depth. Bring the trolley, with tow rope hanging to mid-span, and apply a load of at least 50% of maximum load. Test the rope under load just as the catenary was tested.

In measuring Table 3 and Table 4, light poles may be inappropriate due to site considerations, and a light marked string dropper from mid-span point may be more practical.

When all three tests perform within the guidelines above, the rope is not over-stressed. If one test is out, the tension must be adjusted, and all tests repeated, until we have all three tests correct.

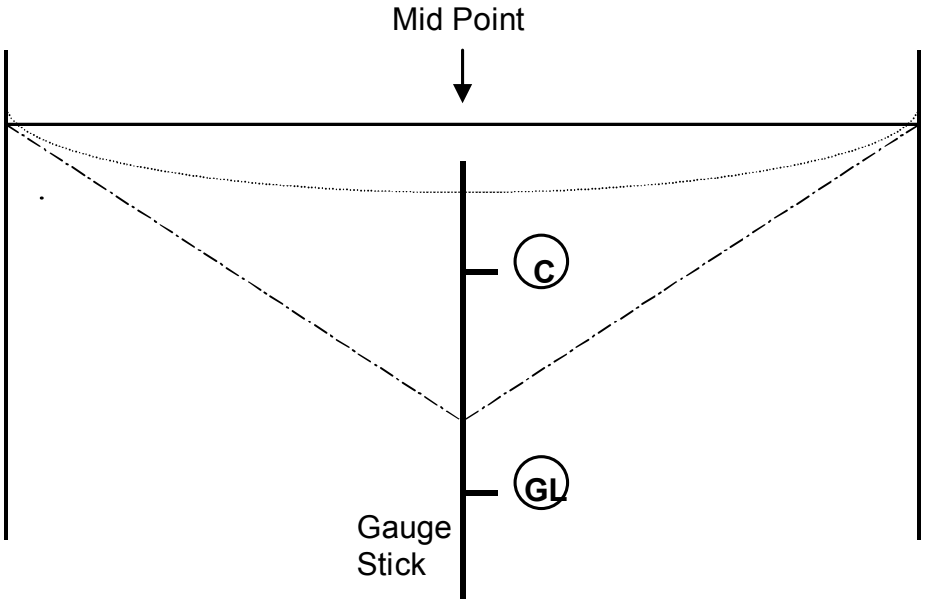


Figure 40 Hawser SAG Measurement

Tape measure to total 'let out' length and draw hawser to match curve.

Set catenary gauge and ensure span line not exceeded.

Set load gauge and ensure span line not exceeded.

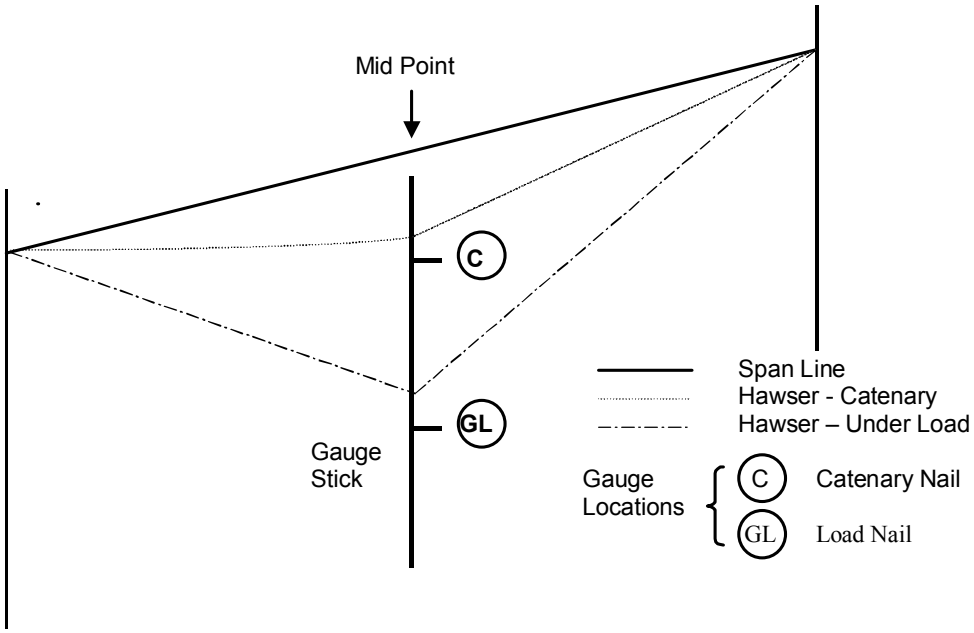


Figure 41 Hawser SAG Measurement on Slope

Where all three tests are impractical or impossible, due to site conditions etc. the first test may be dispensed with, but more care should be taken on completing Table 3 and Table 4.

Where using Table 3 and Table 4 only, it may appear that the catenaries under 'no load' and 'load' are performing at variance to the tables. The cause of this is most likely the catenary in the span line, and great care should be taken if some compensation is made for this. Safety is paramount.

Under no circumstance must the loaded catenary be more than 1: 20 ratio to the span length. (i.e. less than 5% sag on span length)

FFSAC recognise the difficulty in getting a 'straight' span line and measure and is investigating laser technology to assist with more accurate measurement.

Formula for establishing actual let out length (ALOL):

(SLOL/SS) x ACTUAL SPAN = ACTUAL LET OUT LENGTH (SS)

Example: Using the schedule closest to the actual span.

e.g. Let us assume an actual span of 76.5 metres.

(80.40/80) x 76.5 = 76.8825m or round to 76.9m

Note: The above specifications relate to steel ropes.

SCHEDULE OF REQUIRED SAG - NO LOAD APPLIED (CATENARY)	
SPAN (SSPAN)	MINIMUM SAG FOR UNLOADED ROPE (SSAG)
10 m	0.44 m
20 m	0.87 m
40 m	1.75 m
60 m	2.64 m
80 m	3.53 m
100 m	4.43 m

Table 3 Schedule of Required Sag – No Load

Formula for establishing actual Sag - Unloaded (ASAGU)

(SSAG/SSPAN) x ACTUAL SPAN = ACTUAL SAG-UNLOADED (ASAGU)

Example: Using the schedule above for the Actual Span Length

e.g. Let us assume an actual span of 76.5 metres.

(3.53/80) x 76.5 = 3.3755625m or round to 3.38m

Note: The above specifications relate to steel ropes.

SCHEDULE OF REQUIRED SAG – UNDER LOAD APPLIED (ASSUMING 5% SAG CATENARY)	
SPAN UP TO (SSPAN)	ALLOWED SAG (SSAG)
500mm	0.025m
1m	0.05m
2m	0.1m
3m	0.15m
4m	0.2m
5m	0.25m
6m	0.3m
7m	0.35m
8m	0.4m
9m	0.45m
10m	0.5m
20m	1.0m
30m	1.5m
40m	2.0m
50m	2.5m

60m	3.0m
70m	3.5m
80m	4.0m
90m	4.5m
100m	5.0m

Table 4 Schedule of Required Sag – Under Load

Formula for establishing actual Sag - Unloaded (ASAGU)

(SSAG/SSPAN) x ACTUAL SPAN = ACTUAL SAG-UNLOADED (ASAGU)

Example: Using the schedule above for the Actual Span Length

e.g. Let us assume an actual span of 76.43 metres rounded up to 76.5m

Therefore, we allow:

70m = 3.5

+ 6m = 0.3

+ 500mm = 0.025

For 76.5m = 3.825m

(3.53/80) x 76.5 (SPAN) = 3.3755625m or round to 3.38m (SAG)

Note: The above specifications relate to steel ropes.

5.5 Fox Mount and Dismounting Considerations

5.5.1 Fox Mounting

Site depending, this can be a dangerous part of the activity and all care needs to be taken here, all operators shall be on fixed belays if there is any chance of a fall from height. If appropriate, participants may need to be separately belayed prior to being attached to the Fox. Ladders on uneven ground are inherently dangerous and care needs to be taken to void any risk here.

Where possible is best practice to 'preload' the participant onto the hawser. This reduces participant 'free fall' and thereby reduces anxiety (especially Joeys and Cubs) and greatly reduces system dynamic loads.

To preload the hawser:

- Participant either stand or sit on the launch platform.
- Connect Petzl RIG, GriGri or similar device affixed to the dropper to participants harness (bridge) OR crimped wire dropper. Tri-lock, Mag-lock or similar automatically locking devices should be used and NOT relying on operators screwing up carabiner.
- Connect safety backup to participants harness (bridge) on a separate carabineer to a separate fixing on the trolley, i.e. a separate independent safety line with no common points apart from the actual trolley and harness.

- Simultaneously pull down on the hawser (to tension it) and pull rope though the Petzl RIG / Gri-Gri so the participant should feel as though they are being lifted by the dropper. For a fixed dropper if they can walk to a position on the launch platform or sit so they are suspended prior to release.
- Double check connections to the participant and lock off Petzl RIG. If a Gri-Gri is used a Reverse Marlin Spike Hitch MUST be placed in the running end of the dropper rope directly below the Gri-Gri.
- Participant is safe for launch.

The preference I to have a solid launch platform which can be natural ground/rock, scaffold or specific platform offering adequate space for at last the operator and participant to move around safely for launch. The use of ladders for a launch is NOT preferred.

If a tall tree is available offering a high top shear leg a standard 3-4m scaffold platform can a be used, which can generally be hired and has rental company instructions for assembly. Providing such a platform offers an easier launch for younger scout members such as Joey's and Cub's. Such scaffold structures can be assembled by the fox team without necessarily having a licensed rigger. Note however that even this scaffold does need to be guyed as per the detailed description for scaffold towers.

5.5.2 Fox Dismounting

See above. The return journey, on foot, to the top of the run if that is what happens) needs to be safe – roped off areas are important here! Site dependent, additional Fox staff may be required to ensure no possibility of excited riders walking in front of an incoming Fox with potentially disastrous results.

The embarking and disembarking positions must be such that there is no danger to the passengers and/or spectators as a result of the surrounding terrain. Suit-able clear access is essential.

The hawser height, under load, at embarking and disembarking points, must be enough to allow the tallest passenger to be seated in the harness (incapable of touching the hawser or trolley) and legs if fully extended not touching the ground at any point along the travel.

Suitable steps may be needed to assist passengers dismounting from the Flying Fox.

Where embarking or disembarking requires the passenger's feet to be more than 2 metres above clear ground, safety lines must be used for passenger security.

In certain terrain it may be unsafe to disembark at the travel end, and in such cases nothing precludes the tow line rope being used to transport the passenger back to the embarking point for disembarking. This may also apply in reverse, where the passenger boards at the disembarking point, and is towed to the higher point before being released.

5.6 Rescue Gear

The flying fox construction must take into consideration rescue of participants part run down to allow them to be safely lowered to the ground. Due to a range of incidents which may occur, including ensuing medical conditions, it should be possible to lower participants to the ground safely within a short period of time.

Depending the type of construction will determine how best to rescue participants, note however the means of lowering participants must be controlled and not reliant of excessive manual handling by operators where the speed of decent is dependent on the strength of the operators.

Rescue systems used should be rated to carry a minimum of two people and the devices used should be able to be used to lift and to lower the participant requiring rescue.

Considerations for rescue systems should include but is not limited to:

- load magnitude
- ability to raise the person
- ability to lower the person and rescuer
- ability to enable an activity leader to complete contact rescues.

The hawser will be under load with a stranded passenger, and the load must be reduced safely and gently. We would recommend that the first option is to gently lower the hawser using a block and tackle attached to a lizard on the hawser using 3 off double base clamps. Then the hawser can be gently slackened.

Where the jam is too high, or the topology does not easily permit slackening the hawser and alternative system needs to be planned where a second rescue trolley can be lowered down the hawser with appropriately rated equipment to allow the participant to be safely re-attached to the hawser or rescue trolley and allowing safe lowering of the participant.

It should be noted that if a participant is unconscious, he/she can suffer Suspension Trauma (Harness Hang Syndrome or Orthostatic Intolerance) after 5 minutes hanging in a harness. This can result in participant death. The rescue systems used must be safe for the operator and participant, effective and fast.

Possible methods include the following:

- If the participant is jammed near the launch platform, use the return line rope to haul the participant back onto the launch platform.
- If the participant is mid span the rescuer may be able to ascend a step ladder (already on site), disconnect participants safety rope and then lower the participant using the participants Petzl RIG.
- If the participant is mid span and the hawser is ‘higher’ the rescuer can throw a rope over the hawser and ascend the system using a Double Rope Technique (DRT). Once up the height of the participant the rescuer dis-connects participants safety rope and then lowers the participant using the participants Petzl RIG whilst simultaneously controlling their own descent on the DRT system.

- Use of the independent trolley with a trailing rope run through the re-turn line pulley to allow an operator to be lowered down the run slowly to join the participant requiring rescue.
- On the dropper from the travelling bock the rescuer has descender system arranged, sufficiently rated to allow two persons to be safely lowered. This can be a proprietary rescue ascender such as the CMC Rescue MPD or Petzl's JAG system, which allows the operator to raise or lower without changing the rope, or other rock climbing descender.

If a proprietary rescue raising and lower devices are not available a pulley system can be used to raise the participant to be rescued. Fixed at high level directly under the trolley and fixed to the participants harness carabiner and enough trailing rope so operators on the ground can raise the participant allowing them to be disconnected from their dropper and fixed by carabineer to the rescuer dropper. Note that a safety tape should be fixed to the participant during this transfer.

Once the rescuer and participant are fixed to the rescuers descender the rescuer can operate the descender to safely lower them both to the ground.

It should be assumed that the participant to be rescued is not able to assist in the rescue, as they may have injuries, be unconscious and not possess the necessary skill.

Rescue equipment must be readily available to ensure rapid deployment is possible. The equipment must be suitably rated for the purpose, i.e. rock climbing rescue equipment, and suitable for the flying fox arrangement installed.

The qualified fox team must be trained in the use of the rescue equipment and should be practiced periodically.

The expected peak load and possible additional loads if a rescue is carried out must be considered when determining equipment loading.

Note that the lowering of shear legs and or lowering the hawser can only be used as a rescue means if an arrangement can made to lower components slow and in a fully controlled manner.

Note that the lizard can only be used to lower the hawser if it is fixed as per a fully load rated double base clamp arrangement as per the hawser end eyelet and a cum-along is used to slowly lower the hawser.

6.0 Equipment

6.1 General

The equipment selected must be suitable for the purpose it will be used.

This includes ensuring all equipment:

- meets any legislative or regulatory requirements
- is appropriately serviced, stored and maintained
- is appropriate in style, size, quality and quantity for the activity and by FFSAC.

6.2 Hawser Specification

The hawser is the main weight bearing rope that will carry the trolley.

The Hawser specifications are:

Material	Maximum Span	Minimum Diameter	Construction	Maximum Load
Steel – Galvanised	100 m	11 mm	7/19	120 kg
Steel – Galvanised	100 m	11 mm	6/24	120 kg

Table 5 Hawser Specification

6.3 Care of Hawser

When a new HAWSER rope is purchased ensure a one metre sample of the new rope retained in new condition (for cross reference) and a register which records specifically for each rope:

- date and place of purchase, specification and length.
- date of rope usage, weather conditions, fixing methods, span, 'let out'
- length, catenary, load allowance, maximum weight, estimated journeys, and braking systems.

A sample format shown in Table 6.

Each Flying Fox activity is to be recorded on the Flying Fox and Hawser Usage Report shown in Table 7.

It is essential that proper care is given to the Hawser, including:

- Check for broken strands which may be caused by age, abuse, or trolley wear.
- Ensure the rope is coiled and stored correctly in a dry place free of grit, grime and dirt.
- Open lay and check for rust.

Ensure rope is cleaned, inspected and lubricated before storage, after use.

Any rope (be it of any material or construction) that is suspect should be cut to short lengths to ensure that it can no longer be used.

Annually the ropes, together with all blocks and tackles, including trolleys, will require independent written certification by a registered rigger or other persons authorised by FFSAC. This may be 'logged' in the register.

