WOLLO UNIVERSITY

Kombolcha Institute of Technology

Fabric Structure and Design

Course code :- TEng3155

ECTS 5

Target group:- 3rd textile engineering

By Daniel .A

Chapter 1
General Knowledge On Woven Fabric

- **1..1 cloth formation on loom**

1. Concept of woven fabric

- Woven fabric is formed by interlacing two mutually perpendicular sets of yarns

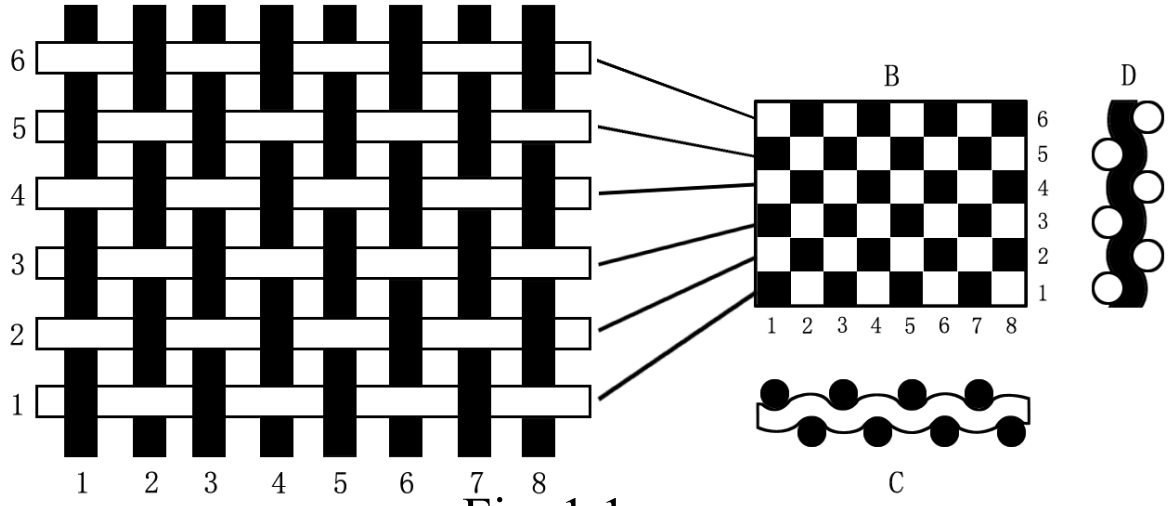


Fig. 1.1

Weaving process—5 motions

1) **Shedding**— Separating the warp threads into two 1ayers, to form the space for the weft insertion, which is called a shed.

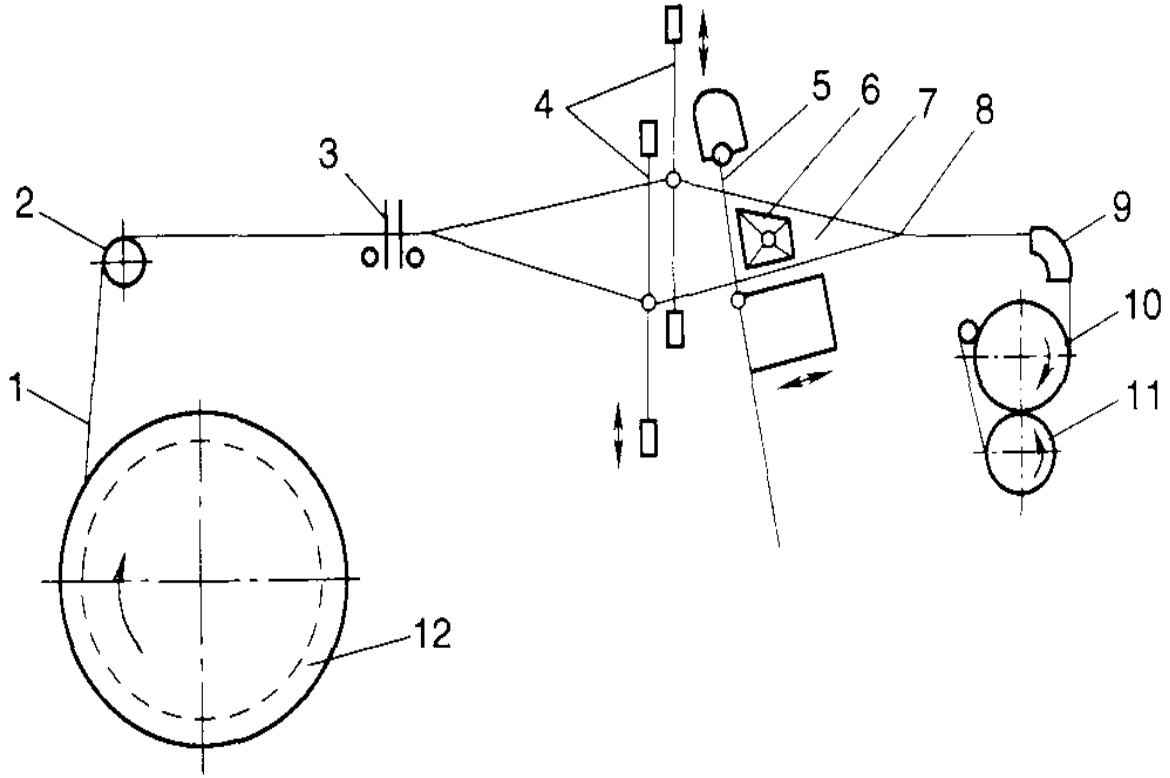
2) **Picking**— Inserting the weft thread through the shed, sometimes by a **shuttle** ,current of **water** and strong **air.**

3) **Beating-up**— Pushing the newly inserted weft, known as a pick, into the already woven fabric to the point called the **fabric fell.**

4) ***Warp letting-off***— Delivering the warp to the formation zone at the required rate and a suitable **constant tension** by unwinding it from the weaver's beam.

