The Future of Education . Application Peter Chew Triangle Diagram In Civil Engineering

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Abstract.
The objective of Peter Chew Triangle Diagram is to clearly illustrate the topic solution of triangle and provide a complete design for the knowledge of AI age. Peter Chew's triangle diagram will suggest a better single rule that allows us to solve any problem of topic solution of triangle problems simple, directly, more easily and more accurately. There are two important rules for the topic solution of triangle, vicelike the sine rule and the cosine rule. The sine rule generally is used to find a non-included angle when we're given two sides and a non-included angle or the opposite side angle given when are given two angles and one side. The cosine rule generally is used to find the angle when we're given three sides or to find the third side when are given two sides and the included angle. Peter Chew Method can let us to find the third side simple when given two sides and a non-included angle. Peter Chew Rule allow us to find a non included angle simple, directly when given 2 sides and an included angle. Applying Peter Chew's Triangle Diagram to Civil Engineering problems allows us to solve Civil Engineering problems simply and easily. This can effectively allow Civil Engineering students to easily learn Civil Engineering, especially when similar covid-19 issues arise in the future.

Keywords: Peter Chew Triangle Diagram, Civil Engineering.
1. Introduction

1.1 Solution of Triangle.

There are two important rules for the topic solution of triangle, vicelike the sine rule and the cosine rule.

The sine rule generally is used to find a non-included angle when we're given two sides and a non-included angle or the opposite side angle given when are given two angles and one side.

The cosine rule generally is used to find the angle when we're given three sides or to find the third side when are given two sides and the included angle.

Peter Chew Method can let us to find the third side simple when given two sides and a non-included angle. Peter Chew Rule allow us to find a non included angle simple and directly when given 2 sides and an included angle.

1.2 The Leaning Tower.

1.2.1 Leaning Tower of Pisa in 2013
The Leaning Tower of Pisa (Italian: torre pendente di Pisa), or simply the Tower of Pisa (torre di Pisa ['torre di ˈpiːza; ˈpiːsa]), is the campanile, or freestanding bell tower, of the cathedral of the Italian city of Pisa, known worldwide for its nearly four-degree lean, the result of an unstable foundation.

The tower is situated behind the Pisa Cathedral and is the third-oldest structure in the city's Cathedral Square (Piazza del Duomo), after the cathedral and the Pisa Baptistery.

The height of the tower is 55.86 metres (183 feet 3 inches) from the ground on the low side and 56.67 m (185 ft 11 in) on the high side. The width of the walls at the base is 2.44 m (8 ft 0 in). Its weight is estimated at 14,500 tonnes (16,000 short tons). The tower has 296 or 294 steps; the seventh floor has two fewer steps on the north-facing staircase.

The tower began to lean during construction in the 12th century, due to soft ground which could not properly support the structure's weight, and it worsened through the completion of construction in the 14th century.

By 1990, the tilt had reached 5.5 degrees. The structure was stabilized by remedial work between 1993 and 2001, which reduced the tilt to 3.97 degrees.
The height of **56.7 meters** (rounded by Google at 57m) is measured from the lowest point on the base to the **highest** point on the top. At its **lowest** point, the Tower measures **55.9m**. However, the Tower is taller than that!

Since its foundation is sunk into the ground (about 2 meters deep at the lowest point) the total height of the Tower would be **58.36 meters**.
1.2.2 Capital Gate in 2013

Capital Gate, also known as the Leaning Tower of Abu Dhabi, is a skyscraper in Abu Dhabi that is over 160 meters (520 ft) tall, 35 stories high, with over 16,000 square meters (170,000 sq ft) of usable office space. Capital Gate is one of the tallest buildings in the city and was designed to incline 18° west. The building is owned and was developed by the Abu Dhabi National Exhibitions Company. The tower is the focal point of Capital Centre.

(a) Foundation

The structure rests on a foundation of 490 pilings that have been drilled 30 meters (98 ft) below ground. The deep pilings provide stability against strong winds, gravitational pull, and seismic pressures that arise due to the incline of the building. Of the 490 pilings, 287 are 1 meter (3 ft 3 in) in diameter and 20 to 30 meters (66 to 98 ft) deep, and 203 are 60 centimeters (24 in) in diameter and 20 meters (66 ft) deep. All 490 piles are capped together using a densely reinforced concrete mat footing nearly 2 meters (6.6 ft) deep. Some of the piles were only initially compressed during construction to support the lower floors of the building. Now they are in tension as additional stress caused by the overhang has been applied.