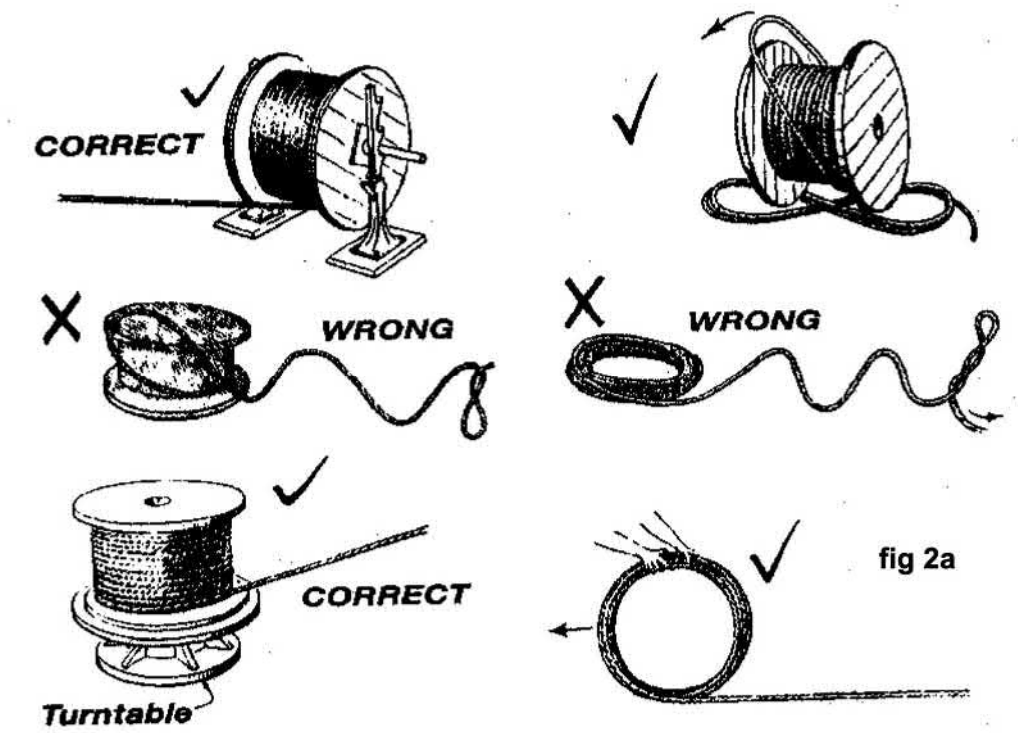


Figure 42 Uncoiling (and coiling in reverse)

6.4 Hawser End Fixings

Where any rope has an eye inserted this MUST include the correctly sized thimble and be affixed in an approved manner that allows minimal or no reduction in the capacity of the rope. ('In line' eyes will still require a thimble, and a temporary securing method).

All rope ends, other than eyes, must be finished in an approved manner, which includes swaged fixing for steel hawsers or the three (3) sets of double base clamps with thimbles as indicated in Figure 43.

Note: Bulldog clips, wire rope grips, single U-bolts are not permitted for use on Hawsers as they are unreliable and tend to damage to wire rope.

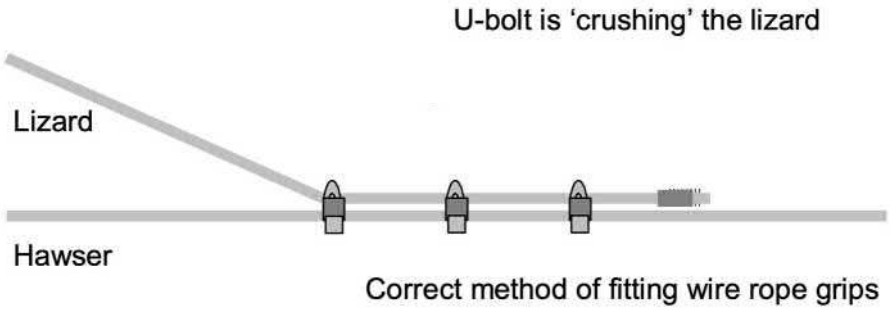


Figure 43 Double Base Clamp Wire Rope Grips

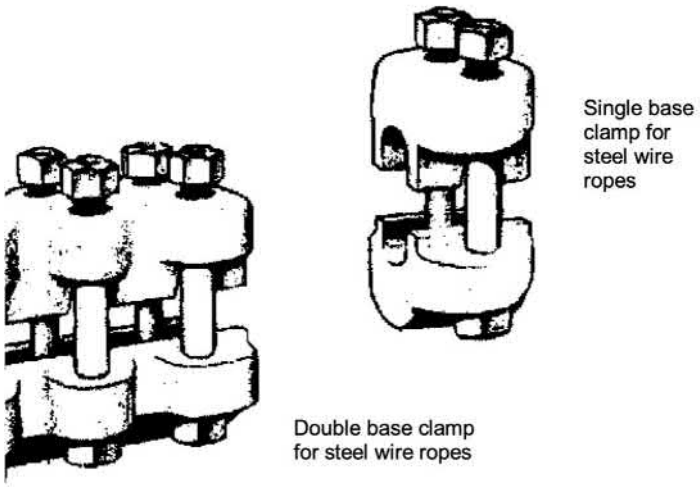


Figure 44 Double Base Clamp

TWIST is defined as S twist (left-hand lay) and Z twist (right hand lay).

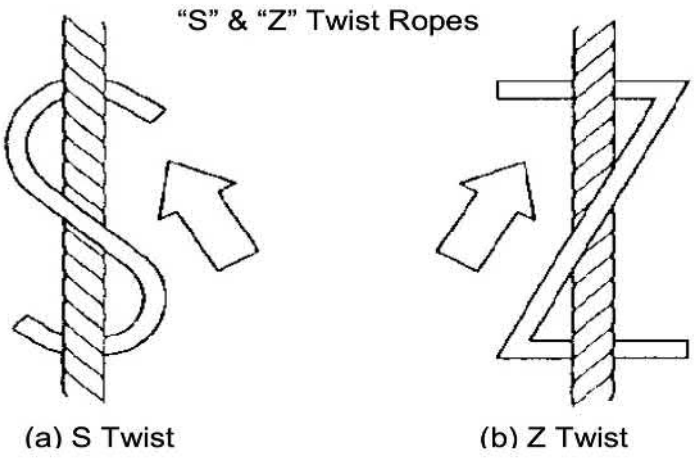


Figure 45 Wire Twist

S twist and Z twist ropes should never be coupled.

6.5 Hawser Damage

As outer wires wear and the wire rope is bent over sheaves, the fatigue will start to break them. The maximum number of broken wires in a flexible steel wire rope is 10% of the total number of wires over 8 times the diameter of the rope.

Our 'approved' minimum rope is 11mm diameter 7 /19 or 6 / 24 Seale.

For an example 7/19 wire:

Diameter 11 x 8 = 88 mm length

Wires 7 x 19 = 133

at 10% = 13.3 wires

Therefore, the total number of broken wires permitted in 88 mm is 13.

Chemical: avoid contact with any harmful agents.

Physical damage and degradation

External Wear: as evidenced by projecting broken surface fibres, unless extensive, is harmless, and may even help protect internal fibres.

Local Abrasion: caused by dragging a rope over a sharp edge under tension, may cause serious loss of strength. Serious damage to one strand or moderate damage to more than one strand, warrants rejection.

Cuts and Contusions: Cuts are caused by a rope under tension over a sharp edge, and contusions are caused by heavy mass applied to a rope. Internal and external damage may result, which may be hard to identify. Avoid the problem by good handling techniques.

Internal Wear: may result from grit off surfaces, windblown or trodden in. Salt crystals from dried out sea water also will cause wear. Signs could include excessive looseness of strands or yarns, or the presence of powdering.

Overloading: may cause permanent elongation, which can lead to rope failure at well below safety levels.

Heat: which is excessive may damage rope.

Cold; No rope should be used below -10 degrees C without reference to the manufacturer, as ice crystals can cause excessive damage.

Removal of rope from a coil: Remove enough bagging to locate end of line and if it is Z twist uncoil the rope so that it comes off the centre of the coil in an anticlockwise direction. (S twist is clockwise).

Removal of rope from a flanged reel: Place the reel on an axle and draw the rope off as the reel rotates.

Rope storage: Rope should be stored in a well ventilated, dry atmosphere, away from heat, strong light and damaging chemicals. Z twists should be coiled anticlockwise and S twists clockwise. (AS 4142.3 ropes should be chained or loosely packed in a bag). Any rope may be flaked, with alternate layers at right angles to each other.

Kinks: When there are increases or decreases in the twist of the rope, a series of turns or loops will develop in a short length. When the radius of the turn or loop is less than the diameter of the rope it is known as a kink. Tension must never be used to remove a kink. Pull the rope on either side of the kink towards the kink (increasing radius) and eventually it will become a turn, which can be rolled out. Kinks must be removed as stated or by being cut out.

	Specification	
	Identification	
Galvanised Steel		

DATE	VENUE	WEATHER	FIXING			SPAN	6A	6B	6C	LOAD	BRAKES	EST	Compiled	CHECK
			TOP	MIDDLE	BOTTOM		LET OUT CATENARY			TEST Kg	FITTED	TRIPS	by	

Table 6 Hawser Usage Log

FLYING FOX AND HAWSER USAGE REPORT										
PROPOSED CONSTRUCTION: _____										
DATE	HAWSER IDENTITY	HAWSER TYPE	SPAN	TENSION TABLES			CLIMATE	TEST kg	USAGE	EST TRIPS
				16.3A	16.3B	16.3C				
ANCHOR /FIXINGS			SHEAR LEGS	BRAKES			HAWSER HEIGHT		TENSION WITH	TOW LINE
TOP	MID	BOTTOM		No.1	No.2	No.3	ON	OFF		
ROPE GRIPS		SPEED		General Report on Operation of Fox						
TYPE	POSITION	m/sec								
LEADER		INSTRUCTOR								
				Site						
ASSESSOR		ATTENDANT		Personnel						
				Equipment						
FIRST AIDER		Group Designation		Construction						
Compiled By				Management						

Table 7 Flying Fox & Hawser Usage Report

6.6 Explanation of Flying Fox & Hawser Usage Report

Generally, this report starts at the time of the initial site inspection, the proposed design is sometimes not what is built.

HAWSER IDENTITY AND TYPE – Each Hawser should be identified, Region - Number 1 etc.

SPAN – the measured distance between the shear legs.

TENSION TABLES – Table 3Unstretched rope length, not always practical. Table 4 Required sag with no load. 16.3C Sag under load, these are derived from calculations and tables.

CLIMATE – The climatic conditions each day of use.

TEST LOAD – Each system must have a test load put on it before going into operation.

USAGE –any usage of the hawser rope should be recorded. E.g. single fox or a dual, tug-of-war.

ESTIMATED TRIPS – keeping track of how many trips (frequency) on each hawser is vital to calculate the ultimate life of the hawser.

ANCHORS/FIXINGS – The type of anchors used at each end, and the method of joining the anchor to the hawser (MID FIXING).

SHEAR LEGS – Type of shear legs used at each end of the run.

BRAKES – Type of each set of brakes used. Each system must have a minimum of two.

HAWSER ON/OFF HEIGHT – Take-off and landing ends.

TENSION WITH – Type of tensioning devices.

TOW LINE – type of tow/retrieval line used.

ROPE GRIPS – Wire generally will use Wire Rope Grips; sisal a seize whipping.

SPEED – this is the actual calculated average speed of the run.

GENERAL REPORT ON OPERATION – General comments and suggestions, difficulties and failures should be noted here.

RISK ANALYSIS – General comments on each category of perceived risk and suggested solutions.

LEADER/INSTRUCTOR ETC – The name of each person involved in the construction and operation of the fox.

GROUP DESIGNATION – The name of the event

6.7 Kernmantle Rope Types

Refer to AS 4142.3 - 1993 - FIBRE ROPES, MAN-MADE FIBRE ROPES FOR STATIC LIFE RESCUE LINES.

KERNMANTLE is a generic term derived from the German word 'Kern' for a core and 'Mantel, for a sheath, and should not be confused with any particular brand of rope.

Plaited sheath on plaited core (Figure 46) while of kernmantle construction is commonly known as 'double braid'.

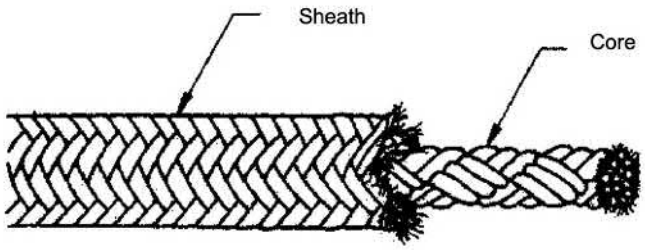


Figure 46 Plaited Sheath on Plaited Core Rope

Plaited sheath on parallel or twisted core (Figure 47 and Figure 48) are commonly known as 'kernmantle' rope.

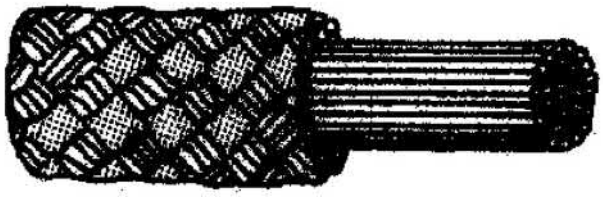


Figure 47 Plaited Sheath on Parallel Core Rope

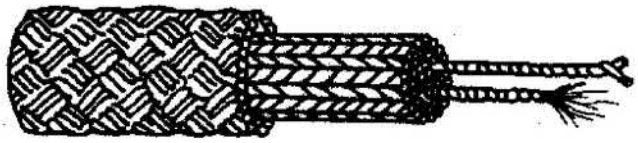


Figure 48 Plaited Sheath on Twisted Core Rope

The construction and performance criteria of kernmantle ropes are as per AS 4142.3 - 1993.

6.8 Trolleys

Only commercially manufactured trolleys for flying fox/zip lines to recognised Australian or International Standards are acceptable to use for Scout Association of Australia, NSW Branch. The trolley must have no single points of failure, i.e. a wheel axel breaking, resulting in the participant falling. There must always be a backup incorporated, i.e. with a carabiner attached to the trolley which is over the hawser or a bridging wire, which in the case of trolley failure in any mode will prevent the passenger falling. The manufacturers User Instructions must be followed in all regards.

Approved examples of acceptable trolleys are illustrated in Figure 49.

Figure 49 Trolleys

The block should have capacity for dual end towing lines, as in certain designs it may be necessary to have the ability to move the load either way, independent of gravity. A minimum of one tow point is mandatory.

Snatch blocks are permitted where the design is such that it is impossible for the snatch to become undone whilst under load. **

Your trainer or FFSAC will have access to the latest information on design parameters and details on cost effective equipment.

For maximum performance and minimum damage to the trolley should be correctly lubricated.

Commercially manufactured equipment that is rated for use as a Flying Fox and is approved by FFSAC may be used.

** Snatch blocks allow for the removal of the trolley from the hawser, so that when the structure is unattended, the flying fox is rendered inoperative.

6.9 Droppers

The harness needs to be attached to the block at a length that precludes any possibility of a passenger contacting the hawser or running gear. The only exception is where an operator needs to check the hawser in situ.

We should aim to have all feet positions on embarking and disembarking at a constant level.

Practically, the most suitable dropper consists of 11mm diameter static kernmantle rope set up as per attached image. It must be set up so the Safety Back up Rope is long enough to enable the lightest participant to launch safely. The participant support rope (from the trolley to the Petzl RIG/GriGri) is infinitely adjustable. If a rescue is required, the Safety Back up Rope can be disconnected, and the participant can be safely lower to the ground. The Running End of the System must have a stopper know installed close the end of the rope and be long enough to allow the lightest participant to be lowered to the ground. Depending on the site ensure there is no risk of the lowering rope snagging on obstacles under the hawser during the run.

Commercially manufactured equipment that is rated for use as a Flying Fox and is approved by FFSAC may be used.

A comforter handle may be provided as this will assist the passenger in avoiding twisting in travel and will also increase the passenger perception of safety. Such a handle is recommended to be made of looped tape or 12mm sisal rope, again using chain as an extender. Where there is a dragging towline, a shock-absorber must be included in the towline.