5) ***Cloth taking-up***— Moving fabric from the formation zone at the constant rate that ensures the required pick spacing, and winding the fabric onto a cloth roller.

Schematic diagram of the loom



1---warp yarn
2---back rest
3---drop wires
4---healds
5---reed
6---shuttle
7---shed
8---fell
9----breast rest
10---take up roller
11---cloth roller
12---weaver's beam

Fig. 1. 2 Schematic diagram of the loom

Description of the schematic diagram:

- ✓ The **warp yarn** 1 from the **weaver's beam** 12 passes round the **back rest** 2 and goes through the **drop wires** 3 of the warp stop-motion to the **healds** 4, which are intended for separating the warp threads for the purpose of shed formation.
- ✓ Then it passes through the **reed** 5 which holds the threads at uniform spacing and is designed for beating-up the pick which is inserted into the **triangular warp shed** 7 by the shuttle 6.

- ✓ The shed is formed by two warp sheets (layers) and the reed.
- ✓ Temples hold the cloth at the fabric fell 8 to assist in formation of a uniform fabric, which then passes over the breast beam 9, round the take-up roller 10 and onto the cloth roller 11.

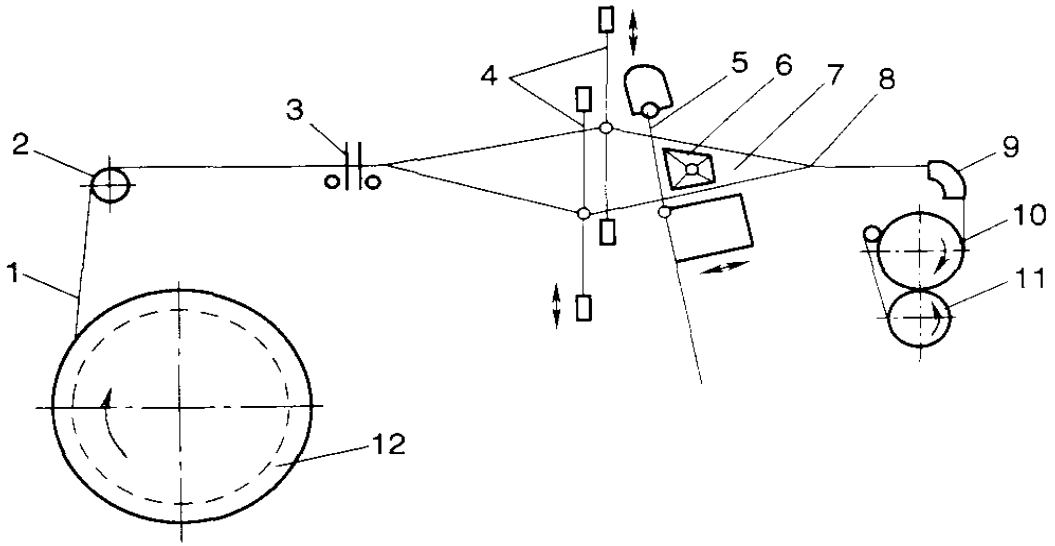


Fig. 1. 2 Schematic diagram of the loom

Classification of fabrics

- ✓ Woven fabrics can be designed by varying
  - *Types of weave*
  - *Densities of warp and weft threads*
  - *Type of yarn and fibers and so on.*
- ✓ Depending on the **type of weave** all these fabrics can be classified under four divisions as follows:
  - *Fundamental weaves.*
  - *Derived and combined weaves*
  - *Compound structures*
  - *Jacquard structures*

1. Fundamental weaves :

- ✓ Simple structures are produced by **interlacing two systems** of threads interlacing together at right angle.
- ✓ Can be sub divided in to primary classes: **plain. Twill** and **sateen**
- ✓ Produced on the looms equipped with a **tappet** shedding motion.

2. Derived and combined weaves :

- ✓ Constructed on the basis of fundamental weaves by means of
  - changing the original **order** of the warp or weft threads in the basic weave
  - by **adding** the warp or weft overlaps in a certain order by rearranging the threads
  - by **combining** the threads of various weaves or by drafting one weave over another.
- ✓ Produced on a conventional loom equipped with a **dobby.**

3. The compound structures

- ✓ Contain more than **two sets** of warp or/and weft **often different** in types of yarn, linear densities and **color**
- ✓ Sometimes the threads are divided in to **ground** and figuring according to different functions of weaving, different tension and the manner of interlacing
- ✓ Need vary often special methods of manufacture and looms with special mechanisms

4. Jacquard structures

- ✓ Are those with **large figure** design.
- ✓ The number of warp threads with different interlacing reaches several **thousands** and the same can be the number of weft threads in the repeat.
- ✓ **Jacquard** machine used as a shedding

Parameters which determine the properties of the fabric

- ✓ The properties of the fabric depend on the fabric structure which is determined by the following parameters:
  - Weave
  - Densities of warp and weft threads, the characteristics (thread thickness, twist, strength, elongation, etc) of warp and weft threads,
  - Characteristics of fiber and the factors introduced during weaving g such as crimp

Fabric Analysis:

✓ The properties of the fabric are closely linked to fabric parameters

I. Making samples

II. Identification of face or back of the fabric

III. Identification of warp and weft

IV. Density measurement

V. Crimp measurement

VI. Linear density (tex) measurement

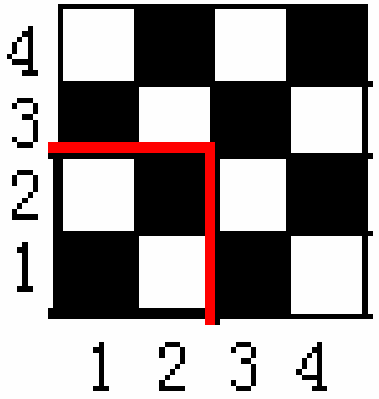
VII . Fiber identification

VIII .Fabric weight

IX. Fabric structure and color arrangement

Repeat of weave and shift

1. Repeat:



- Here is a plain weave. From the diagram, we can see, the 3rd warp thread has the same movement with the 1st, and the 4th same with 2nd.
- Similarly, the 3rd weft thread is same with the 1st weft thread; the 4th is same with the 2nd.

