Joint Beginning and Intermediate Engineering Graphics
9th Week Lecture Notes & Study Questions
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Topic: Threads and Fasteners

1st Subject: Types of Threads and Fasteners and Their Nomenclature

A. Functions of screw threads and standardization:

The three basic usages of screw threads are: (1). to hold parts together; (2). to adjust parts with reference to each other's position; and (3). to transmit power.

In 1948, the ABC nations (USA, UK and Canada) reached agreement to merge the American Standard screw system with the English Whitworth screw system into Unified Screw Thread system, as required by wartime cooperation between the Allies (ANSI Y14.6-1978 and Y14.6aM-1981).

Standard threads use 60◦ Sharp-V Thread originally called the United States Standard Thread or Sellers Thread. In 1946, ISO (International Standardization Organization) initiated efforts to standardize metric screw system, and with cooperation from the IFI (Industrial Fasteners Institute), the American National Standards Institute, a metric fastener standard (IFI-500-1975) was presented.

B. Nomenclature (structure) of screw-thread:

- Screw thread: A ridge of helix-shaped uniform section, on the inside or outside surface of a cylinder. A helix is a continuous series of threads winding around a shaft in a curve.
- External thread: A thread winding on the outside of a cylinder such as a shaft (Example, threads on a screw).
- Internal thread: A thread winding on the inside of a cylinder such as a hole.
- Angle of thread: The angle between the sides of the thread.
- Depth of thread: The distance between the crest and the root of the thread.
- Forms of thread: The cross section of thread cut by a plane through the axis. They can be:
    1. American National thread: flattened crest and root, strong.
    2. Unified thread: basically similar to American National; flat or rounded external thread, and round root.
    3. Metric thread: flat crest and root, but with external thread often rounded when formed by the rolling process. Similar to AM and Unified but with less depth of thread.
    4. Square thread: theoretically the ideal thread for power transmission but due to inherent disadvantage such as difficulty of disengagement of split nuts, is replaced by Acme threads.
    5. Acme thread: a modification of square thread. Stronger and easier to cut than square thread. Easy disengagement from a split nut.

6. Standard Worm thread: similar to Acme thread but deeper. Used on shafts to transmit power to worm wheels.
7. Whitworth thread: the old UK standard now being replaced by the Unified thread.
8. Knuckle thread: usually rolled from sheet metal but occasionally cast, used in electric bulbs and sockets, bottle tops, etc. Round crest and root.
9. Buttress thread: used to transmit power in one direction only (jacks, breech locks of large guns, airplane propeller hubs, etc.)

American National, Acme, Square and Knuckle are the four major categories.

- Series of thread: Standard number of threads per inch for various diameters.
- Major and minor diameters: The major diameter is the largest diameter of a screw thread (crest-to-crest). The minor diameter is the smallest diameter of a screw thread (root-to-root). These definitions apply to both internal and external threads.
- Pitch and pitch diameter: The pitch is the distance from a point on a screw thread to the corresponding point on the next thread, measured parallel to the axis. The pitch is expressed in terms of the number of threads per inch, or P=1/number of threads per inch (if a thread has 4 threads per inch, then the pitch is ¼"). The smaller the number of threads per inch, the larger the pitch and the thread. The pitch diameter is the diameter of an imaginary cylinder passing through the threads, which make equal the widths of the threads and the widths of the space cut by the cylinder. The pitch or number of threads per inch can be measured with a scale or a thread-pitch gage.
- Crest: The top surface joining the two sides of a thread.
- Root: The bottom surface joining the sides of two adjacent threads.
- Side: The surface of the thread that connects the crest with the root.
- Axis of screw: The longitudinal centerline of a screw.
- Lead: The distance a screw thread advances axially in one turn.

C. Types of threads:

- Right-hand and left-hand thread: A right-hand (RH) thread winds in a clockwise and receding direction and advances into the nut when turned clockwise. A left-hand (LH) thread behaves in the opposite way. A thread is always considered as right-hand unless specified LH on the drawing.
- Single and multiple threads: A single thread is made of one ridge, and in this thread, the lead is equal to the pitch. Multiple threads are made of two or more ridges running side by side; in double threads, the lead is twice the pitch; in triple threads, the lead is three times the pitch. In one turn, a double thread advances twice as far as a single thread; and a triple thread advances three times as far as a single thread. Multiple threads are for quick motion but not for transmission of great power. Examples: toothpaste caps, valve stems, fountain pens, etc.

D. The most common categories of threads and fasteners:

- Standard bolts and nuts: available in hexagon form (inch and metric series, chamfered at 15°-30° but both drawn at 30° for simplicity) and in square form (inch series, chamfered at 30°). Bolt types include regular bolts and nuts for general use and heavy bolts for heavier service or easier wrenching, high-strength bolts and nuts for structural bolting.

- Locknuts and locking devices: locknuts used to prevent nuts from unscrewing, available with or without washer face in the regular and heavy types, with flat tops chamfered at 30°.
  Standard cap screw: can have hexagon head, flat head, round head, fillister head, and hex socket, are used on machine tools and other machines which require accuracy and good appearance, but infrequent removal and few adjustment.
  Standard Machine screw: are similar to cap screws but are in general smaller, can have round head, flat head, oval head, fillister head etc., are particularly adapted to screwing into thin materials, and are used in jigs, firearms, dies and fixtures.
- American National Standard Wood Screw: can have three standardized styles of heads (flat, round, and oval), use Phillips style recessed head with three styles of cross recesses standardized by ANSI. Use special screwdriver for rapid assembly without damage to the head.