At all times the weight must be borne by the harness, not the comforter, and every effort must be made to ensure the dynamic load does not vary by ‘bouncing’ comforter to harness.

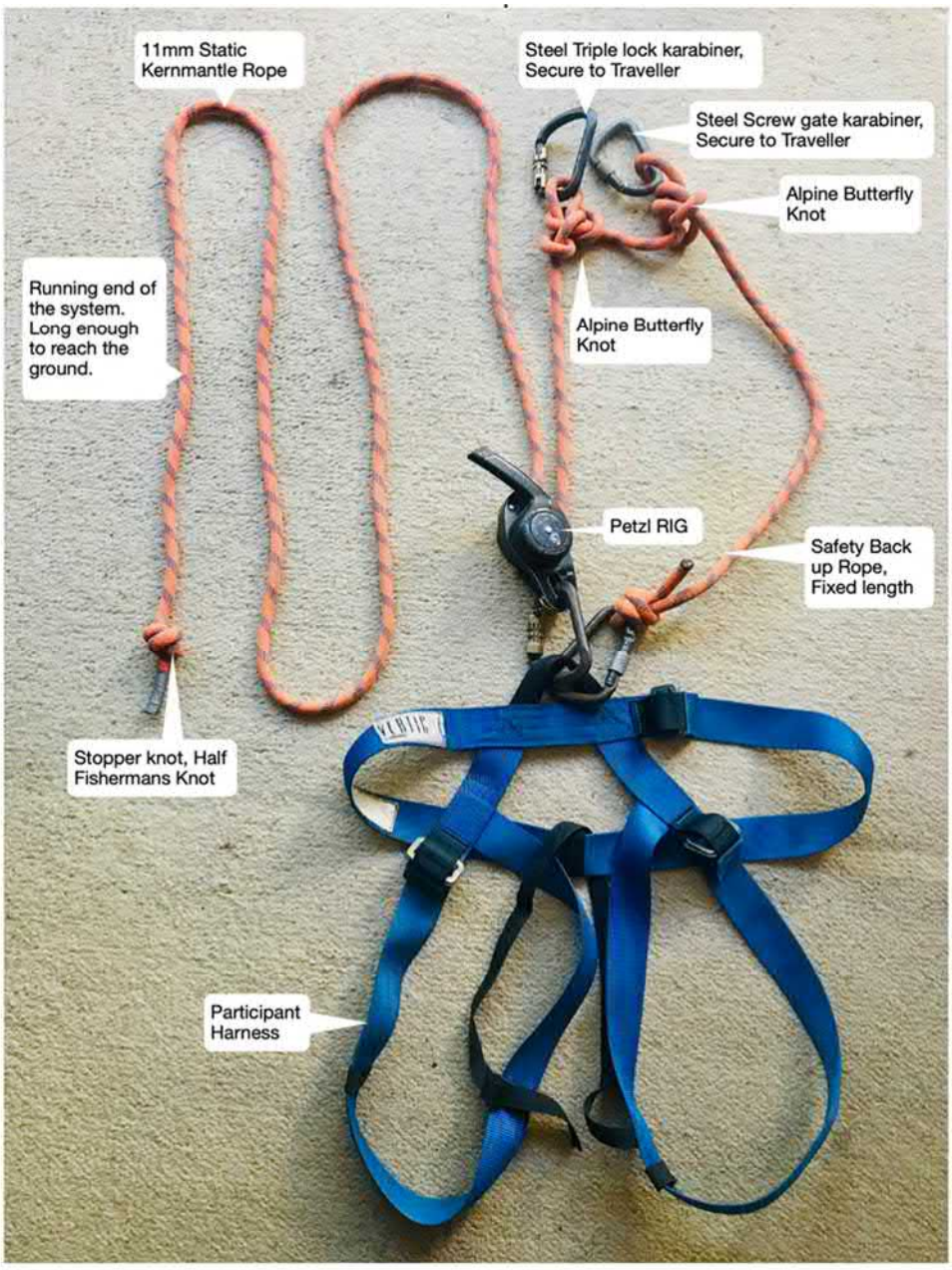


Figure 50 Petzl RIG & Kernmantle Rope Dropper

6.10 Pickets and Spars

Spars: These are used to fabricate the shear legs.

They must be sound, and the butt must be a minimum of 125 mm (5 inches), irrespective of length.

Pickets: As a minimum, these shall be metal 'star' pickets (or similar) of a minimum 900 mm in length.

Where any installed picket is exposed in such a way that it may cause injury, the picket should be bagged or capped to prevent such injury.

6.11 Ropes

All cordage herein referred shall be natural fibre, unless otherwise specified.

This will include:	**MINIMUM DIAMETER**
Shear leg lashings	12 mm
Shear leg guys	12 mm
Sling (as defined in glossary) - tensioning only **	18 mm
Slings - all other Slings including the defined glossary version where the load will be borne by it **	Same as hawser
Tow line (assuming no brake attachment)	6 mm
Tow line (assuming brake)	12 mm or 7 mm static kernmantle
Block and tackle rope (block to match)	12 mm
'In line' static brake rope	12 mm

Note:

1) In using a knot to complete an 'in line' eye in natural fibre ropes, a seized whipping would be appropriate. 6 mm binding will suffice, and the whipping overall length should be, at least, the diameter of the rope.

2) If the hawser is of a 'flow through' design, a prussik knot (or similar) should be used to lizard the block and tackle. This cordage should be 12mm for tensioning only and must not be used to carry direct human load.

All rope should be fully inspected prior to use. Only use rope of good condition. Where doubt may exist during operation, check again.

** Where Slings are used these should not be spliced, but should be made by forming the length of rope into a loop with a Double Fisherman's Knot with tails tucked in.

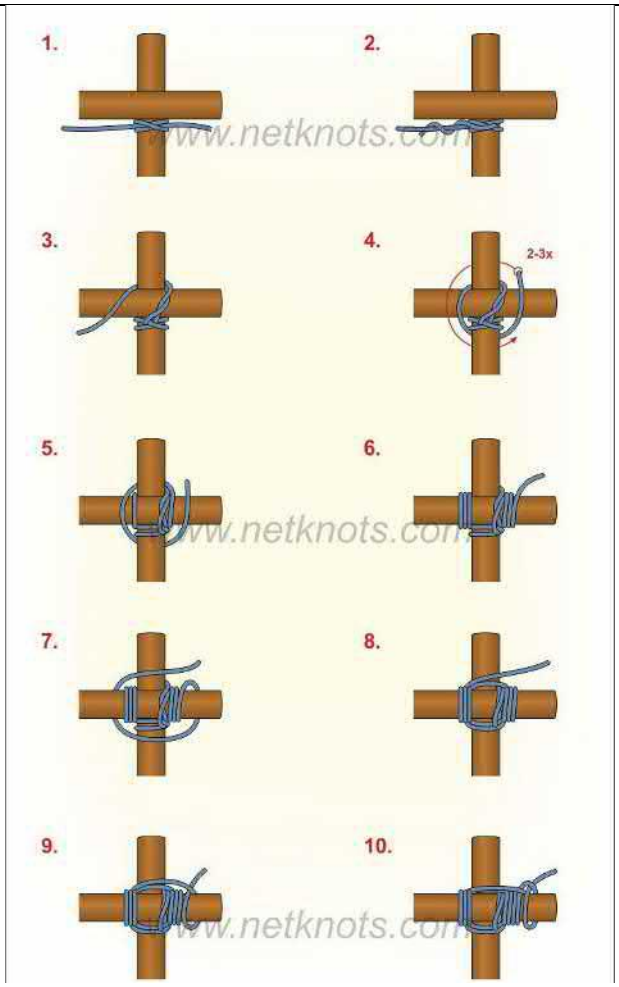
6.12 Knots & Lashings

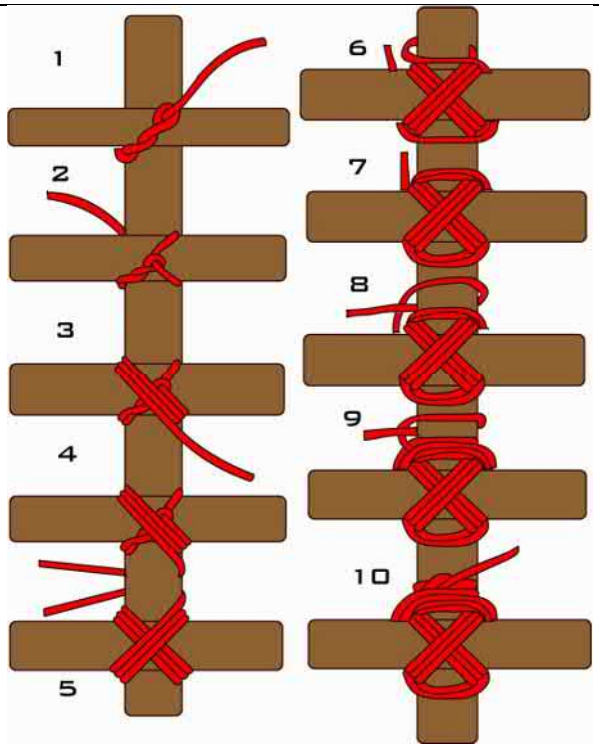
The following listed knots and lashings form a solid basis to enable the construction and operation of a Scout approved Flying Fox. As detailed explanations of how to tie the knots are available from several publications and on the internet, it is not intended to explain how to tie the knots in this manual. Following are a picture and explanation of the likely application of each knot or lashing in the construction of either a rope or steel wire Flying Fox.

	Reef Knot The Reef Knot is used to join the two ends of the same sized rope. (Difficult to undo after load has been applied, particularly when using Sisal rope)
	Figure of Eight Knot The Figure of Eight Knot is used as a stopper knot at the end of a line.
	Figure of Eight on the Bight The Double Figure of Eight is a very secure knot used to form an anchor loop in the end of a rope. It can be used as the end of a towing line or brake line where attached to a karabiner. Double Figure of Eight Knots can also be used very effectively to join rope (especially heavier lines). (Can be difficult to undo after a load has been applied)

	Double Figure of Eight (Rethreaded) As above but used to join two ropes of equal size together. (Can be difficult to undo after a load has been applied)
	Double Fisherman's Knot The Double Fisherman's Knot is used to join two ropes of equal size together. Useful when joining two shorter lengths of 7mm kernmantle brake line. (Can be difficult to undo after a load has been applied)
	Double Sheet Bend The Double Sheet Bend is a good non slip knot used to join two ropes of unequal size together. (Generally, very easy to undo after a load has been applied)
	Clove Hitch The Clove Hitch is used as an anchor to either a spar or rope. (It is just two half hitches, and can be strengthened by the addition of extra half hitches)

	Round Turn & Two Half Hitches The Round Turn and Two Half Hitches is used as an anchor to a solid spar or tree. It does not reduce the load carrying capacity of the rope. It can be tied when the standing part of the line is already under load.
	Rolling Hitch The Rolling Hitch allows you to slide the knot up and down the running part of the rope. It can be used on tent ropes and as the adjustable end of a guy rope for the shear legs, in fact anywhere you want to be able to loosen or tighten a rope quickly.
	Tape Knot The Tape Knot is used to join two lengths of webbing and is essentially a flattened version of a rethreaded Double Thumb Knot. (Used to join the webbing straps behind the back when using a chest harness on smaller children.
	Alpine Butterfly The Alpine Butterfly knot is the classic midline loop. It allows a loop to be placed anywhere along the rope other than at the ends. The simplicity of this knot also allows it to be undone readily despite relative high tension placed upon it. (Used as a mid-line anchor point in a hauling line.)

	Prussic Knot Where-ever and when-ever a rope needs to be fixed to another rope or rail the Prussic Knot will perform excellently. Will not slip along the rope or spar if there is a load applied. Also used as the start of a lashing instead of a Clove Hitch. (See “Prussic Square Lashing”.)
	Square Lashing The traditional Square Lashing is used to lash poles wherever the intersecting poles are somewhere near a right angle. It is started with a clove hitch under the cross member to which the load is applied but relies on the tightness of the lashing coils and the finishing frapping turns for its success. (Use for intersecting pole lashings other than the main top hawser support in a shear leg “H” frame.) See also “Prussic Square Lashing”.

	Prussic Square Lashing The Prussic Square Lashing is like the traditional Square Lashing, except that it is started with a Prussic Knot instead of a Clove Hitch. It will not slip, and experience has demonstrated towers and working frames can be constructed and used as desired without any loosening of the lashings. Remember the secret to success is to tie adequate turns in the starting Prussic Knot to prevent slippage. However, it is of no advantage when used other than in situations where the load is along the line of the pole where the starting Prussic Knot is tied. (Use for the lashings at the main horizontal top member of the shear legs on an “H” frame shear leg frame.)
	Diagonal Lashing The Diagonal Lashing can be used where the poles intersect at any angle, and it does not matter which pole the load is applied to. (Use to lash the intersecting cross brace on a dual flying fox “H” frame shear leg.) Better picture

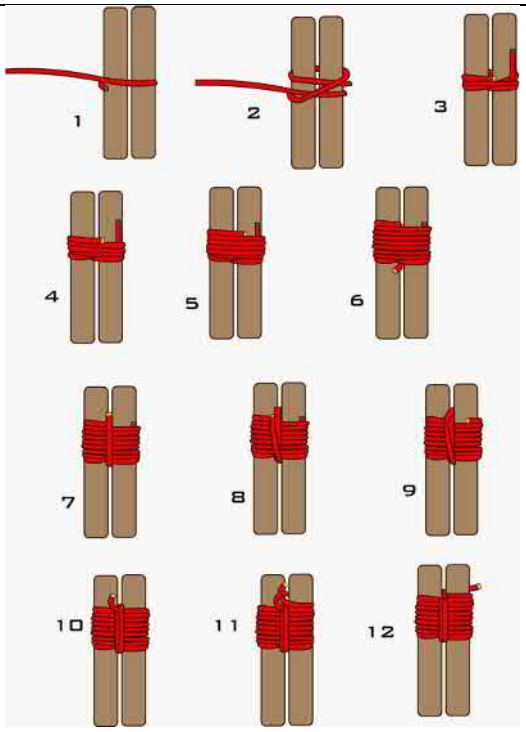
	Shear Lashing The shear Lashing can be used where the poles intersect at any angle, and it does not matter which pole the load is applied to. (Use to lash the top of an “A” frame shear legs on a single flying fox.)
	Banjo Lashing The Banjo Lashing is used to link a pair of poles or star pickets and is used to restrain the anchor log of a flying fox log and picket anchor.

Figure 51 Key Flying Fox Knots and Lashings

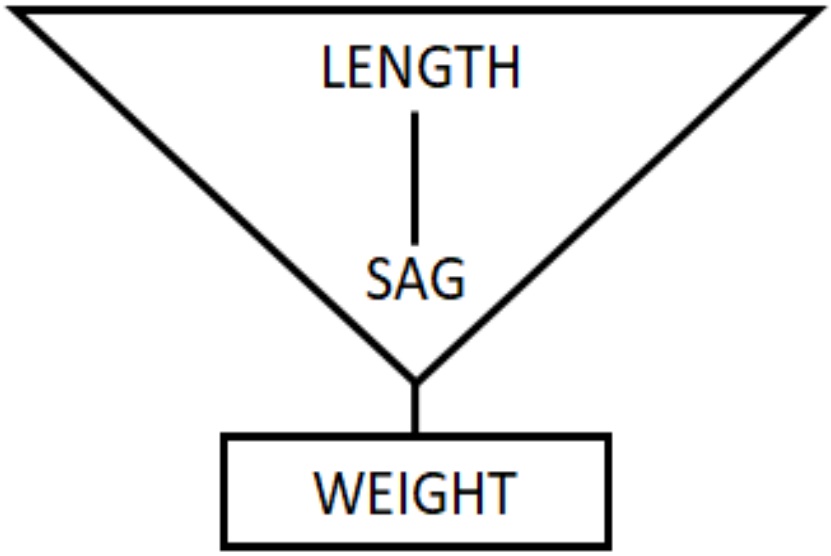


Figure 52 Rule of Thumb Rope Sizing

(LENGTH (m) x WEIGHT (kg)) / 4 x SAG (m) = TENSION (kg) - to be equated to LOAD

FOR SISAL (new) Diameter (mm) x Diameter = LOAD (kg)

FOR STEEL 8 x Diameter x Diameter = LOAD (kg)

For example, a suitable diameter rope to hang an 80 kg load over a 20 metre span with 5% sag (0.05 x 20 = 1 m).