Methods of Weave Representation

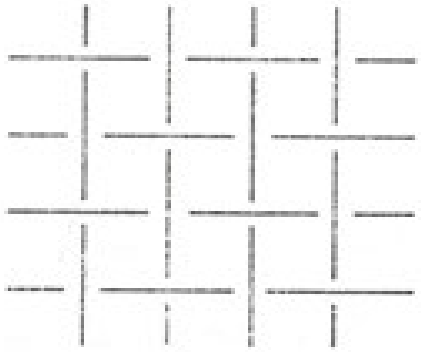
- ✓ There are two practical methods of weave representation:

(i) Linear

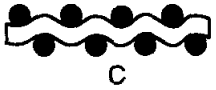
(ii) Canvas

1. **In the linear method,** each warp thread is represented by a vertical line and each weft thread by a horizontal line.
   - ✓ The point of intersection of lines corresponding to a **warp overlap** is marked by the **dot**, and the point of intersection corresponding to **weft overlap** remains **unmarked.**
2. **In the canvas method**, a **squared paper** is employed on which each vertical space represents a warp thread and each horizontal space represents a weft thread.

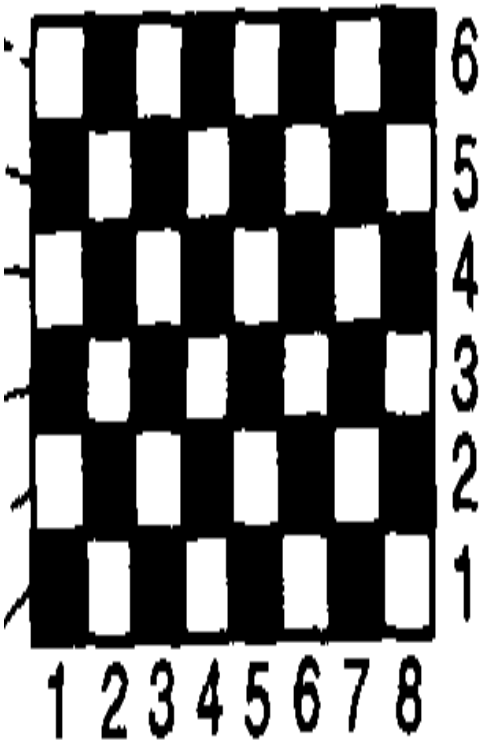
- ✓ Each square therefore indicates an intersection of warp and weft thread.
- ✓ To show the warp overlap, a square is filled in or shaded. The blank square indicates that the weft thread is placed over the warp i.e. weft overlap.