Capital Gate was designed by architectural firm RMJM and was completed in 2011. The tower includes 16,000 square meters (170,000 sq ft) of office space and the Andaz Hotel on floors 18 through 33.
2. Peter Chew triangle Diagram

<table>
<thead>
<tr>
<th>Given 2 sides and an angle</th>
<th>Given 2 sides and one non-included angle</th>
<th>Given 2 sides and an included angle</th>
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1. Find side b, use Peter Chew Method.
   Use $a^2 = b^2 + c^2 - 2bc \cos A$
2. Find angle C, use sine rule,
   Use $\frac{a}{\sin A} = \frac{c}{\sin C}$
3. Find angle B,
   Use sine rule, find angle C first, then $\angle B = 180^\circ - \angle A - \angle C$.

<table>
<thead>
<tr>
<th>Given 2 angles and one sides or three sides</th>
<th>Three sides</th>
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<tbody>
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2 angles and one sides

1. Find side b, use sine rule.
   Use $\frac{b}{\sin B} = \frac{c}{\sin C}$
2. Find side a, use sine rule,
   Use $\frac{a}{\sin(180^\circ - \angle B - \angle C)} = \frac{c}{\sin C}$
3. Find angle A,
   Use $\angle A = 180^\circ - \angle B - \angle C$.

1. Find angle A, use cosine rule.
   Use $a^2 = b^2 + c^2 - 2bc \cos A$
2. Find angle B, use cosine rule.
   Use $b^2 = a^2 + c^2 - 2ac \cos B$
3. Find angle C, use cosine rule.
   Use $c^2 = a^2 + b^2 - 2ab \cos C$
3. Peter Chew triangle Diagram Example solution

<table>
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<th>Given 2 sides and one non included angle</th>
<th>Given 2 sides and an included angle</th>
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</thead>
<tbody>
<tr>
<td>Find side</td>
<td>Find angle</td>
<td>Find side</td>
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<tr>
<td></td>
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<td>Find angle</td>
</tr>
</tbody>
</table>

**Given 2 sides and an angle**

**Use Peter Chew Method**

\[ a^2 = b^2 + c^2 - 2bc \cos A \]

**Use Sine rule:**

\[ \frac{a}{\sin A} = \frac{c}{\sin C} \]

\[ \frac{6}{\sin 30^\circ} = \frac{4}{\sin C} \]

\[ \sin C = \frac{4 \sin 30^\circ}{6} = 0.3333 \]

\[ C = 19.47^\circ, 161^\circ (reject) \]

**Find side**

\[ b^2 = 6.928 \]

\[ b = 9.12, -2.19 (reject) \]

**Find angle**

\[ b = 5.385 \]

**Use Cosine rule:**

\[ a^2 = b^2 + c^2 - 2bc \cos A \]

\[ \cos A = 0.7143 \]

\[ A = 44.41^\circ \]

**Given 2 sides and one non included angle**

**Use Peter Chew Method**

\[ a^2 = b^2 + c^2 - 2bc \cos A \]

\[ 6^2 = b^2 + 4^2 - 2b(4) \cos 30^\circ \]

\[ b^2 - 6.928 b - 20 = 0 \]

\[ b = 9.12, -2.19 (reject) \]

**Use Sine rule:**

\[ \frac{a}{\sin A} = \frac{c}{\sin C} \]

\[ \frac{6}{\sin 30^\circ} = \frac{4}{\sin C} \]

\[ \sin C = \frac{4 \sin 30^\circ}{6} = 0.3333 \]

\[ C = 19.47^\circ, 161^\circ (reject) \]

**Find side**

\[ b = 5.385 \]

**Find angle**

\[ b = 5.385 \]

**Given 2 angles and one sides or three sides**

**2 angles and one sides**

**Use Sine rule:**

\[ \frac{b}{\sin B} = \frac{c}{\sin C} \]

\[ \frac{3}{\sin 50^\circ} = \frac{c}{\sin 30^\circ} \]

\[ c = \frac{3 \sin 30^\circ}{\sin 50^\circ} = 1.958 \]

**Find side**

\[ \cos A = 0.7143 \]

\[ A = 44.41^\circ \]

**Use Cosine rule:**

\[ a^2 = b^2 + c^2 - 2bc \cos A \]

\[ 5^2 = 7^2 + 4^2 - 2(7)(4) \cos A \]

**Find angle**

\[ A = 44.41^\circ \]

4. Application of Peter Chew Triangle Diagram In Civil Engineering
4.1 Given 2 sides and included angle, find another non included angle. Peter Chew Triangle Diagram recommend Peter Chew Rule.

Example 4.1 The elevation angles of a leaning tower top(A) measure from point C on ground level is 50°. Given that that BC = 40 km, AC= 110 km, find the degree of inclination of the leaning tower.