(20m x 80kg) / (4x1m) = 400 kg tension (this is the 'load')

A suitable sisal rope diameter would then be:

D2 (squared) = 400, 20 x 20 = 400 i.e. 20 mm is suitable diameter in this situation.

A suitable steel rope diameter would be:

8 x D2 (squared) = 400, D2 = 400/8 = 7.1 mm (i.e. 8 mm [round up] is suitable

The above exercise is included in this manual to highlight what is generally accepted as a 'COMMON' 'RULE OF THUMB' used to approximate the required rope, parameter.

The specific requirements in this manual taken precedence over these "Common Rule of Thumb" examples.

6.13 Block and Tackle

This should consist of one double and one triple sheaved metal block to suit 12 mm diameter natural fibre rope. This will be set up to give a 6:1 purchase ratio.

The rope must sit within the sheave groove.

The block and tackle are designed for tensioning the system, and whilst it can form an integral part of the load carrying system, this is illegal, but it MAY be left 'in line', un-tensioned, as an emergency back-up.

The 'hooks' on these blocks are preferred to be 'eyes', but at worst 'gated eyes' (as defined, and being the same as gated hooks) may be used. Open hooks, moussed or otherwise, are banned.

Like all mechanical things, they perform best when correctly lubricated.

6.14 Personal Protection Equipment

6.14.1 Harnesses

At minimum it must be a correctly fitting harness (mountaineering, abseil or gym style) that the occupant can't fall out of.

Bosun's chairs and Tee Bar Handles are no longer approved under Australian standards.

The harness must be set up so that the occupant has no possibility of physically fouling the hawser or trolley.

Up to about nine years of age, and particularly boys, the hips of our youth are not developed sufficiently enough that in the event they inverted during travel they would not be retained by a climbing or gym harness alone, then it is mandatory that an additional chest harness or full body harness be used.

Do not just set an age at which these will be used, as the younger ones will soon realise this, and you will be told less than the truth. Each child differs, so check each child, and if in doubt, use a chest harness.

6.14.2 Helmets

All persons travelling on a flying fox must be wearing a correctly fitted, hard shell, four point attachment helmet. An example of permitted helmets includes abseil styles.

During erection of the fox, the site is to be considered a construction zone. All personnel helping will wear a helmet. During the operation of the fox, all personnel will wear a helmet.

6.15 Tools and Accessories

These will include:

- sacking for trees and saddle in crutch of shear legs.
- ‘star’ or similar picket driver.
- spade or trenching tool.
- suitable knife.
- extension ladder or step ladder (If tree used for shear leg and/or for dismounting in the landing area).
- caving ladder and throwing lines (if required for safe mounting).
- safety lines (if required by the design).
- tail rope(s) (to extend in-line brakes with a safety override).
- bricklayer’s line or similar non elastic string.
- Leather gloves and rags (for steel rope)
- Spare thimbles of appropriate size
- Tape measure to cover maximum span (100 metres).
- Long gauges (lightweight) and nails, to measure catenary.
- Correct lubricant for mechanicals.
- and other gear mentioned in this manual.

6.16 Gear Inspections

6.16.1 General

All fibre pieces of equipment include slings, ropes and harnesses that support human load (either directly or indirectly) have a rated maximum life, refer to the manufacturer's guidelines for details.

The rated life of metal items (hawser, turnbuckles, bow shackles, thimbles, star pickets, karabiners, chain block or 'Turfer', double base clamps, Lizard) is less definitive. It is advised for the Flying Fox Advanced Guide (Supervisor) the personally check each piece of equipment (fibre & metal) for signs of 'wear and tear' or damage before or as the Flying Fox is being constructed and when it is being dismantled. Any faulty or damaged equipment to be removed from service and disposed of.

For equipment care, maintenance and inspection requirements follow the manufacturers recommendations and guidelines. It is recommended to keep a copy of these with the gear.

6.16.2 Wire rope inspection.

Wire rope must be inspected in accordance with the manufactures recommended standards and guidelines.

As a general guide only on rope inspections refer to the following wire sling inspection guide. The same principles apply to the hawser and lizard.

WIRE ROPE SLING/CHOKER INSPECTION GUIDELINES

How Often Should A Wire Rope Sling/Choker Be Inspected?

- Pre-Use:
  - The equipment should be inspected prior to use
  - Note: If the equipment becomes damaged during use, it should be removed from service and destroyed immediately
- Annually:
  - All wire rope slings/chokers shall undergo an annual inspection by a competent person
    - The annual inspection shall include the tagging of the equipment with a "Yearly Color"

Who Can Inspect The Equipment?

- A Competent Person
  - An OSHA "competent person" is defined as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them" [29 CFR 1926.32(f)].
  - The employer must assign the inspection duties to a person who they deem to be a "competent person". This will be someone who is capable of reading, understanding, and using this guide. This person must also have the authority to remove from service, equipment that he/she deems unsafe and/or not fit for use.

What Should The Competent Person Look For?

- According to ASME B30.9
  - Missing or illegible sling information (missing tag)
  - Broken Wires:
    - For strand-laid and single-part slings, 10 randomly distributed broken wires in one rope lay, or 5 broken wires in one strand in one rope lay.
    - For Cable-Laid Slings, 20 broken wires per lay.
    - For less than eight-part braided slings, 20 broken wires per braid.
    - For eight-part or more than eight braided slings, 40 broken wires per braid.
  - Severe localized abrasion or scraping.
  - Kinking, crushing, "bird caging", or any other damage resulting in damage to the rope structure.
  - Evidence of heat damage.
  - End attachments that are cracked, deformed, or worn to the extent that the strength of the sling is substantially affected.
  - Severe corrosion of the rope, end attachments, or fittings.
  - Other conditions, including visible damage, that cause doubt as to the continued use of the sling.

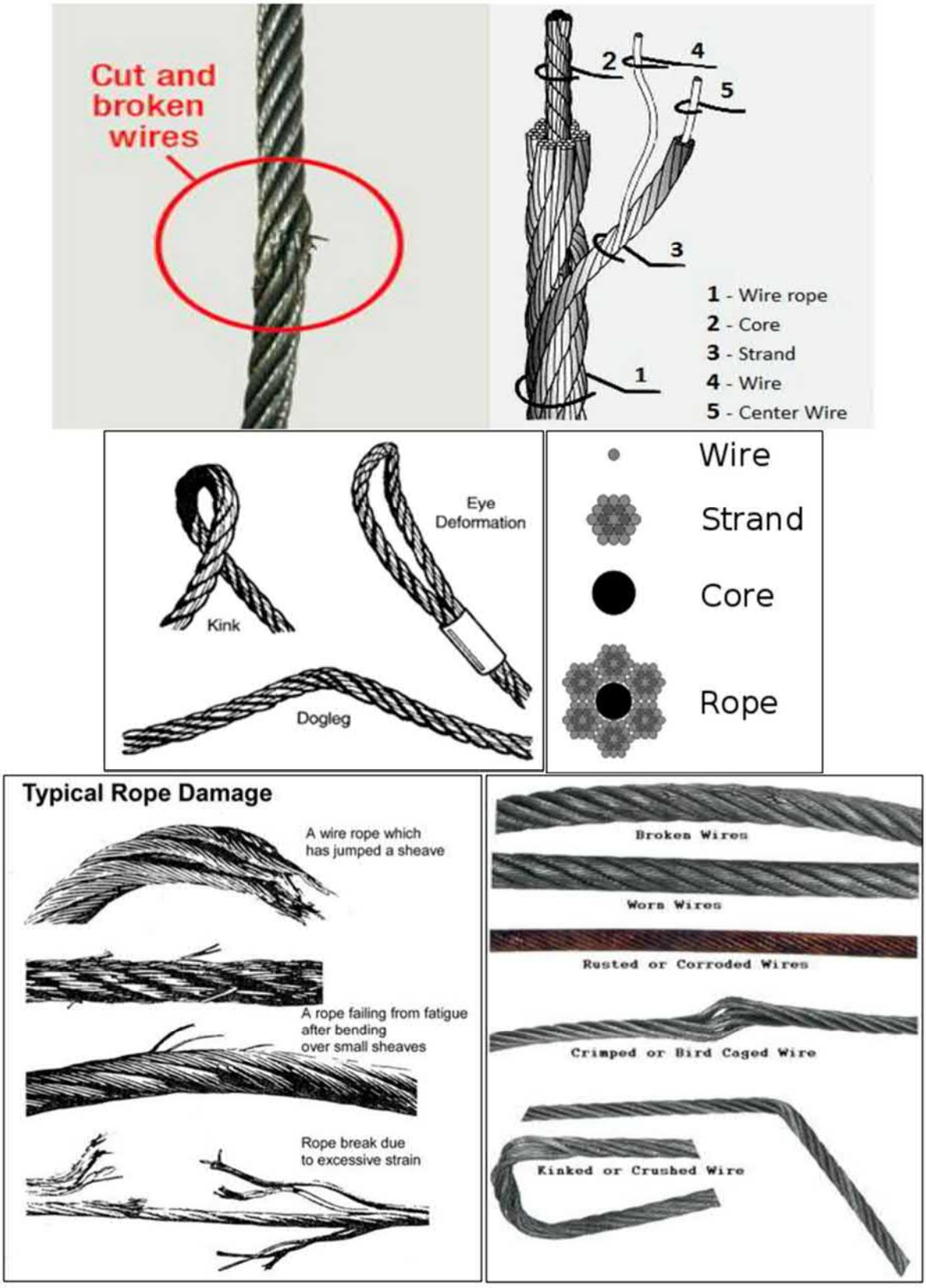


Figure 53 Wire Rope Inspection

6.16.3 Kernmantle Rope Inspection.

See below the Petzl Kernmantle rope inspection guide and when to watch the rope, cut the rope or dispose of the rope. When inspecting kernmantle ropes the entire length of the rope should be inspected. Modern kernmantle rope has a tracer tape in its core that states the date of manufacture and manufacturer information. This can be helpful when determining rope life.

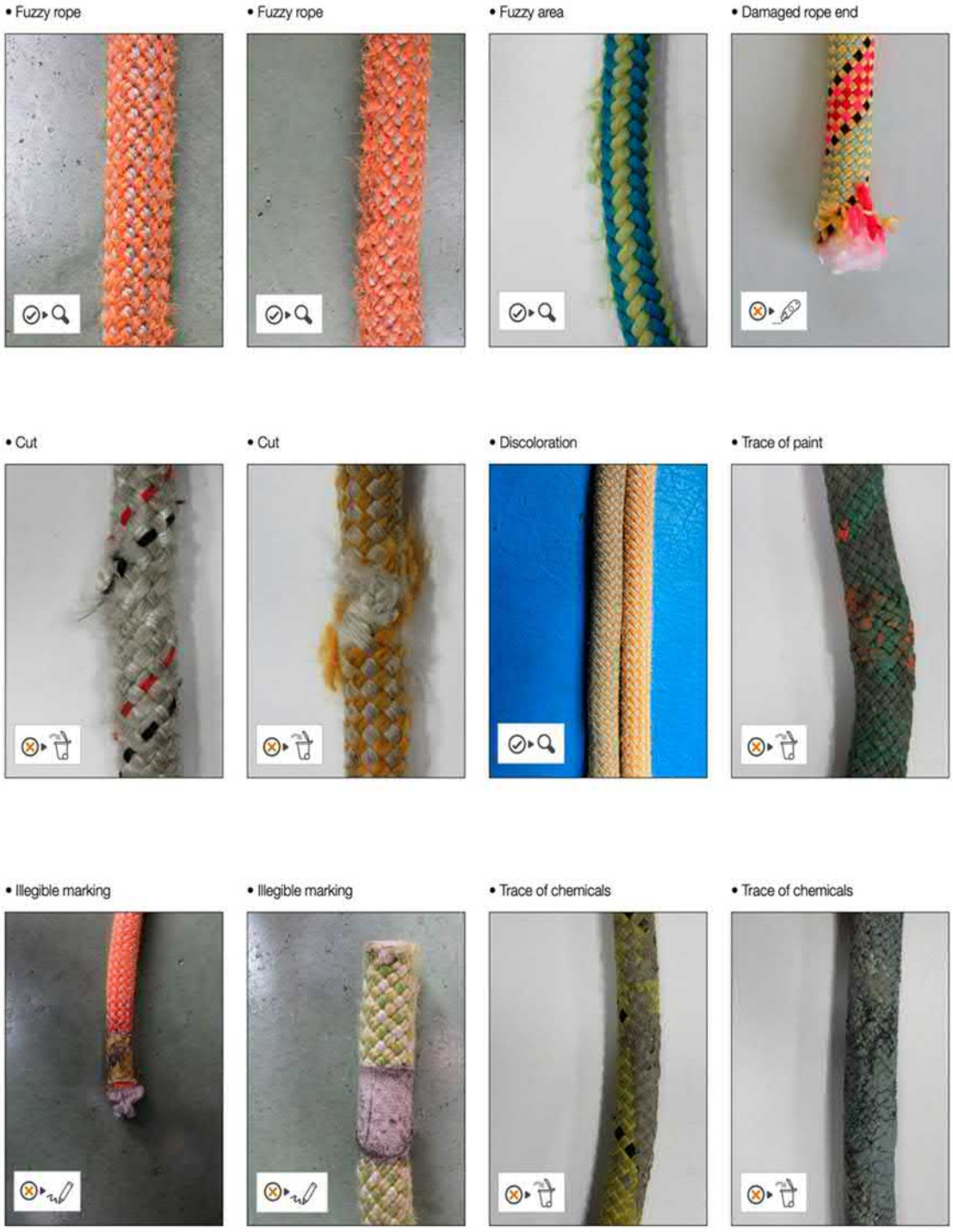


Figure 54 Kernmantle Rope Inspection

Natural fibre rope inspection (and Kernmantle rope)
Rope must be inspected in accordance with the manufactures recommended standards and guidelines.

As a general guide only rope inspections can be carried out using the following checklist.

Tyson's Ships Riggers Limited

For your guidance, we have included an inspection checklist, as below.

INSPECTION CHECK LIST

CONDITION	DISCARD
Rope diameter reduced by abrasion	√
3 strand construction by 10%	√
8 strand construction by 25%	√
12 strand construction by 25%	√
Braidline (Double Braid construction) Sheath by 50%	√
Circular Braid construction sheath by 100%	√
CUT STRANDS	
3 strand one or more adjacent strand cuts	√
8 strand one or more adjacent strand cuts	√
12 strand two or more adjacent strand cuts	√
Braidline (Double Braid) three or more adjacent strands	√
Superline any visible damage to core element	√
INCONSISTANT DIAMETER	
Localised reduction in diameter	√
Localised increases in diameter	√
INCONSISTANT FLEXABILITY	
Localised areas of stiffness	√
HEAT FUSION	
Extended areas of heat fusion	√
DISCOLOURATION	
Areas caused by Chemical Contamination	√

Figure 55 Natural fibre Rope Inspection

6.16.4 Bow Shackles, D shackles and Turn Buckles

It is highly unlikely that bow shackles, D shackles and turn buckles will be subject to loads that will cause damage to them in 'normal' operation of the Scout Flying Fox. Below are images of damage that can occur on bow shackles and would require immediate removal from service and/ or disposal. The same principles apply to turn buckles and a lesser extent thimbles.

Figure 56 Shackle Inspection

6.16.5 Double Base Clamps

The main cause of damage to double base clamps is that excessive load is applied to nut which strips the thread on the U bolt. This is evident when tightening the nut and it will not tension. Another way the double base clamp can be damaged is the U bolt can be distorted. If this happens it will be difficult to assemble to double base clamp. If either of the above happens the double base clamp should immediately be removed from service and disposed of.

6.16.6 Harnesses

Harnesses must be inspected in accordance with the manufactures recommended standards and guidelines. The life of a harness must also be in accordance with the manufacturer's recommendations.

As a general guide only inspect your harness for signs of damage and wear before and after each use. It is vitally important that your harness be in good condition. A damaged harness must be retired immediately.