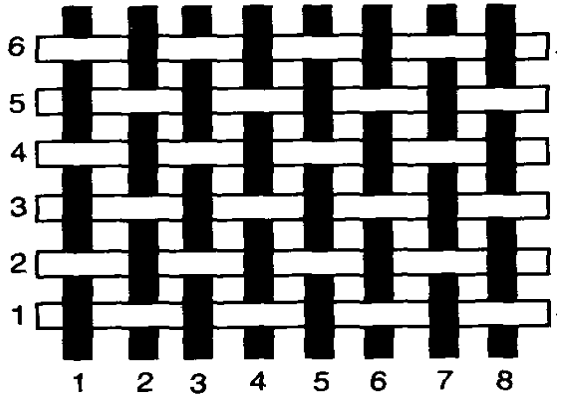
Linear method



Cross-section diagram



Canvas method

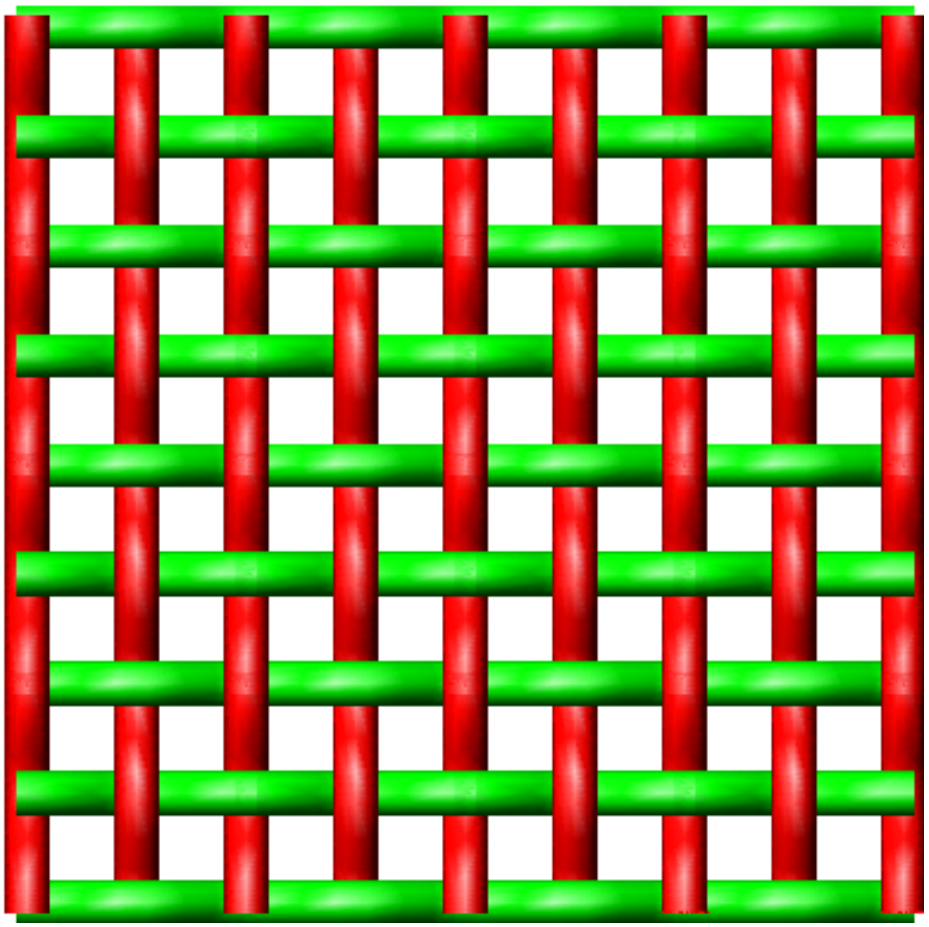


Plan diagram

longitudinal-section diagram

Plan diagram

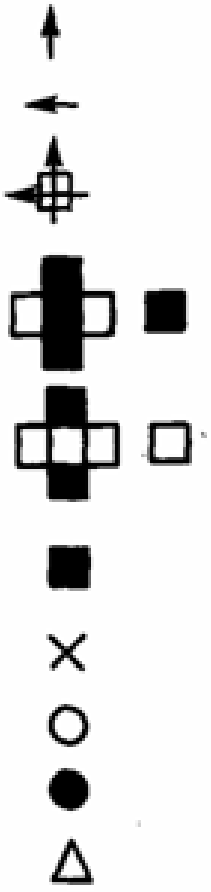
longitudinal-section diagram



Cross-section diagram

Main points about the canvas method:

- The canvas method is widely used in the world.



Each vertical space represents a warp end
Each horizontal space represents a weft pick
Each square indicates an intersection point of 1 end and 1 pick

Warp floats = Warp over weft
Only warp floats or lifts are indicated
Weft floats = Warp under weft
Blanks represent weft floats

In some structures several different marks are used simultaneously
It is important to give a clear indication of the key to a diagram
All marks = warp up

BASIC ELEMENTS OF A WOVEN DESIGN

- ✓ The three basic elements in a woven design are ,

(i) Design

(ii) Draft or drawing plan

(iii) Peg or lifting plan

1. design - The design indicates the **interlacement** of warp and weft threads in the repeat of the design.

- ✓ It is made up of a number of **squares,** which constitute the repeat size of a design.
- ✓ The **vertical direction** of the squares indicate the **picks** and the **horizontal direction** indicates the **ends.**
- ✓ A **blank** in a square indicates that a **warp** goes **below** the corresponding weft and **'X'** mark in the square indicates that the warp floats above the weft.

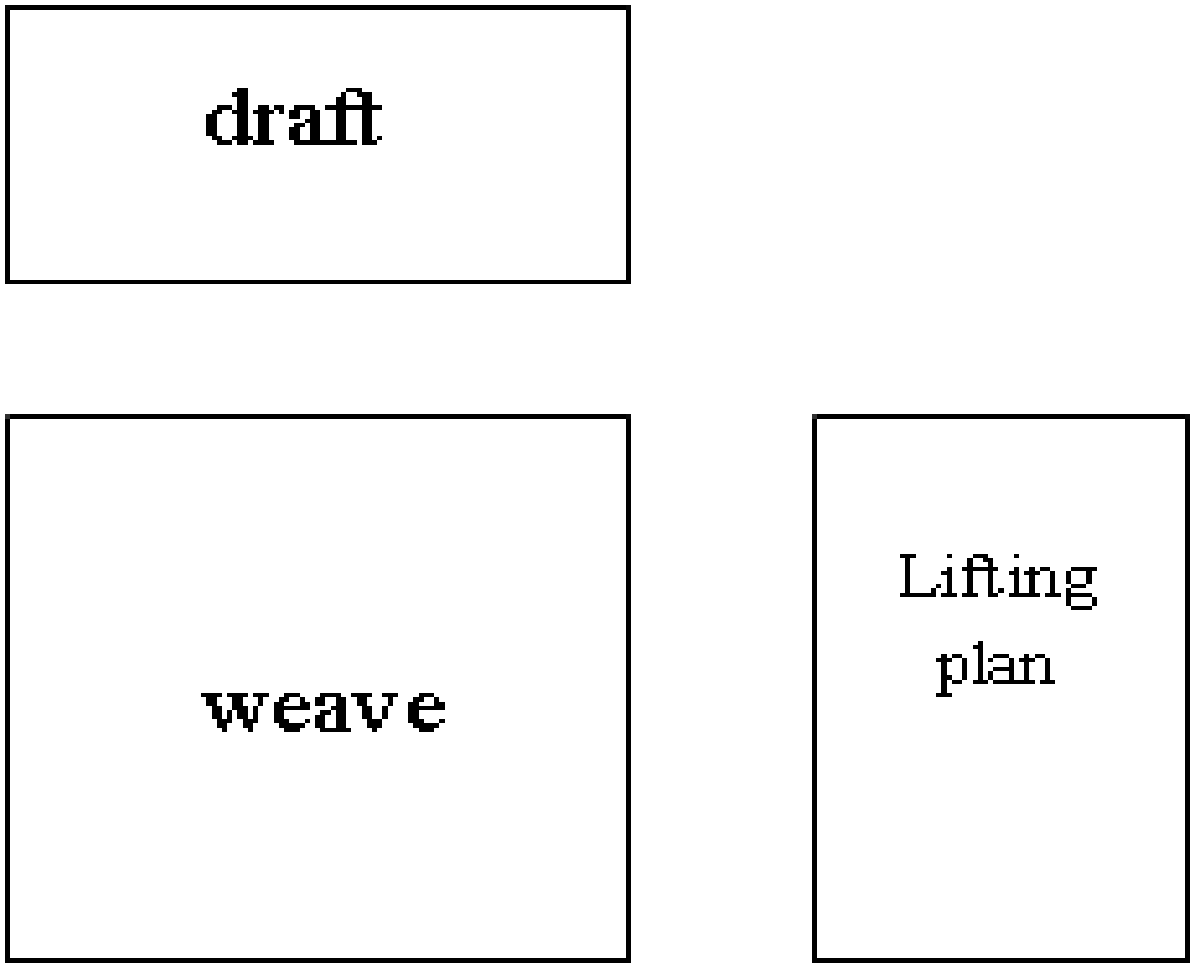
2. The draft or drawing plan - indicates the manner of **drawing the ends** through the heald eyes and it also denotes the number of heald shaft required for a given weave repeat.