- Rivets: used as permanent fastenings and hold rolled steel shapes or sheet metal together, are made of wrought iron, copper, carbon steel etc. Large rivets or heavy hex structural bolts are used in bridges, building, ship and boiler's structural constructions.
  Springs: are mechanical devices used to store energy when deflected and to return the equivalent amount of energy when released, and are classified as helical springs (cylindrical or conical but usually cylindrical) and flat springs. Springs are drawn in detailed and schematic methods but not in true projections.

2nd Subject: Graphic Representation of Threads and Fasteners

A. Thread symbol: three graphic conventions are used:

- Detailed: is a graphical approximation of the appearance of a screw thread but not a true projection.
- Schematic: shows the individual threads in a symbolic way and is more commonly used than detailed.
- Simplified: does not show the individual threads but instead the whole screw in a symbolic way, and is more commonly used than detailed.

For clarity of representation, the three types of thread symbols can be combined on a single drawing. Phantom lines can be used to represent identical thread features and to save drafting time.

3rd Subject: Fits and Specifications of Threads and Fasteners

Threads are classified as Fine (F), Extra Fine (EF) or Coarse (C) according to their properties and qualities. Threads can also be classified according to their fits (degree of looseness or tightness between mating parts (for example, a screw and a threaded hole)
For Metric and Unified screw threads:
According to ANSI B1.1-1982 standard for Unified screw threads, there are three classes of fit defined by specific tolerances and allowances (degree of looseness or tightness)

between mating parts, with letter □ designating external threads and letter □ designating internal threads:

- Class 1A and 1B fits: used for rapid assembly and disassembly with generous tolerances;
- Class 2A and 2B fits: used in the normal production of bolts, nuts, screws, etc.;
- Class 3A and 3B fits: used in cases where highly accurate and close-fitting threads are required.

For American National Thread Fits: According to ANSI B1.1-1982, for general use, there are three classes of screw thread fits between mating threads (between nut and bolt, etc.) which are produced by the application of tolerance:

- Class 1 fit: good only for screw thread work where clearance between mating parts is vital for rapid assembly and where shake or play is OK.
- Class 2 fit: high quality commercial thread product good for the great bulk of interchangeable screw thread work.
- Class 3 fit: exceptionally high quality commercially threaded product good only in cases where the high cost of precision tools and continual checking are warranted.

Compare these three fits of the American National threads with the three fits for the Unified threads, and try to understand their similarities and differences.

4th Subject: Thread Notes

A. Use of thread notes: used in specifications for parts, taps, tools, gages and dies, on shop and stockroom records, and in correspondence. Screw threads are usually drawn symbolically, and therefore, usage of thread notes or callout is vital in a drawing.

B. Examples of notation formats for different types of thread:

- Metric thread notes:

Basic note: M10 x 1.5	M10: Metric Nominal size (basic x 1.5: Pitch
Detailed note: M10 x 1.5-6H LH	M10 x 1.5-: Basic note 6H: Tolerance grade LH: Left-hand
Detailed: M10 x 1.5-6H/5g6g	M10 x 1.5 -: Basic note 6H/5g6g: Tolerance grade for ext./internal thd (absence of LH indicates RH)
Detailed: M10 x 1.5-6H/6g-N-LH	M10 x 1.5-: Basic note 6H/6g-N: Length of thd engagement (S=short, N=normal, L=long) LH: left hand

- American National thread notes:
  Examples: 2-8N-2, 2-12N-2, and 2-16N-2 LH

- Unified thread notes: distinguished from American National by the letter U before the series and by the letter A or B for internal or external thread. Examples:
  Internal thread: ¼-20 UNC-2B LH, 9/16-18 UNF-2B
  External thread: ¼-28 UNF-2A, ¼-20 UNC-2A TRIPLE

C. Designation for internal and external threads:

- Hole (internal) thread note: Thread note for holes should be attached to the circular view.
  Complete note: .6562 DRILL 1.38 DEEP 3/4-10 NC-2 LH-1.00 DEEP
  .6562 DRILL 1.38 DEEP: total depth
  3/4-: major thread diameter
  10: number of threads/inch
  NC-2: series ad fit
  LH-1.00 DEEP: left hand, 1.00 inch thread depth
  If the thread is a multiple thread, then the word DOUBLE, TRIPLE, or QUADRUPLE should precede the thread depth, otherwise, it would be understood as a single thread:
  .6562 DRILL 1.38 DEEP 3/4-10 NC-2 LH-TRIPLE 1.00 DEEP

- Shaft (external) thread note: Thread note for external thread (screws) should be attached to the longitudinal view of the threaded shaft. Examples for external thread notes:
  - M10 x 1.5
  - 1½-6NC-3 LH DOUBLE
  - 1½-3 SQUARE
  - 1¼-5 ACME-2G (Class of fit=2, General-purpose thread)
  - 1¼-6 ACME-4C (Class of fit=4, Centralizing ACME thread)

Study Questions:

1. What are the three basic usages of screw?

2. What is the difference between internal and external threads?

3. What is the definition of the series of thread? Give some examples.

4. Study the attached handouts and sketch the forms of the following threads, and indicate their usage: Unified, Square, Acme, Worm, Whitworth, Knuckle, Sharp V, and Buttress.

5. What is the difference between RH and LH threads?

6. What is the difference between single and multiple threads? What are their applications?

7. What are Standard bolts and nuts used for?

8. What are Locknuts and locking devices used for?

9. What are Standard cap screws used for?

10. What are Standard Machine screws used for?

11. What are American National Standard Wood Screws used for?

12. What are rivets used for?

13. What are springs used for?

14. Can the three types of thread representation appear on the same drawing? Please explain the reason.

15. For Metric and Unified threads, what are the applications of Class 1A and 1B fits, Class 2A and 2B fits, and Class 3A and 3B fits?

16. For American National threads, what are the applications of Class 1, 2,and 3 fits?