Retire a harness immediately if:

- There is any kind of rip or hole in the webbing.
- The webbing is burnt, singed, or melted.
- There are any torn threads, or heavy abrasion to the webbing.
- Bar tacks are abraded or showing wear.
- One of the buckles is cracked, corroded, has a burr, or is damaged or deformed in any way.
- The webbing is faded from exposure to ultraviolet light.

If a harness has been involved in a severe fall, but is not obviously damaged, it still may be ready for retirement. If you have any doubts about the dependability of your harness, retire it and get a new one.

Anytime you retire a piece of gear, destroy it to prevent future use.

7.0 Operation and Logistics

7.1 General

Any Flying Fox Activity using a Temporary Structure must be under the control/supervision of a Guide (Operations and Construction) or above.

In addition to at least one Guide (Operations and Construction) in charge of the activity, the following *minimum level of support* for the flying fox to run the activity is recommended:

At least two Trained Participant's or above

At least two Safe Participants (which can be recruited from Scout Leaders available on the activity) or above

Where youth members are participating in the activity, an Adult Leader must be present. Where more than six youth members are present there must be adequate supervision for all stages of the Flying Fox activity to ensure its safe operation for all participants and operators.

Parent permission requirements of the Scout Activity Notification procedures must be adhered to. Where the flying fox is an activity on a camp notification of a flying fox activity should be incorporated on the camp registration forms.

Where `non-Scouts' or members of the public are likely to participate, the activity must be under the direct control of a Guide, and parent permission obtained for all youth participants. This requirement may only be varied upon the authorisation of the Regional Coordinator (Flying Fox).

Responsibility for the operation of a Flying Fox always lies with a 'qualified' Guide. Should Nature call, you require sustenance, or you require a rest then the activity must be halted. When you are unable to directly supervise the operation of a flying fox for which you are responsible, you MUST ensure no one can use the structure in your absence. The removal of the trolley (if of a secure snatch block design) is simplest, with the remaining structure being left in the care of someone with a Certificate of Adult Leadership.

Where the qualified person in charge of the erection is satisfied that safety is not compromised, the assistance of unqualified persons and youth is permitted in the erection.

7.2 Fox Team

7.2.1 Leadership

Each area must be under the direct control/supervision of an appropriately qualified Flying Fox Leader.

Construction - Temporary Structures

When constructing a Temporary Flying Fox, each construction area must be under the control/supervision of a Fox Advanced Guide or above.

Operation - Harnessing Area

must be under the control/supervision of a Trained Participant or above with the assistance of at least one Fox Helper or above.

Operation - Top Take-off area - Permanent Structure

must be under the control/supervision of a Guide or above with the assistance of at least one Trained Participant or above.

Operation - Top Take-off area - Temporary Structure

must be under the control/supervision of a Fox Advanced Guide or above with the assistance of at least one Trained Participant or above.

Operation - Bottom Take-off area - Permanent Structure

Controls fox operation always must be under the control/supervision of a Guide or above with the assistance of at least one Fox Helper or above.

Operation – Bottom Take-off area - Temporary Structure

Controls fox operation always must be under the control/supervision of a Fox Advanced Guide or above with the assistance of at least one Fox helper or above.

7.2.2 Roles

Activity Coordinator

Overall control and responsibility for the Flying Fox Activity

Interface with the camp organisers where part of a camp activity

Responsible that the correct planning and procedures are being followed

Harnessing Leader

Control and supervision of the Harnessing area

Supervision of Harnessing Assistants

Correctly fit harnesses and safety helmets to all participants

Harnessing Assistant

Assist Harnessing Leader to assist correctly fitting harnesses and safety helmets to all participants

Top Take-off Leader

Supervision of the Top Take-off Area and Top Take-off Assistants

Final check harnesses and helmets are correctly fitted

Attach participants to Trolley

Responsible for Ready signal from Top Take-off Area

Top Take-off Assistants

Check harnesses and helmets are correctly fitted

Attach safety line to participants

Supervise waiting participants

Bottom Take-off Leader

Supervision of the Landing Area and Landing Assistants

Responsible for Ready signal from Landing Area

Detach participants from Trolley

Bottom Take-off Assistant

Assist Landing leader to detach participants

Ensure participants exit Landing Area after detachment

First Aiders

All Flying Fox Leaders are required to keep First Aid qualifications current

Assist with any injuries

Complete Incident reports for any Injuries

7.3 Fox Construction

7.3.1 Fox Set-up

Safety

Safety helmets to be worn before any constructions or hawsers are raised off the ground. The wearing of a correctly fitting, four point attachment, safety helmet (e.g. climbing helmet) is required for participants in Flying Fox activities. Industrial type helmets may be worn in situations where the participant is not at risk of falling (e.g. during Flying Fox construction).

Safety harnesses and safety lines must be used whenever working above one meter or within two meters of any drop-off point

Site Selection

- Site selection will denote what gear will be needed.
- Identify Anchor point locations and select types of anchors to be used.
- Work out the span of the Fox
- Mark out work zone
- Work out the heights of the Shear Legs/Towers
- Identify Shear Leg/Tower locations - minimum distance from the anchor must be at least twice the height of the cross spar
- Scaffolding Towers should be set up prior to the construction of the Flying Fox
- Identify suitable braking options
- Calculate the required catenary
- Identify a suitable location for Harnessing
- Identify pathways for participants

Allocate Equipment

- Transport required equipment to each construction location
- Anchor points
- Set up top and bottom anchors
- Shear Legs/Towers
- Construct selected Shear Legs or Towers
- Align Shear Legs/Towers between anchor points
- Connect guy ropes to Shear Legs/Towers
- Attach return line pulleys to ends of cross spar on Top Shear Leg/Tower
- Run out Return Line through pulleys on top tower
- Connect brake bungee pulley to cross spar on bottom tower
- Drive in pickets for guy ropes

Hawsers

- Lay out Hawsers between anchor points (prior to raising Shear Legs/Towers.)
- Secure hessian bagging to cross spars on top and bottom towers
- Secure hawsers to towers so the hawser stays over the bagging
- Secure hawsers to top anchors
- Fit brake blocks/shackles to hawsers

Raise Top Tower

- Safety helmets on
- Harnesses and safety lines if working near drop offs
- Lift tower into place
- Use a Gin Pole if over 5m tall (refer below)
- Tie off guy ropes
- Check cross spar is level (adjust if required)
- Secure base of tower to ground

Raise Bottom Tower

- Safety helmets on
- Lift tower into place
- Tie off guy ropes
- Check cross spar is level (adjust if required)
- Secure base of tower to ground

Raise and Tension Hawsers

- Attach hawser fixing hardware to bottom anchor
- Take up slack in hawser and attach lizard to hawser as close to tower as possible
- Tighten fitting to correct tension

Set-up Tensioning Device at Bottom Anchor

- Tension each hawser to the correct catenary
- Check all equipment is correctly moussed

Braking Systems

- Complete set up of braking systems
- Minimum of two separate braking systems required

Set-up Top Take Off Area

- Any Platforms utilised for attaching participants to the trolley must be secured in a manner to prevent unsafe movement
- Safety lines must be provided and used for team members operating the Top Take off point
- Safety lines must be provided and used to transfer passengers to or from the top take-off point
- Fencing/gates should be set up to prevent non team member access to the top take-off point until called.

- Attach Trolleys

Set-up Fencing

- All running areas should be clearly fenced off to prevent access during operation
- Pathways should be clearly identified and marked if appropriate to prevent accessing fenced areas
- Gateways should be placed at appropriate locations for participant access / exit and should be able to be closed off when system not in operation

Set up Harness Area

- Ensure harnessing team have appropriate protection from the elements. E.g. Gazebo
- Refer to 6.6 for Participant Briefing requirements
- Adequate seating for harnessing team should be provided
- A Water station should be considered for the use of Team Members and Participants
- Required safety equipment should be close at hand

Pre-start Safety Check

- Complete checklist to be completed as per Figure 59
- Work from one end to the other, checking all areas

System Load Test

Prior to running any human load, the entire structure should be tested and reviewed.

All the equipment we have recommended has adequate capacity, well within the limits of the midpoint loads permitted, but the safety of your design must be tested, and retested.

The Activity Coordinator controls and is responsible for, the continuing safety review whilst the flying fox is operational.

- Anchorage and securing knots are best reviewed under load.
- Rope integrity is best checked when no load is applied.
- Entire system must be Load Tested prior to operation
- Attach a dead weight of twice the maximum imposed load (250kg) to each trolley and run down each hawser.
- Static Test. One to three ropes looped over the hawser or temporary ropes attached to trolley. Adult team members (combined weight of approximately 250kg) hang onto ropes and raise their legs just off the ground. Members apply movement to the hawser while they are suspended just off the ground.
- If there is any doubt, or if there is any sign of weakness in the structure, it must be corrected, or the activity abandoned.
- Re-check system/constructions at completion of load test

System Run Test

- Attach trolleys.
- Tie off Return Line to Shear Legs/Tower.
- Hook up a member of the Flying Fox team to the trolley.
- Take the weight on the Hawser.
- Control the descent of the trolley by friction turns around the bottom spar or other spar which will not be unstable by using it in this way.
- Control descent with a stop at about every 5 meters.
- Once the halfway point has been reached then the return rope can be released for free travel along the rest of the run
- All the equipment we have recommended has adequate capacity, well within the limits of the mid-point loads permitted, but the safety of your design must be tested, and retested.

7.3.2 Dismantling

Safety

- Safety helmets to be worn until any constructions have been lowered to ground level
- Safety harnesses and safety lines to be used whenever working above one meter or within two meters of any drop-off point

Pack-up Inspection

All equipment should be inspected during the dismantling stage. Faulty or damaged equipment should be isolated and removed from use.

- Lower Hawsers
- Lower Shear Legs/Towers
- Release Hawsers from Anchors
- Roll up hawsers
- Dismantle Shear Legs/Towers
- Dismantle Anchors
- Dismantle Fencing
- Pack-up Harnessing area

Pack away all equipment for appropriate storage

7.3.3 Equipment Storage

For the safety of Flying Fox Team Members and participants, the integrity of all equipment used must be accountable.

- Usage logs should be kept up to date and stored with the equipment.
- All equipment should be securely stored and locked away to prevent unauthorised access or usage.
- All equipment should be stored in a secure and dry location out of direct sunlight.
- Hawsers need to be cleaned and dried prior to storage
- All ropes to be cleaned and dried before storage

7.4 Communications

7.4.1 Team Briefing

A team briefing should be conducted prior to any running period and should cover as a minimum:

- Assign roles
- Safety talk to all team members
- Pre-Start system check
- Organise regular Safety Checks
- Organise welfare rotation and refreshments
- Communicate session timings and breaks
- Record any equipment issues during construction
- Communicate any changes to standard set-up
- Review of Operating Signals

7.4.2 Participant Briefing

A participant briefing shall be on clear display at the Harnessing area or verbally provided to all participants by a member of the Harnessing Team

The participants briefing should cover such items as:

- Keep out of fenced area
- Form one line at clearly marked point
- Harness fitting supervision by Flying Fox team members
- Once Harnessed, move to Top Take-off area
- No access to Top platform until advised

- Only one participant allowed in Top Take-off area at a time
- When released at bottom, exit through gate to harness area
- Follow directions of Flying Fox Leaders

7.4.3 Post Review Briefing

At the completion of any running period, a review should be conducted by the Flying Fox Team

The review should cover such areas as:

- Any incidents / accidents / injuries
- Any equipment failure
- Any equipment requiring replacement
- Review Safety Checks
- Check all equipment packed up and stored correctly
- Review any set-up changes required during activity

7.4.4 Fox Team Communications

Bottom Take-off Leader and Top Take-off Leader should be clearly recognisable to all Team Members by sight. i.e. specific coloured bands on helmets or safety vests that are a different colour to participants or other Team Members.

Line of sight should always be maintained between the Bottom and Top Take-off Leaders during operation.

Hand Signals

It is generally accepted that the control of the Fox is given to the bottom end operator. Control is either by hand signals or radio (greater distances). *Note signalling only to be used by assigned Bottom and Top Take-off Leaders.*

Stop: One arm raised straight above the head, palm open towards the top end.

Go: One arm extended at 90 degrees to the body with palm open towards the top end.

Cease Fox Operations: Two arms crossed above head

Radios may be used to assist communications between areas, but line of sight must be maintained for the use of hand signals to control operation.

7.5 PPE Supervision

No personal gear to be used by participants without approval by the Activity Coordinator

All team members personal gear should be inspected and approved for use by the activity coordinator prior to the commencement of activity

All PPE should be inspected at the beginning and end of each activity. All faulty PPE should be isolated and removed from use.

Harnesses and Helmets should be fitted by assigned Team members.

Whilst many can self-harness or other Scout members can help; all harness and helmet final fitting must be checked by a Fox Helper or above.

Harnesses and Helmets should be checked for correct fitting, by a Trained Participant or above, prior to being attached to the trolley.

7.6 Participant Movement

Restricted areas to be clearly fenced to prevent access.

Signage to be attached to fencing where appropriate. Participant briefing to outline paths of travel entering and departing operational areas of any Flying Fox

Restriction of only one/two participant in the Top Take-off area, depending on single or dual hawser, to be strictly enforced by all Team Members.

7.7 Emergency Procedures

All equipment and installation techniques herein are ‘safe’, and hawser or anchorage failure should not occur BUT one area that must be covered in an emergency is a trolley jam or failure where the passenger is stranded on the hawser. The Emergency Rescue Plan must be known in advance.

These considerations must form part of the planning stage and be known by all persons involved in running the flying fox. A template for the Emergency Rescue Plan is in Figure 57Figure 57, however specific Emergency Rescue Plan needs to be developed for each site and should consider the capability of the Fox Team present to ability to undertake the rescue procedures and type of dropper arrangement used.

Activity:		Date:	
Max. Participant Height to Harness Attachment (m)		Dropper Arrangement (Fixed/ Petzl RIG/GriGri)	
Fox Team:			
RESCUE SCENARIOS			
No.	Scenario	Rescue Plan (Examples Only)	
1	Participant stuck on hawser, but can be pulled to top Take-Off	Landing Fox Team pull participant up and Take-off team remove participant.	
2	Participant stuck on hawser, can NOT be pulled to top Take-Off but greater than 3m off ground	Fox Team drop hawser OR Take-off team descend (same/parallel hawser) with rescue kit to take participant of the dropper and lower to ground OR descend together to Landing area.	
3	Participant stuck on hawser, can NOT be pulled to top Take-Off but less than 3m off ground	Landing team use sling rope and add weigh to bring hawser lower to ground so ladder can be used to remove participant	
4	Participant injured and cannot offer any assistance	Same as above but emergency first aid response called immediately, and rescue must not depend of the participant releasing safety dropper or descender. (rescue kit should be altered to provide alternative rig to cater for this)	
5	Participant unconscious	Same as above but emergency first aid response called immediately, and rescue must not depend of the participant releasing safety dropper or descender. (rescue kit should be altered to provide alternative rig to cater for this)	
6	Other		

Figure 57 Emergency Rescue Plan

7.8 First Aid

The qualified Guide conducting the activity must ensure that a qualified First Aider and relevant safety and first aid equipment are present at the activity site.

Trained Participant and above are to have current First Aid qualifications

7.9 Inspections

7.9.1 Detailed Equipment Inspections

Detailed Equipment Inspection shall be undertaken approximately at 3 yearly intervals by the Fox Team. It is recommended if an external inspector can be arranged, i.e. from another region or external professional with expertise in this area, this does provide better independent advice:

- Inspect the Hawser for degree of wear and damage
- Inspect all equipment for wear and damage
- Inspect all PPE for wear or damage, refer to manufactures guidelines for inspections
- Inspect all slings for wear or damage, refer to manufactures guidelines for inspections
- Inspect all ropes for wear and damage
- Inspect the trailer usually used to transport the Fox gear

Remove any damaged equipment.