- The choice of the type of drafting plan depends upon the type of fabric woven.
- The various drafts can be classified as follows:

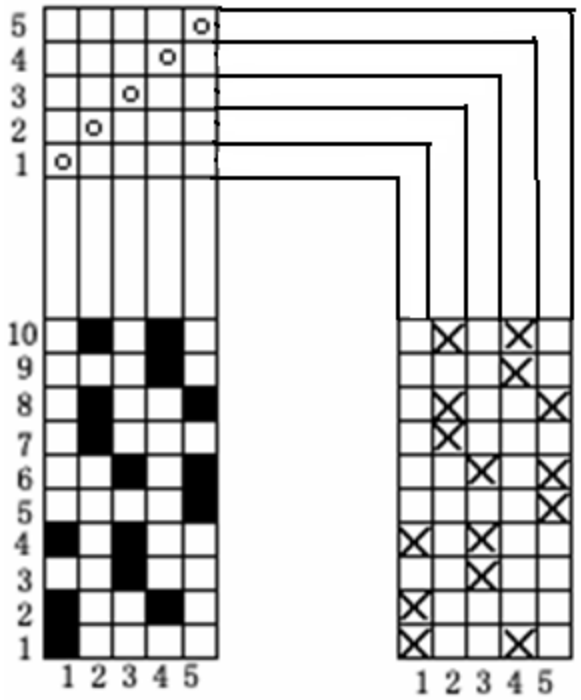
(1). Straight
(2). Skip and sateen
(3). Pointed
(4). Broken
(5). Divided
(6). Grouped
(7). Curved
(8). Combined

3. The peg or lifting plan provides useful information to the weaver.

- ✓ It denotes **the order** of lifting of heald shafts.
- ✓ In a peg plan the **vertical spaces** indicate the **heald shafts** and the **horizontal spaces** indicate the **picks.**
- ✓ The peg plan depends upon the drafting plan.
- ✓ In the case of **straight draft,** the **peg plan** will be the **same** as **design.** Hence no peg plan is necessary in the case of straight draft.


draft
weave
Lifting plan

- ✓ These three elements are closely dependent on one another. If any two elements of the weaving plan are known, the third element can be constructed. (see the figure on the right)
- ✓ Weaving plan gives the introduction of weaving process.