![Diagram of leaning tower with angle measurements and lengths](image)

**Current Solution**

Applying the cosine rule, \( AB^2 = 110^2 + 40^2 - 2(110)(40)\cos 50° \)

\[ = 8043 \]

\[ AB = \sqrt{8043} = 89.68 \text{ km} \]

Let the degree of inclination of the leaning tower as \( \alpha \)

Applying the sine rule:

\[ \frac{89.68}{\sin 50°} = \frac{110}{\sin \alpha} \]

\[ \sin \alpha = \frac{110 \sin 50°}{89.68} \]

\[ = 0.9396 \]

\[ \angle AOB = 110° \ 1', \ 69°59', \text{ (Reject) } \]

**Hence**, the degree of inclination of the leaning tower \( \alpha^\circ \) is **110° 1'**.

**Peter Chew Rule For Solution Of Triangle**

\[ \tan \alpha^\circ = \frac{110 \sin 50°}{40 - 110 \cos 50°} \]

\[ = -2.744 \]

\[ \alpha^\circ = 110° \ 1' \]

**Note:** Peter Chew Triangle Diagram will suggest a better single rule that allows us to solve any problem of topic solution of triangle problems directly, more easily and more accurately.
If we use Math Portal for calculation Example 4.1 (as of 12-12-2023), we can see that Math Portal recommends complex solutions.

**Explanation**

**STEP 1: find side $c$**

To find side $c$ use Law of Cosines:

$$c^2 = a^2 + b^2 - 2 \cdot a \cdot b \cdot \cos(\gamma)$$

After substituting $a = 40$, $b = 110$ and $\gamma = 50^\circ$ we have:

$$c^2 = 40^2 + 110^2 - 2 \cdot 40 \cdot 110 \cdot \cos(50^\circ)$$

$$c^2 = 1600 + 12100 - 2 \cdot 40 \cdot 110 \cdot \cos(50^\circ)$$

$$c^2 = 13700 - 2 \cdot 4400 \cdot \cos(50^\circ)$$

$$c^2 = 13700 - 8800 \cdot 0.6428$$

$$c^2 = 13700 - 5656.531$$

$$c^2 = 8043.469$$

$$c = \sqrt{8043.469}$$

$$c \approx 89.6854$$

**STEP 2: find angle $\beta$**

To find angle $\beta$ use Law of Cosines:

$$b^2 = a^2 + c^2 - 2 \cdot a \cdot c \cdot \cos(\beta)$$

After substituting we have:

$$110^2 = 40^2 + 89.6854^2 - 2 \cdot 40 \cdot 89.6854 \cdot \cos(\beta)$$

$$12100 = 1600 + 8043.469 - 7174.8311 \cos(\beta)$$

$$7174.8311 \cos(\beta) = 1600 + 8043.469 - 12100$$

$$7174.8311 \cos(\beta) = -2456.531$$

$$7174.8311 \cos(\beta) = -2456.531$$

$$\cos(\beta) = -0.3424$$

$$\beta = \arccos(-0.3424)$$

$$\beta \approx 110.022^\circ$$
4.2 Given 2 sides and an included angle, find another side. Peter Chew Triangle Diagram recommend Cosine Rule as same as current Method.

Example 4.2 The elevation angles of a leaning tower top(A) measure from point C on ground level is 50°. Given that BC = 40 km, AC= 110 km, find AB.

Applying the cosine rule, \[ AB^2 = 110^2 + 40^2 - 2(110)(40) \cos 50° \]
\[ = 8043 \]
\[ AB = \sqrt{8043} \]
\[ = 89.68 \text{ km} \]

4.3 Given 2 sides and one non-included angle, find another angle. Peter Chew Triangle Diagram recommend Sine Rule as same as current Method.

Example 4.3: The elevation angles of a leaning tower top(A) measure from point C on ground level is 50°. Given that AB = 60 km, AC= 50 km, find the degree of inclination of the leaning tower.

Current Method. Let the degree of inclination of the leaning tower as \( \alpha \)

Applying the sine rule: \[ \frac{60}{\sin 50°} = \frac{50}{\sin \alpha°} \]
\[ \sin \alpha° = \frac{50 \sin 50°}{60} \]
\[ = 0.6384 \]
\[ \alpha° = 39°40', 140°20' \] (which is impossible in this case)

Hence, the degree of inclination of the leaning tower \( \alpha° \) is 39°40'.
4.4 Given 2 sides and one non included angle, find side. Peter Chew Triangle Diagram recommend Peter Chew Method.

Example 4.4: The elevation angles of a leaning tower top(A) measure from point C on ground level is 50°. Given that that AB = 60 km, AC = 50 km. Find BC.

Solution:

Step 1: Let the degree of inclination of the leaning tower as \( \alpha \)

Applying the sine rule:

\[
\frac{60}{\sin 50°} = \frac{50}{\sin \alpha°}
\]

\[
\sin \alpha° = \frac{50 \sin 50°}{60}
\]

\[
\alpha° = 39°40', 140°20' \text{ (which is impossible in this case)}
\]

Step 2: When \( \alpha° = 39°40' \), angle BAC = 180° - 39°40' - 50° = 90° 20'.