7.9.2 Operation System Inspection

Prior to operation a complete Operation System Inspection and checklist to be completed by a Fox Guide or above:

- Prior to construction undertail a general equipment check, including the following:
    - Inspect all equipment for wear and damage
    - Inspect all PPE for wear or damage, refer to manufactures guidelines for inspections
    - Inspect all slings for wear or damage, refer to manufactures guidelines for inspections
    - Inspect all ropes for wear and damage
- At the completion of construction, prior to any live running
- Note the environmental conditions, i.e. the Fox cannot run during storm event, high wind (causes hawsers or shear legs to move) or ice conditions
- At the beginning of each period where the temporary construction has been unattended by the Fox Team

- according to the amount of use to which the system is subjected, the checks can be performed more frequently
- after any exceptional event
- after any equipment has been withdrawn from use or replaced
- after any modifications to the system

7.9.3 Running System Inspection

A Running System Inspection and checklist to be completed by a Trained Participant or above

- after imposed load testing and prior to any live running
- at regular intervals, not exceeding every 2 hours of running time
- at the completion of any live running period

7.9.4 Explanation of System Checks

ENVIRONMENT - Practice as far as possible to minimize any environmental impact. This impact includes disturbance of fauna, flora, soil compaction and erosion.

Are trees bagged from ropes? If heavy rain likely to fall will it compromise the fox construction? Where heeling shear legs, has the grass been remove correctly so it can be replaced? Is there a defined pathway to minimize environmental impact?

TOP ANCHORAGE - Are there enough pickets? Are they capped? Is the log sound? Is there any movement in the system and are the lashings in place?

Typical issues are:

- Soil disturbance around pickets
- Picket movement
- Tree movement
- Tree ‘groaning’
- Knotting to anchorages secure?

TOP HARDWARE - Is all hardware of correct rating and are they secured in place? Slings and slings in position, shackles moussed, turnbuckles moussed, in-line eyes with thimbles and double base clamps with washers and nuts secured and torque to correct setting, lizard attached with “U” bolts on the lizard not the hawser?

TOP SHEARLEGS - Is the structure secure, stable and design correct and of suitable material? Lashing and knots correctly tied? Are the legs heeled or picketed, guy ropes correctly placed, pickets capped, top spar bagged? Any other items such as outrigger with pulleys, braking system attached correctly.

Typical issues are:

- Pickets bending
- Soundness of spars and logs
- Spars and logs ‘groaning’
- Integrity of lashings
- Embedding of shear legs

TOP TAKE OFF POINT - Is the take off point safe, stable and secure? Are there safety lines for operator and passenger securely in place? Ladder tied off and belay line set. Are operators and passenger wearing appropriate safety equipment (helmet, harness, footwear, gloves etc)?

HAWSER - Has the hawser catenary been set for the span so as not to exceed 5% sag? Was the system load tested prior to operation? Has a sight line been taken?

Typical issues are:

- Hawser Slippage
- Base camps and eye secure
- Rope stretching
- Rope degeneration
- Load maximum not being exceeded

During regular running system inspections check that the hawser has not slipped through the base clamps. Whilst this can be check by close inspection of the base clamps and any sign of scrapping on the hawser it can most easily be inspected by placing tape, sticky side out so as not to introduce a sticky surface onto the hawser. on the lead-in and tail lengths as indicated in Figure 58 to see if the tape becomes misaligned.

Figure 58 Hawser Slippage Inspection

RUNNING GEAR - Is the running gear in good condition and operating correctly? Carabineers fitted correctly and locked off with the appropriate length dropper? Are the pulleys in good order and the return line running freely. Typical issues are:

- Running free
- Correctly lubricated

BRAKE 1 - Is the brake system able to operate when required. The primary brake is usually a tyre or chain brake system. Are the nylon brake blocks running free on the hawser with nut done up. The top tyre is set in the air with the last tyre anchored. Tyres should move up and down freely through a pulley with a stabilizer rope with shock cord attached at the bottom end.

BRAKE 2 - The secondary brake is usually a static brake set at 90 degrees to the hawser with its own anchor pickets.

BOTTOM TAKE OFF POINT - Is this point safe, level and stable. The operator is always in control of the fox operation.

BOTTOM SHEARLEGS - Is the structure secure, stable and design correct and of suitable material. Lashing and knots correctly tied. Are the legs heeled or picketed, guy ropes correctly placed, pickets capped, top spar bagged. Any other items such as outrigger with pulleys, braking system attached correctly.

Typical issues are:

- Pickets bending

- Soundness of spars and logs
- Spars and logs ‘groaning’
- Integrity of lashings
- Embedding of shear legs

BOTTOM HARDWARE - Is all hardware of correct rating and are they secured in place. Slings and slings in position, shackles moussed, turnbuckles moussed, in-line eyes with thimbles and double base clamps with washers and nuts secured and torque to correct setting.

BOTTOM ANCHORAGE - Are there enough pickets. Are they capped. Is the log sound. Is there any movement in the system and are the lashings in place.

Typical issues are:

- Pickets bending
- Excessive movement

GUY ROPES - Are all guy ropes in good condition, tied off with correct knots. Are they tight. Check no movement in the stakes holding the guys.

Typical issues are:

- Pickets bending
- Integrity/damage to lashings
- Slippage up pickets

PARTICIPANT BRIEFING - Is there a participant briefing on display or arranged for harnessing team to provide to participants.

FENCING – are all restricted/running areas fenced off to prevent access.

HARNESSING AREA - is the area set up with protection from the elements for the harnessing team. Is there appropriate seating for the team. Is all the required equipment in easy reach of the team. Is there a supply of drinking water available for team members and participants. Integrity and correct fitting of the harness.

OPERATORS - How many operators are present at the time. Are they all wearing appropriate equipment.

AREA SECURITY - Has the area been secured.

LOAD TESTING - has the whole system been appropriately load tested prior to live running.

END OF DAY SECURITY - This is when the fox is not in operation. Has all running gear been removed and locked up. Remove ladders or steps. Note – some sites such as public fair may need overnight patrols.

RUNNING SYSTEM CHECK

(Please enter time and date of each system check and print name)

	Day 1								Day 2								Day 3							
Date & Time																								
Weather Suitable (low wind, dry)																								
Top Anchorage																								
Top Hardware																								
Top Shear Leg																								
Top Guy Ropes																								
Top Take-off Point																								
Catenary																								
Running Gear																								
Dynamic Brake																								
Static Brake																								
Bottom Take-off Point																								
Bottom Shear Leg																								
Bottom Hardware																								
Hawser Slippage																								
Bottom Anchorage																								
Bottom Guy Ropes																								
Area Security																								
Harnessing Area																								
Operators																								
End of Day Security																								
Sign-off Fox Team Checker																								
Sign-off Activity Leader																								

Figure 59 Running System Safety Checklist

8.0 Recognition of Scout Skills and Training

8.1 General

New candidates for Flying Fox teams are encouraged to join their local/regional Fox Team, assist on several Foxes, and maintain a log of their hours and tasks. This progressive development of skills and knowledge is consistent with the Scout Method.

A Flying Fox course is designed to provide Fox candidates with the underpinning knowledge required to understand the construction and operation of a Flying Fox within the requirements of Scout Association of Australia, NSW Branch. The candidates are provided with a copy of the manual and workbook for Trained Participant evidence.

The candidate may be progressively assessed following the course when assisting on other Fox activities. The workbooks, logs, checklists and progressive assessments provide evidence for attainment of Flying Fox recognised skill levels.

Evidence for competency and currency at all levels is assessed and reviewed by Participation and practical demonstration

In the practical sessions, demonstration of sufficient knowledge and application of the following is also required:

- WHS principles
- Application of Scout Policy and Organisational Information, and any other relevant standards
- Environmental stewardship and minimal impact
- Care, logging, inspection and maintenance of equipment
- Maintaining the physical and psychological wellbeing of others.

Further evidence of knowledge and understanding may include answering questions and discussion (includes workbooks)

Experience in a variety of settings and ongoing development of skills and application to novel or difficult situations (log book).

Engagement and contribution to review of the activity at both local and state levels

> *NOTE 1: previously the recognised skill levels were referred to as Fox Qualifications. With the adoption of selected adventurous activities training units and qualifications within scouting, the 'Fox quals' were no longer recorded beyond the local Fox teams.*
>
> The following sections describe the roles and requirements for each level and the pathway for recognition of scout skills in flying fox operation and construction of temporary structures.

8.2 Acquisition of Flying Fox Skills and Recognition

Safe Participants (previously known as "Helpers").

Helpers (Safe Participants) may be recruited on the day but are not recognised as regular Fox Team members.

New candidates for Flying Fox teams are encouraged to join their local/regional Fox Team, assist on several Foxes, and maintain a log of their hours and tasks. Their contribution is recognised by calling them Safe Participants.

Progression to the next level requires completion of core Outdoor Scouting Skills, attendance at a Flying Fox course, and submission of completed Fox Workbook 1 Trained Participant, and personal log illustrating assistance on several Foxes, successfully participating in several tasks.

Trained Participant (previously known as "Basic Foxer")

The candidate has

- Completed basic outdoor Scout training (previously Common Core A),
- Attended Flying Fox course and reviewed training materials.
- The candidate will be provided with workbook 1 prior to the course. This contains the sections of the manual in order to be familiar with the terminology used and relevant knots so that the course can proceed efficiently.
- The candidates are provided with a copy of the Flying Fox Guide. Flying Fox course materials are designed to provide Fox candidates with the underpinning knowledge required to understand, construct and run a Flying Fox within the requirements of the Scout Association.
- Completed Fox Workbook 1 which includes a revision of core learnings from the course materials and verification of practical tasks. This includes participation and practical demonstration of sufficient knowledge and application of Scout Policies, WHS principles, application of and other relevant standards, and environmental stewardship.
- maintenance of personal Fox activity log

Skill recognition process:

- submit evidence (includes personal verified Flying Fox activity log, workbook 1 and required Scout Units) for endorsement by the local Advanced Guide,
- This evidence is then tabled and assessed by the FFSAC.

If approved, the evidence will be forwarded to the Scout Association of Australia, NSW Branch Training Officers.

The course attendance and the skill level (Trained Participant) will be recorded on the member's record.

Further progression and skill recognition is consistent with other outdoor and adventurous activities in scouting. The candidate who wishes to progress to Guide Operations, must submit their application through their Regional Fox Coordinator to the FFSAC as follows:

Guide, Operations
The candidate has fulfilled the requirements of Trained Participant, and

- Must satisfy requirements of Scouts Australia for Activity Guide, including relevant rescue units.
- Satisfactory completion of Workbook 2 flying Fox Operations
- Provide current personal Fox activity log book

Skill recognition process:

- submit evidence (includes personal verified Fox activity log, and workbook 2 to FFSAC).
- When FFSAC are satisfied that all requirements are met, evidence can then be forwarded to Scout Association of Australia, NSW Branch Training Officers.
- The skill level (Guide, Operations) will be recorded on the member's record.

This level of skill enables the person to run the operation of the activity independently following induction to the particular structure. They may be the nominated "Supervisor" if the activity is run on a permanent structure. This level may assist with operations on a temporary flying fox but cannot fulfil the role of Fox Supervisor on the temporary structure.

Advanced Guide OC (Operations, and Construction of temporary structures)
The candidate has fulfilled the requirements of Guide Operations, and

- Must satisfy requirements of Scouts Aust. for Activity Guide, including relevant rescue units.
- Satisfactory completion of Workbook 3 Temporary Structure
- Provide current personal Fox activity log book

Skill recognition process:

- submit evidence (includes personal verified Fox activity log, and workbook 3 to FFSAC).
- When FFSAC are satisfied that all requirements are met, evidence can then be forwarded to Scout Association of Australia, NSW Branch Training Officers.
- The skill level (Advanced Guide, Operation and Construction Temporary Structures) will be recorded on the member's record.

This level of skill enables the person to run the operation of the activity independently following induction to the particular structure and fulfil the role of Supervisor of the construction and adjustments of a temporary flying fox structure.

NOTE 2:

Fox Supervisor is an operational role. This person is the overall supervisor of the running of the activity and must be registered as a Guide with the appropriate skills. If they leave the site, they can only be relieved by a Guide of similar level, or the activity is suspended until their return.

NOTE 3.

The FFSAC - Flying Fox State Advisory Committee is recommended to be formed following the 2021 review. Its roles and functions include monitoring and maintenance of standards and compliance with policy, resolving issues and recognising NSW Flying Fox Scout Skills.

8.3 NSW recognition of Scouting Skills Flying Fox

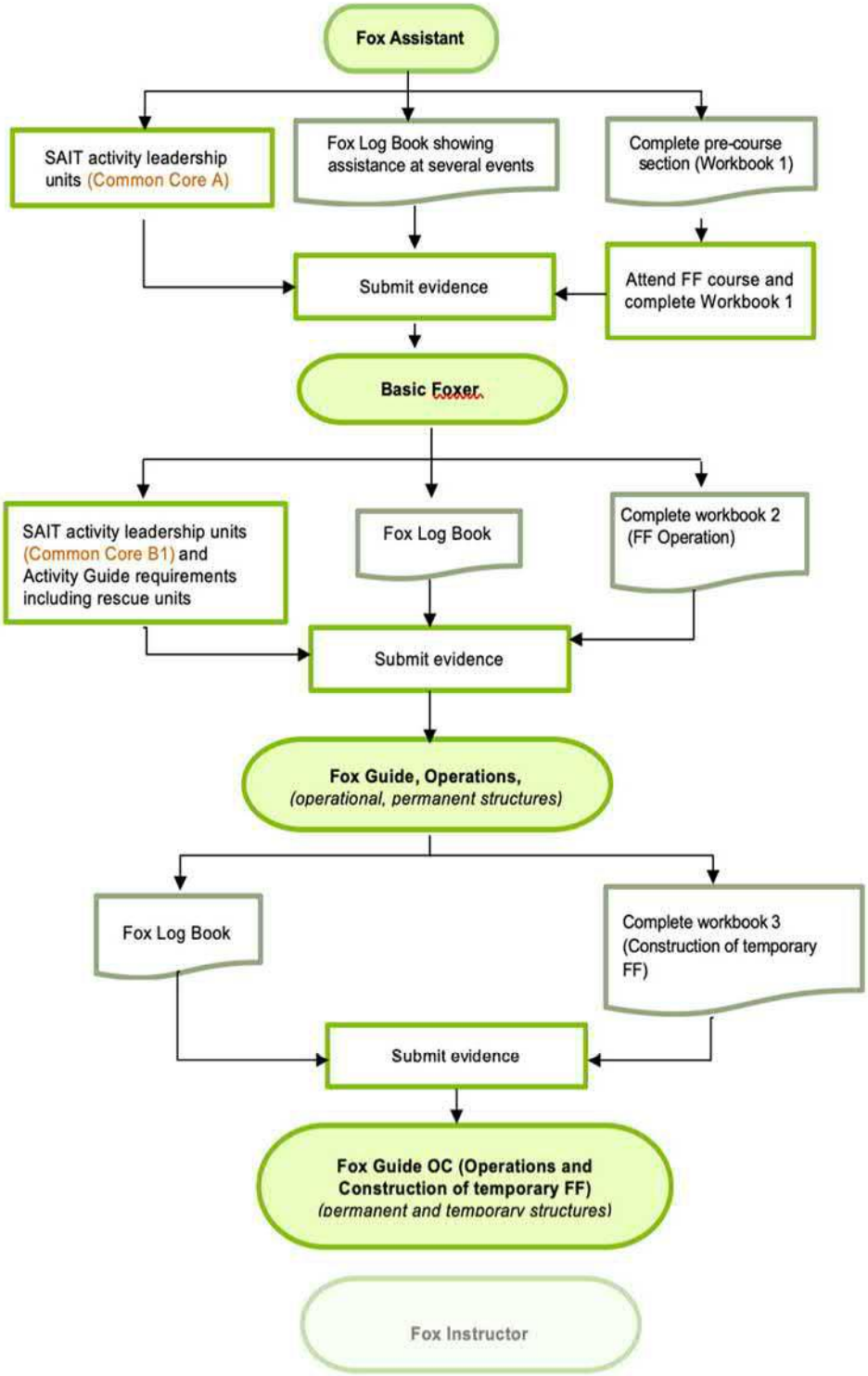
Scout Skill FF	Role	Demonstrates the following	Scout Association of Australia, NSW Branch requirements, for Skill Recognition
1. Safe Participant	Under supervision follows directions, may assist with construction and help manage participants while waiting for the activity.	the necessary maturity and common sense to safely conduct and supervise youth members participating in Flying Fox Activities. ability to fit safety equipment to meet the manufacturers' specifications	WWCC Mandatory training including WHS and Child Safety to the satisfaction of the Flying Guide
2. Trained Participant	under the supervision of the FF Guide, *assists* with assembly or construction *assists* with operational tasks including monitoring and inspections	the necessary maturity and common sense to safely conduct and supervise youth members participating in Flying Fox Activities. Knowledge of relevant policy and understand aspects of FF construction and operation. Under supervision, demonstrates technical ability to safely complete assembly of FF Under supervision, runs aspects of the Flying Fox activity, conducts risk assessments, routine inspections and documentation. Maintains personal log of Flying Fox tasks and activities	All above, plus attend FF course (or mentored equivalent) completed workbook 1 currently required SIS units (including Organise personal work plan, Provide Customer Service, Comms, Environmental impact and Interpret weather in the field) to the satisfaction of the Flying Guide*, and approval of the SAC Fox*