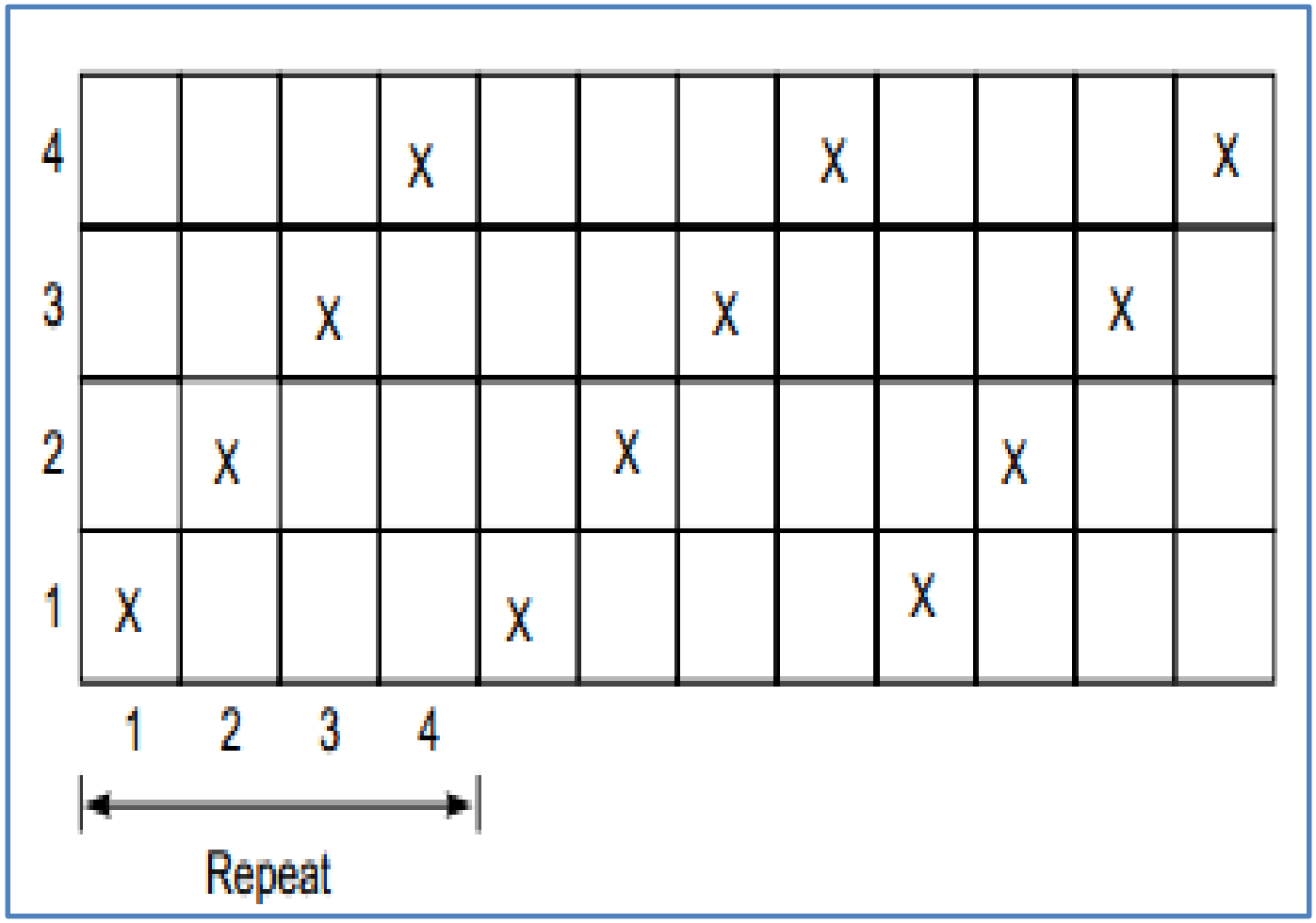


Type of draft plan

- ✓ The various drafts are classified as follows
  - ✓ Straight
  - ✓ Pointed
  - ✓ Skip and sateen
  - ✓ Broken
  - ✓ Divided
  - ✓ Grouped
  - ✓ Combination

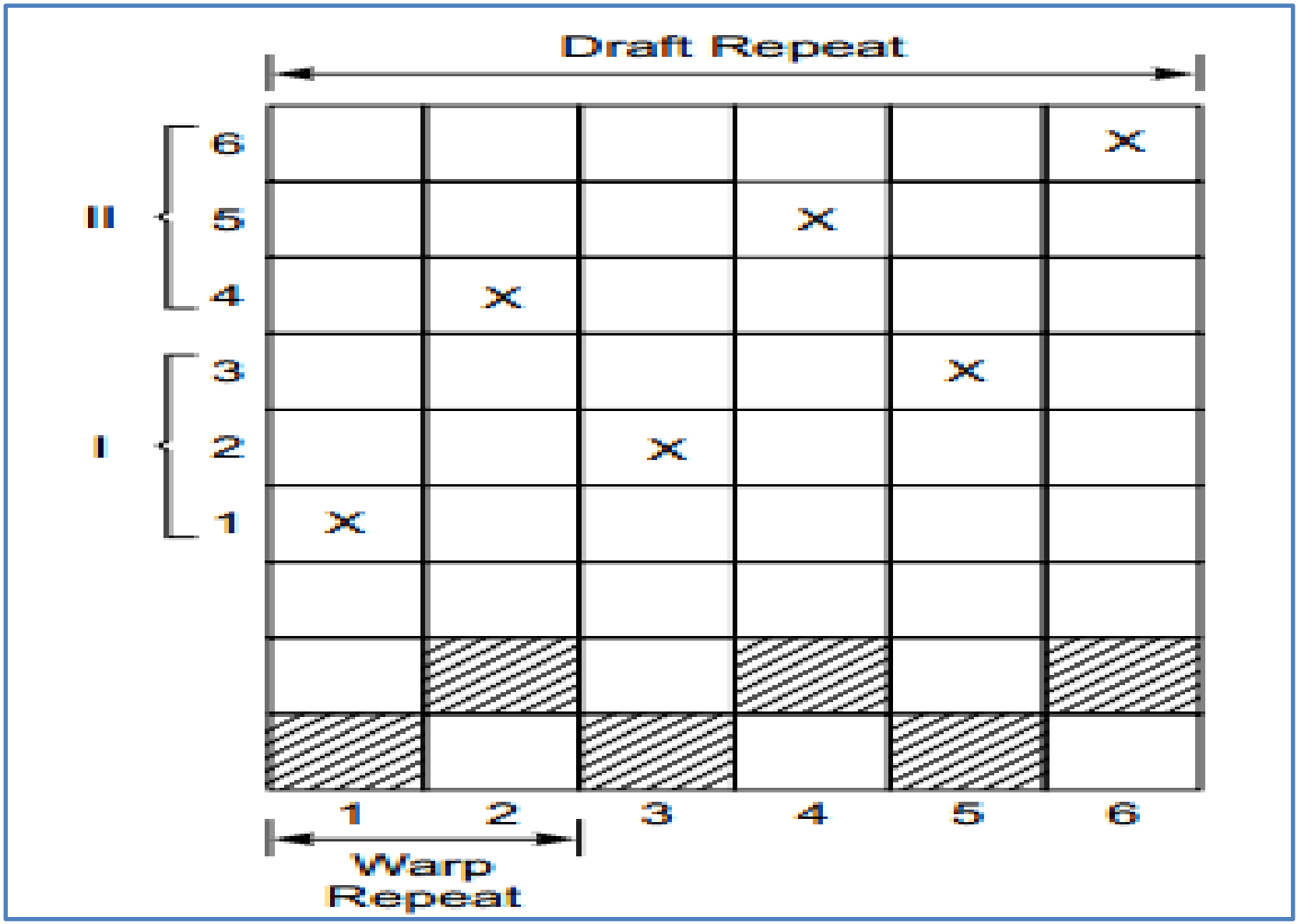
1. STRAIGHT DRAFT

- ✓ This is the most common and simplest types of draft plans.
- ✓ In this kind of draft the **drafting order progresses successively** from first to the last heald frame.
- ✓ Thus the **first warp** end of a weave is **drawn through the first heald shaft**, The **second warp** through the **second heald frame** and so on.
- ✓ One **important feature** of the straight draft that distinguishes it from other types of draft plans is that **the peg or lifting plan is same as the design.**
- ✓ Hence it is sufficient to indicate only the design.


4
3
2
1
X
1
2
3
4
Repeat

2. Skip draft

- The skip draft is suitable for a fabrics having **heavy warp thread density**.
- In this kind of draft plan the **number of heald frames** may be **twice** or **more than the minimum required** for a weave.
- Only to distribute the warp threads more uniformly so as to **prevent abrasion** of the threads due to overcrowding.
- The **heald frames** are divided into **two groups.**
- All **odd** numbered warp threads are **drawn through** the **first group** of **heald frames** and all **even numbered** warp ends are **drawn through** the **second group** of **heald frames.**


Draft Repeat
II
I
6
5
4
3
2
1
X
1
2
3
4
5
6
Warp
Repeat

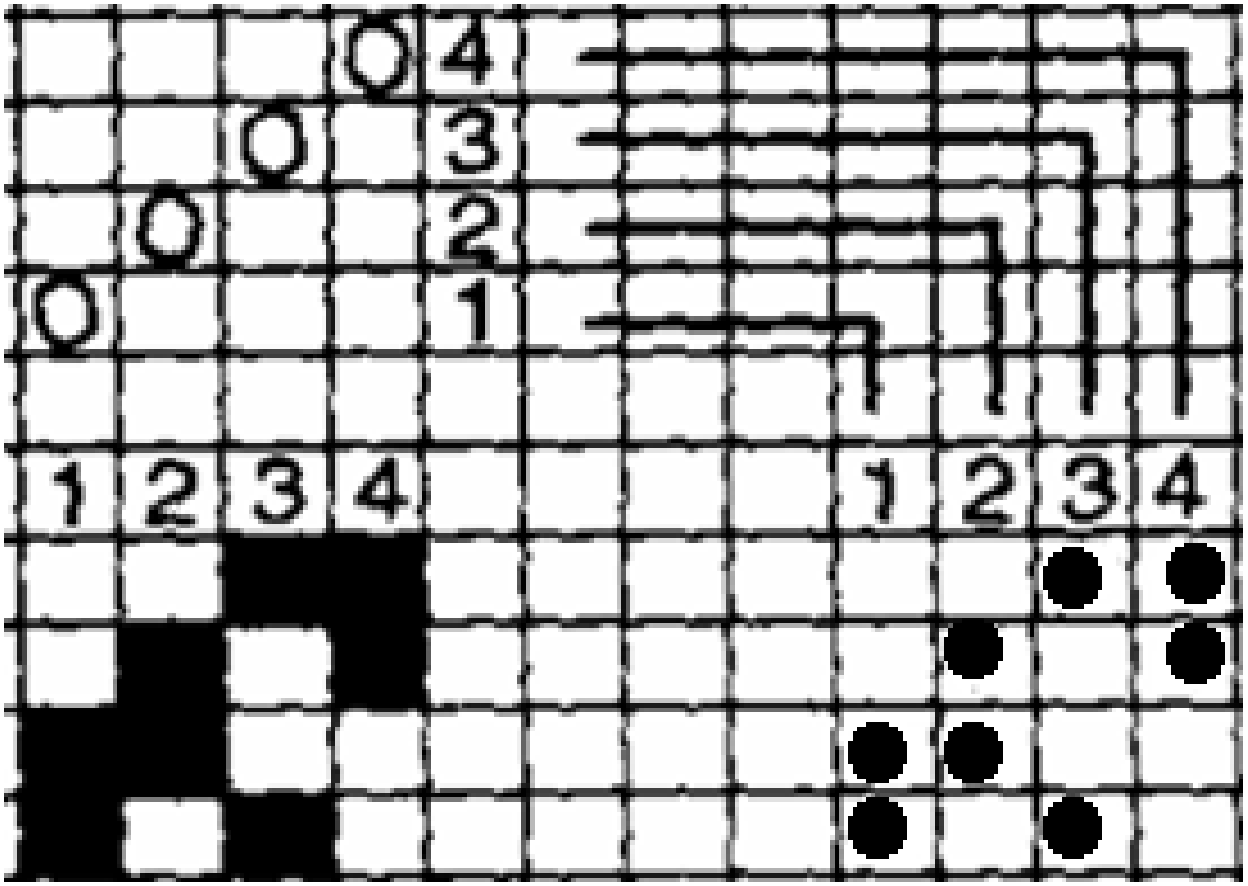
- The sateen draft serves the same purpose as the skip draft.
- A skip draft is normally employed for weaves such as plain and twill up to a repeat of 4.
- Whereas the sateen draft is used for weaves having repeat size of more than 5.

Relations between Weave, Draft, and Lifting.

- ✓ Three elements of a weaving plan are dependent on one another.
- ✓ Any element of the weaving plan can be constructed if two others are given.
- ✓ The construction of any woven fabric depends upon the design, draft and lifting plan,
- ✓ These are very closely dependent upon one another.
- ✓ Knowledge of inter dependence is very valuable to the designer upon whose skill,
- ✓ Several mechanical limitations of the loom may be imposed.
- ✓ The drafting systems and lifting orders enables to introduce variety into rigid mechanical systems of operation.