Scout Skill FF	Role	Demonstrates the following	Scout Association of Australia, NSW Branch requirements, including SIS units
3. Guide, Operations (Permanent Structures only)	Runs the operation of the activity independently. May be the nominated ***Supervisor** if the activity is run on a permanent structure. *May assist with operations on a temporary flying fox but cannot be the Fox Supervisor.*	Safely manage Flying Fox activities on a permanent structure including risk assessments, routine inspections and documentation. Understand the limits and risks of the equipment Provide positive supervision and direction to Safe Participants and Trained Participants Respond to and manage the diversity of participants Problem solving abilities Implement appropriate rescue plans Implements risk assessment and management strategies and understands the importance of incident and near miss reporting.	Has fulfilled the requirements of Trained Participant, Satisfy requirements of Scouts Aust. for Activity Guide, including Rescue units Satisfactory completion of Workbook 2 Current log book SAC Fox are satisfied that all requirements are met, and evidence can then be forwarded to state office training team
4. Advanced Guide OC (Operations, and Construction of temporary structures) (Supervisor*)	Supervises construction of the temporary structure. Runs the operation of the activity independently. May be the nominated *Supervisor.	All requirements for Guide Operations, ***and in addition*** Technical ability to construct the temporary FF structure, and adjust any component as required. Safely manage Flying Fox activities on a mobile structure including the activity participants, risk assessments, routine inspections and documentation. Implement rescue plans on the mobile structure	Has fulfilled the requirements of Guide, Operations, and Satisfactory completion of workbook 3 Current log book SAC Fox are satisfied that all requirements are met, then evidence can be forwarded to the state office training team.

Scout Skill FF	Role	Demonstrates the following	Scout Association of Australia, NSW Branch requirements, including SIS units
5. Fox Instructor	Can fulfil any Fox role, and has the skills, qualifications and maturity to oversee training and assessment of courses and candidates.	Fulfil requirements of Advanced Guide OC Instructional ability to train both adults and youth members in the requirements for safe construction and management of Flying Fox Activities. Technical ability to assess, safely construct and manage Flying Fox activities in a variety of locations, over a range of spans. Knowledge of all aspects of the Flying Fox training and assessment tools.	SAIT requirements for Instructor *Nominated by the FF SAC, other Fox Instructors, and the satisfaction of an Independent Assessor*

Progression through different levels of Flying Fox Skill levels are described in the following flow chart.

Figure 60 Flow chart: Qualification/Skill Recognition Pathway for Flying Fox



8.4 Upskilling and Maintenance of Flying Fox during transition period

The transition period refers to the time from the acceptance and endorsement of the current Flying Fox Policy and Manual for Scout Association of Australia, NSW Branch (2020) until Regional Commissioners who have Fox equipment and previously experienced Fox team members are satisfied that reasonable efforts have been made to support the local team to

- become familiar with the revised Fox Policy and Manual
- inspect gear for compliance with standards
- demonstrate understanding and compliance to the satisfaction of SAC Fox members with Policy and Manual during a Fox Activity.

Recommendations will be made from the SAC Fox to the RC regarding the outcome of the Region Fox support program.

9.0 Appendix A – Engineers Report

References to “The Manual” in the following engineer’s report relate to The Scouts NSW Flying Fox Manual Ver. 6 and forms the basis for the revised Flying Fox Guide – Operations and Construction.

Civil & Structural Engineering Design Services Pty. Ltd.

Scouts NSW has commissioned a structural analysis to confirm actual forces experienced in the longest temporary flying fox arrangement so as worst case load rating and anchor arrangements can be determined. ***Note:*** *that the engineer is not able to certify the use of timber shear legs constructed as a pioneering structure as there is no way to guarantee the performance for a structural analysis. However, FFSAC recommends the continued use of min. 120mm diameter treated pine poles for hawser structures, i.e. greater diameter than the 95mm diameter used in the engineering report, and that such construction needs to be under the supervision of an Advanced Fox Guide since they will have the relevant experience to ensure the construction is adequate.*

Client: **Scouts Australia NSW**
Project: Structural Analysis on 100m flying fox structure (Single Hawser Shear Leg) for Scouts Australia NSW

Reference: The Scouts NSW Flying Fox Manual Ver. 6

Report by: SD
Checked by: EAB
Date: 16/12/2020
Amendment: -

JOB NO: D-11-268292-1A

Contents

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1. Introduction:

Scouts NSW have instructed our company to perform checks for the safe erection of various flying fox profiles included within their Manual dated 28-9-2020 and consequently, checking these profiles we are of the opinion that Timber Dual Hawser Shear Construction is inadequate for the 100m Flying Fox, which is to say that it would be an impossibility to recommend structural certification.

This is mainly due to the numerous possibilities of workmanship failings, apart from the fact that analysis with common structural software, is also unavailable in timber. We then decided to analyse the 100m flying fox using steel shear legs with clipped and bolted connections, due the likelihood of less workmanship failings. Refer pages 37 to 43 of the latest version of the Manual.

2. Calculation

2.1 Load summary

2.1.1 Dead Load

Dead load	G[kN/m]	γ_f [-]
Self-weight of the steel construction	-	1.20
11mm Cable	S.W	1.20

G - characteristic value of dead load

$\gamma_{f,g}$ - *Combine action factor*

2.1.2 Live load and Pre-stress Force

Live load	q_k [kN]	$\gamma_{f,q}$ [-]	γ_D [-]
A person (120 kg) per a cable	1.30	1.50	2.00
Pre-stressed force	0.9	1	1.00

G - characteristic value of dead load

$\gamma_{f,g}$ - *Combine action factor*

γ_D - *Dynamic load factor*

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The two load combinations of 1.2G+Presstress and 1.2G+1.5Q+Prestress are used for ultimate analysis and design. The factor of two is used for considering the effect of dynamic applied load.

The calculation is in accordance with Australian Standard – Steel structures (AS 4100 – 1998), Australian/New Zealand Standard – Structural design actions, Part 0: General principles (AS/NZS 1170.0:2002) and Australian standard – Residential slabs and footings (AS 2870 – 2011).

3. Geometry:

3.1 3D MODEL

Member Sizes:

Vertical Post: 75x75x3.5 SHS

Horizontal Members: 75x75x3.5 SHS

Diagonal Braces: 75x75x3.5 SHS

Hawser: 11mm dia. steel cable

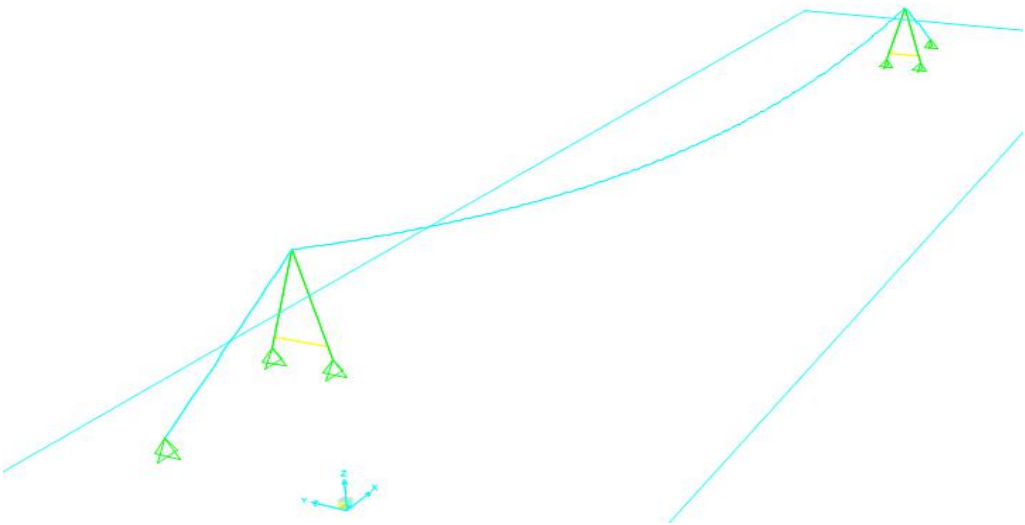

Fig: Typical 100m long Flying Fox

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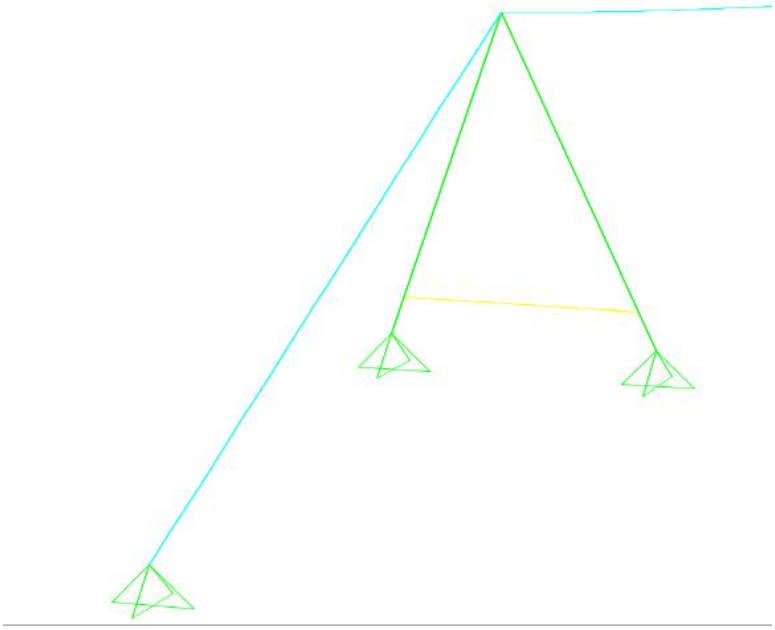

Fig: Typical Shear Leg

Figure 17 Log and Picket Anchor

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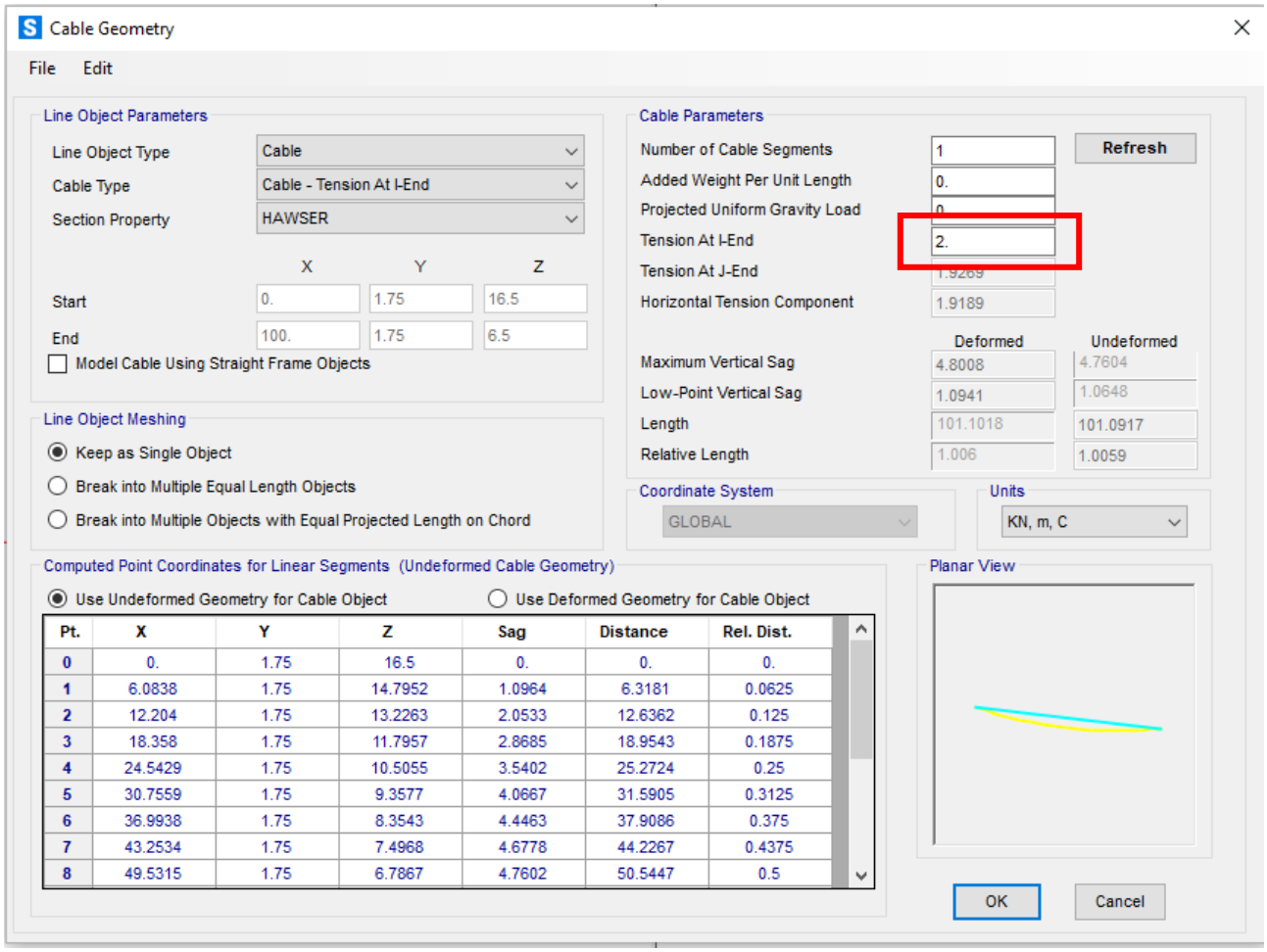
4. Calculations: From SAP 2000 analysis run

4.1 Prestress Force Calculation:



Pt.	X	Y	Z	Sag	Distance	Rel. Dist.
0	0.	1.75	16.5	0.	0.	0.
1	6.0838	1.75	14.7952	1.0964	6.3181	0.0625
2	12.204	1.75	13.2263	2.0533	12.6362	0.125
3	18.358	1.75	11.7957	2.8685	18.9543	0.1875
4	24.5429	1.75	10.5055	3.5402	25.2724	0.25
5	30.7559	1.75	9.3577	4.0667	31.5905	0.3125
6	36.9938	1.75	8.3543	4.4463	37.9086	0.375
7	43.2534	1.75	7.4968	4.6778	44.2267	0.4375
8	49.5315	1.75	6.7867	4.7602	50.5447	0.5