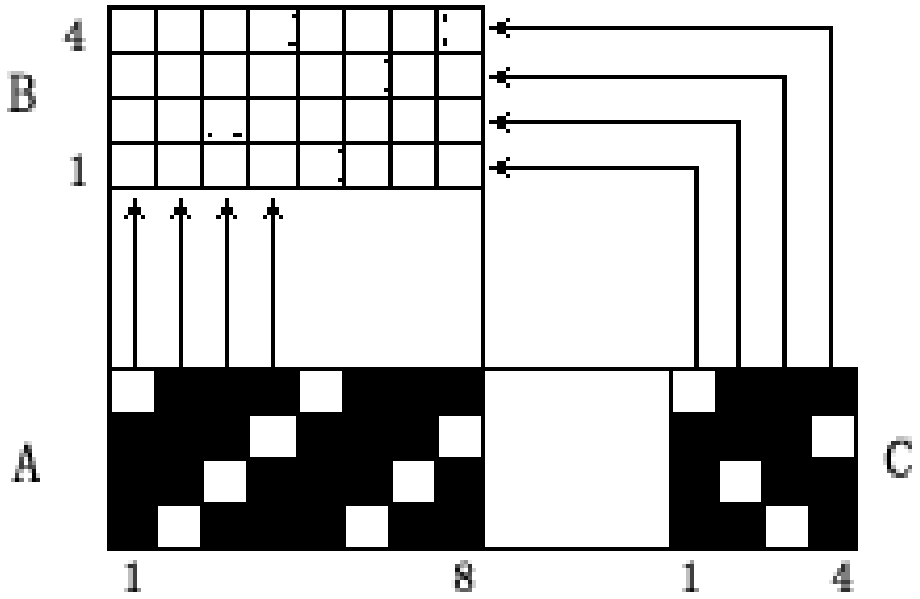
- In normal practice the designer has to produce a range of designs for looms with a known pattern scope.
- Usually involves the draft and the lifting plan construction.
- A similar procedure is adopted when the designer is asked to reproduce a specific design from a sample.
- The weave in the sample is analysed and a suitable draft and lifting plan is derived.

1. Construction of Lifting Plan from the Given Weave and Draft.



2. Construction of Draft from a Given Lifting Plan and Weave.

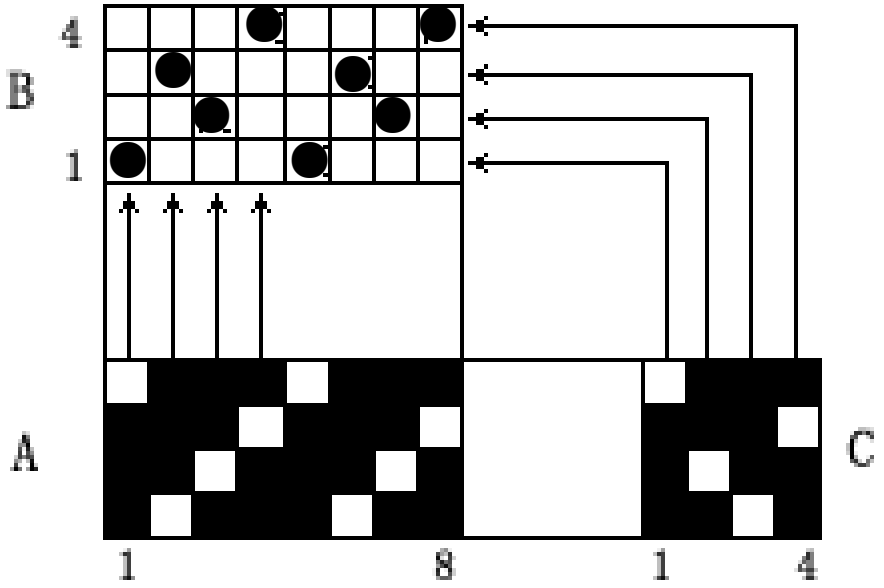
- ✓ This diagram shown the lifting plan and the weave are given, and the problem is to construct the draft.



To Construct the draft

Principle and method

- The number of vertical spaces at C corresponds to the number of horizontal spaces at B.
- It means that the first vertical space at C controls the first shaft, the second vertical space controls the second shaft, and so on.
- Then the draft is constructed by comparing the arrangement of the lifting plan at C and weave at A. and so on.



3. Construction of weave from a Given Draft and lifting plan.

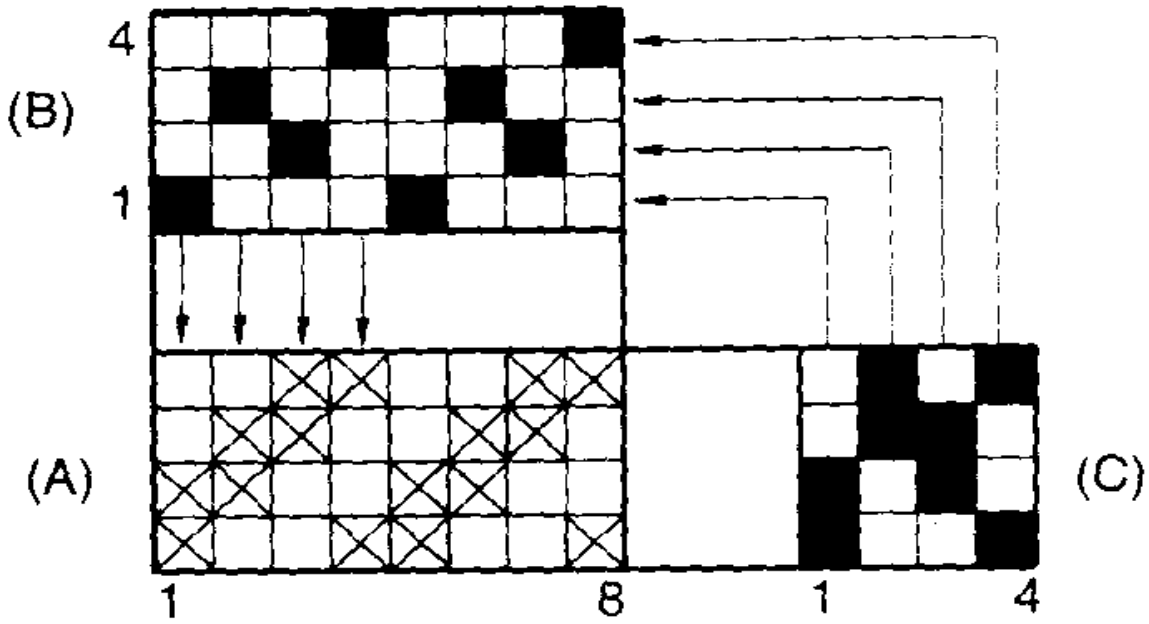


Fig. 1. 19 Construction of weave