Tension at main cable end is 2 KN Pre-stressing force to limit the sag to 5m

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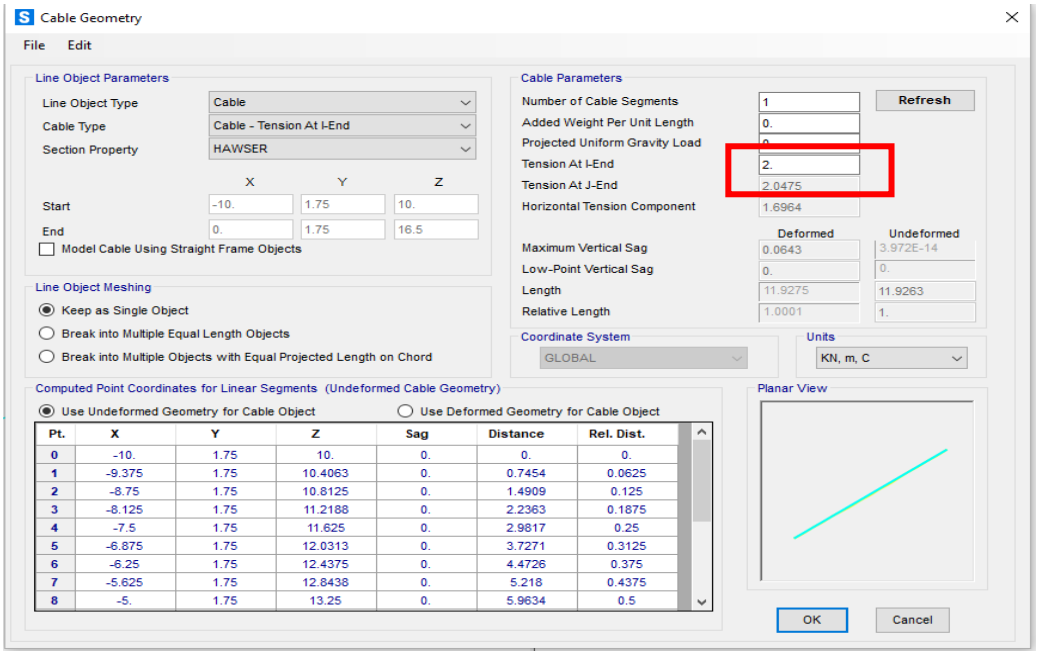
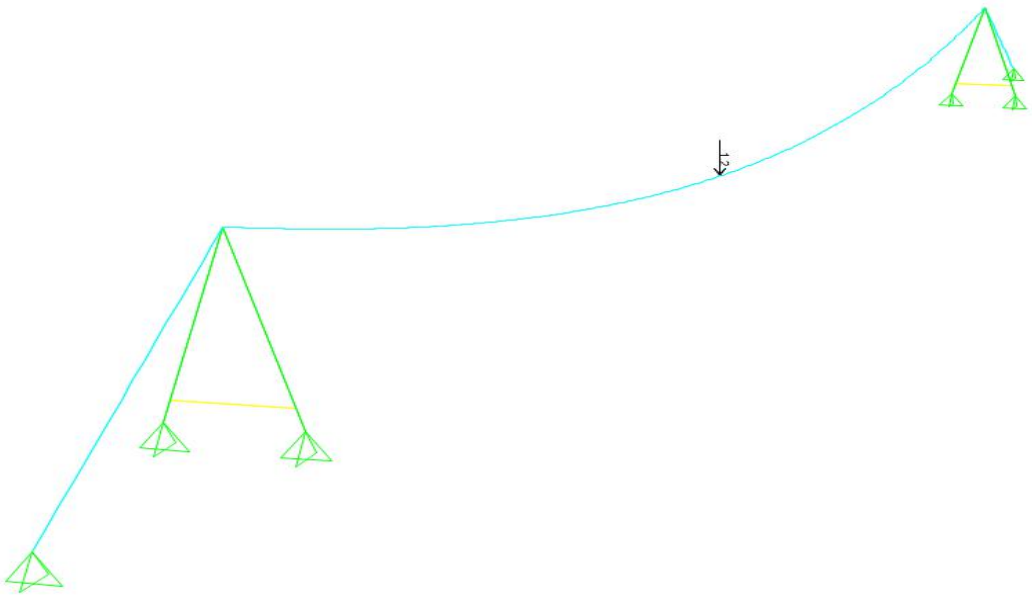


Tension at ground anchorage is 2 KN Pre-stressing force on each cable supporting the shear leg.

Refer fig. from the manual

4.2 Live Load:



Live Load: 1.2 KN

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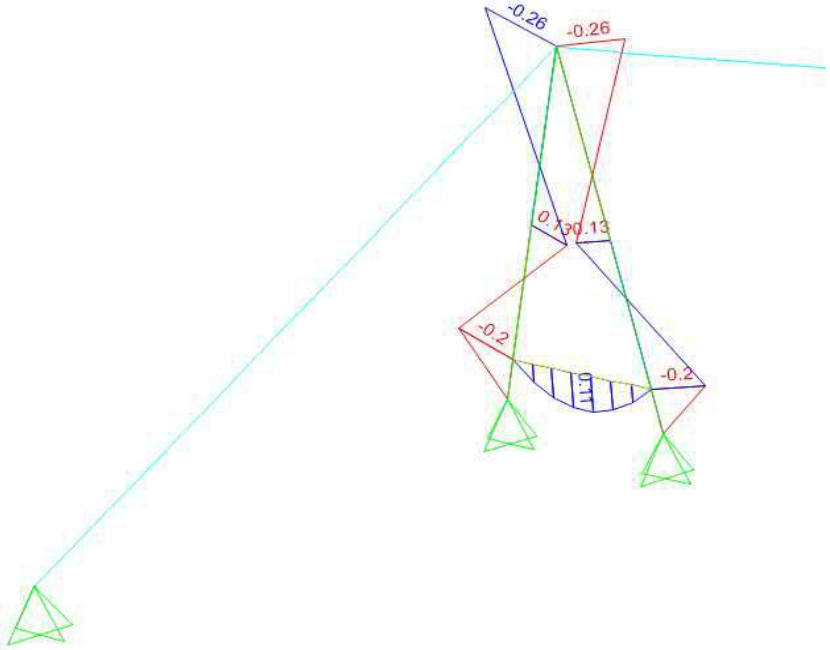
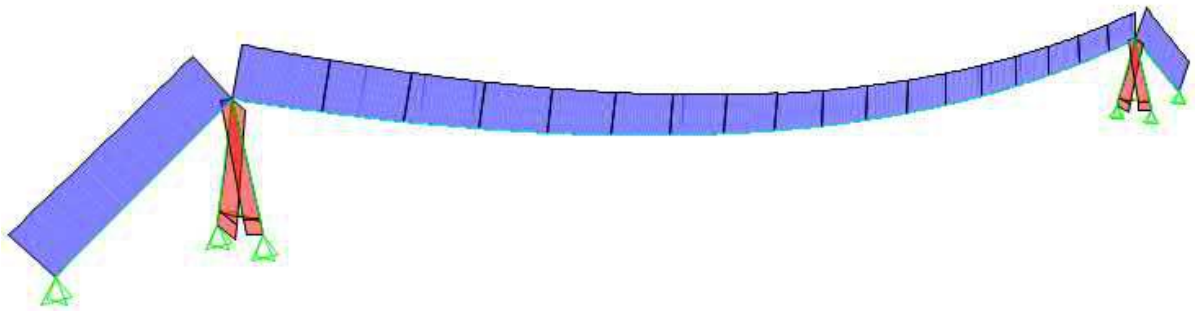
5. Analysis Results:

5.1 Maximum Bending moment in major axis:



Maximum Bending Moment: 0.26 KNm

5.2 Maximum Axial force:



Maximum Axial Force: 0.26 KNm

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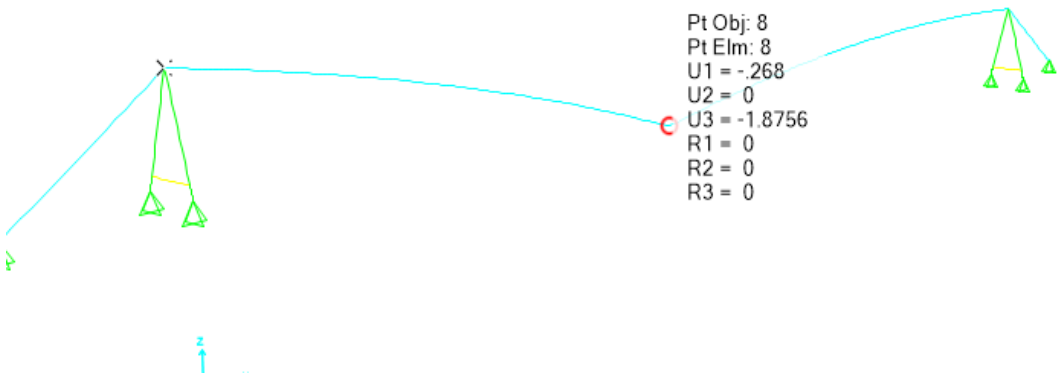
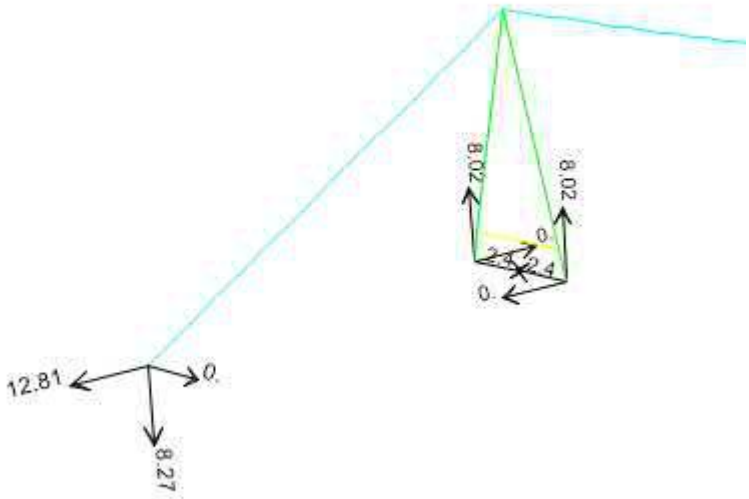
5.3 Maximum deflection:



Maximum Deflection: 1.88m Deflection at the centre

5.4 Maximum reactions



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6. Timber Member Design – AS4100:1998

TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.7.03

Analysis results

Design moment in major axis	M^*_x = **0.270** kNm
Design shear	V^* = **0.300** kN
Design axial compression	N^*_c = **8.000** kN

Timber section details

Breadth of timber sections	b = **95** mm
Depth of timber sections	d = **95** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **95** mm
Timber species	**Mixed Australian hardwoods**
Moisture condition	**Seasoned**
Timber strength grade - Table H2.1	**F17**

Member details

Load duration - cl.2.4.1	**Short-term**
Equilibrium moisture content	**15 %**
Overall length of member	L_x = **6500** mm
Effective length factor - Table 3.2	g_{13} = **1**
Distance between lateral restraints in major axis	L_{ax} = **6500** mm
Distance between lateral restraints in minor axis	L_{ay} = **6500** mm

Section properties

Cross sectional area of member	A = N × b × d = **9025** mm^2
Section modulus	Z_x = N × b × d^2 / 6 = **142896** mm^3
	Z_y = d × (N × b)^2 / 6 = **142896** mm^3
Second moment of area	I_x = N × b × d^3 / 12 = **6787552** mm^4
	I_y = d × (N × b)^3 / 12 = **6787552** mm^4
Radius of gyration	r_x = √(I_x / A) = **27.4** mm
	r_y = √(I_y / A) = **27.4** mm

Modification factors

Duration of load factor for strength - Table 2.3	k_1 = **0.97**

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Moisture condition factor - cl.2.4.2.3	k_4 = **1.00**
Temperature factor - cl.2.4.3	k_6 = **1.00**
Length and position of bearing factor - cl.2.4.4	k_7 = **1.00**
Strength sharing factor - Table 2.7	k_9 = **1.00**
Temporary design action ratio	r = **0.25**
Material constant - exp.E2(1)	$\rho_b = 14.71 \times (E / f'_b)^{-0.480} \times r^{-0.061}$ = **0.98**
Distance between discrete lateral restraints	L_{ay} = **6500** mm $L_{ay} / d > 64 \times [N \times b / (\rho_b \times d)]^2$
Major axis slenderness coefficient - exp.3.2(4)	$S_1 = 1.25 \times d / (N \times b) \times (L_{ay} / d)^{0.5}$ = **10.34**
Major axis bending stability factor - exp.3.2(11)	$k_{12bx} = 1.5 - 0.05 \times \rho_b \times S_1$ = **0.99**
Minor axis slenderness coefficient - cl.3.2.3.2 (c)	S_2 = **0.00**
Minor axis bending stability factor - cl.3.2.4	k_{12by} = **1.00**
Material constant - exp.E2(3)	$\rho_c = 11.39 \times (E / f'_c)^{-0.408} \times r^{-0.074}$ = **1.08**
Major axis slenderness coefficient - exp.3.3(5)	$S_3 = L_{ax} / d$ = **68.42**
Major axis comp.stability factor - exp.3.3(11c)	$k_{12cx} = 200 / (\rho_c \times S_3)^2$ = **0.04**
Minor axis slenderness coeff. - exp.3.3(8) & (9)	$S_4 = \min(L_{ay} / (N \times b), g_{13} \times L_x / (N \times b))$ = **68.42**
Minor axis comp.stability factor - exp.3.3(11c)	$k_{12cy} = 200 / (\rho_c \times S_4)^2$ = **0.04**

Bending strength - cl.3.2.1

Capacity factor - Table 2.1	ϕ_b = **0.95**
Design capacity in major axis bending - cl.3.2(2)	$\phi M_x = \phi_b \times k_1 \times k_4 \times k_6 \times k_9 \times k_{12bx} \times f'_b \times Z_x$ = **5.480** kNm

PASS - Design capacity in bending exceeds design bending moment

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1	ϕ_c = **0.95**
Cross-sectional area of member	$A_c = N \times b \times d$ = **9025** mm^2
Major axis design capacity in compression - exp.3.3(2)	$\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f'_c \times A_c$ = **10.315** kN
Minor axis design capacity in compression - exp.3.3(2)	$\phi N_{cy} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cy} \times f'_c \times A_c$ = **10.315** kN

PASS - Design capacity in compression exceeds design compression

Combined bending and compression - cl.3.5.1

Combined bending and compression check - exp.3.5(1) and exp.3.5(2)

$[M^*_x / \phi M_x]^2 + [N^*_c / \phi N_{cy}]$ = **0.778** < 1

$[M^*_x / \phi M_x] + [N^*_c / \phi N_{cx}]$ = **0.825** < 1

PASS - Beam design meets combined bending and compression criteria

Flexural shear strength - cl.3.2.5

Capacity factor - Table 2.1	ϕ_s = **0.95**
Shear plane area	$A_s = N \times b \times d \times 2 / 3$ = **6017** mm^2
Design shear capacity - exp.3.2(14)	$\phi V = \phi_s \times k_1 \times k_4 \times k_6 \times f'_s \times A_s$ = **19.960** kN

PASS - Design shear capacity exceeds design shear force

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All Members Pass

7. Picket Anchor Design

minimum embedment depth for lateral bearing:

Max. Horizontal Force	12.81
Max. Vertical Force	8.27
Number of Pegs	12
Horizontal Load per peg	1.1
Vertical Load per peg	0.7
Sticking out of Ground	0
S (bearing capacity)	150
d	0.01
H	200
M	**0.00**
γ	20
min required Embedment:	**712**
F.S	**1.87**
	OK

Bending:

Profile	Star Pickets
Fy	350
Ze	98.2
phi	0.9
phi Ms	**0.03**
	OK

Pull out Checking:

Clay:

Cu	40
α	1
Provided Embedment	1330
L/d	133
Rs	0.70
Perimeter	31
Total Surface Area	0.042
min required Embedment:	0.78
F.S	1.70
	OK
Coefficient of Friction	0.6
Equivalent Ballast	**2.14**

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8. Summary

1. The Flying Fox structure as specified has been analyzed with a conclusion that it has the capacity to withstand Pre-stress force up to and including 2KN as well as 1.2kN Live Load positioned for the worst-case scenario (Centre).
2. Maximum sag was limited to 5m for a 100m cable requiring 2KN Pre-stress force and riders weight allowed 1.2kN (125kg)
3. The cables supporting the shear legs should be pre-stressed to 2KN force (minimum).
4. The shear legs are to have minimum specifications as specified on page 43 of Scouts NSW Flying Fox Manual.
5. The footing is required to withstand reactions shown in Cl. 4.5 and requires to be designed as site specific.
6. The timber is to be good quality (Minimum F17 Hardwood).
7. The analysis is based on all lashings and knots providing a firm fastening which does not slip or become loose.

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