Step 3: When angle BAC = 90° 20'

\[
(BC)^2 = 60^2 + 50^2 - 2(60)(50) \cos 90° 20'\]

\[
= 6135
\]

\[
BC = 78.33 \text{ km}
\]

Peter Chew Method:

Cosine rule:

\[
60^2 = (BC)^2 + 50^2 - 2(BC)(50) \cos 50°
\]

\[
(BC)^2 - 64.28 \times BC - 1100 = 0
\]

\[
BC = 78.32 \text{ km} \div 14.04 \text{ (Reject, BC>0)}
\]

Note: Peter Chew Triangle Diagram will suggest a better single rule that allows us to solve any problem of topic solution of triangle problems directly, more easily and more accurately.
If we use Math Portal for calculation Example 4.4 (as of 12-12-2023), we can see that Math Portal recommends complex solutions.


Problem

Find side $a$ of a triangle if side $b = 50$, side $c = 60$ and angle $\gamma = 50^\circ$.

Solution

$\alpha = 78.3231$

Explanation

STEP 1: find angle $\beta$

To find angle $\beta$ use The Law of Sines:

$$\frac{\sin(\beta)}{b} = \frac{\sin(\gamma)}{c}$$

After substituting $b = 50$, $c = 60$ and $\gamma = 50^\circ$ we have:

$$\frac{\sin(\beta)}{50} = \frac{\sin(50^\circ)}{60}$$

$$\sin(\beta) = 0.766$$

$$\beta = \arcsin(0.6384)$$

$\beta = 39.6704^\circ$
**STEP 2: find angle $\alpha$**

To find angle $\alpha$ use formula:

$$\alpha + \beta + \gamma = 180^\circ$$

After substituting $\beta = 39.6704^\circ$ and $\gamma = 50^\circ$ we have:

$$\alpha + 39.6704^\circ + 50^\circ = 180^\circ$$

$$\alpha + 89.6704^\circ = 180^\circ$$

$$\alpha = 180^\circ - 89.6704^\circ$$

$$\alpha = 90.3296^\circ$$

**STEP 3: find side $a$**

To find side $a$ use Law of Cosines:

$$a^2 = b^2 + c^2 - 2 \cdot b \cdot c \cdot \cos(\alpha)$$

After substituting $b = 50$, $c = 60$ and $\alpha = 90.3296^\circ$ we have:

$$a^2 = 50^2 + 60^2 - 2 \cdot 50 \cdot 60 \cdot \cos(90.3296^\circ)$$

$$a^2 = 2500 + 3600 - 2 \cdot 50 \cdot 60 \cdot \cos(90.3296^\circ)$$

$$a^2 = 6100 - 2 \cdot 3000 \cdot \cos(90.3296^\circ)$$

$$a^2 = 6100 - 6000 \cdot (-0.0058)$$

$$a^2 = 6100 - (-34.5145)$$

$$a^2 = 6134.5145$$

$$a = \sqrt{6134.5145}$$

$$a \approx 78.3231$$
4.5 Given 2 angles and one side, find another side. Peter Chew Triangle Diagram recommend Sine Rule as same as current Method.

Example 4.5: The elevation angles of a leaning tower top(A) measure from point C on ground level is 40°. Given that AC = 50 km and the degree of inclination of the leaning tower is 80°. Find AB.

\[ \frac{AB}{\sin 40^\circ} = \frac{50}{\sin 80^\circ} \]
\[ AB = \frac{50 \sin 40^\circ}{\sin 80^\circ} = 32.64 \text{ km} \]

4.6 Given 3 sides, find angle. Peter Chew Triangle Diagram recommend Cosine Rule as same as current Method.

Example 4.6: Given that AB = 50 km, AC = 60 km and BC = 80 km. Find the degree of inclination of the leaning tower.

Solution:
Current Method. Applying the cosine rule,
\[ 60^2 = 50^2 + 80^2 - 2(50)(80)\cos \angle ABC \]
\[ 8000 \cos \angle ABC = 5300 \]
\[ \cos \angle ABC = 0.6625 \]
\[ \angle ABC = 48.51^\circ \]
6. Conclusion

The objective of Peter Chew Triangle Diagram is to clearly illustrate the topic solution of triangle and provide a complete design for the knowledge of AI age. Peter Chew's triangle diagram will suggest a better single rule that allows us to solve any problem of topic solution of triangle problems simple, directly, more easily and more accurately. There are two important rules for the topic solution of triangle, vicelike the sine rule and the cosine rule.

Applying Peter Chew's Triangle Diagram to Civil Engineering problems allows us to solve Civil Engineering problems simply and easily. This can effectively allow Civil Engineering students to easily learn Civil Engineering, especially when similar covid-19 issues arise in the future.

The objective of Peter Chew Triangle Diagram to solve any problem of topic solution of triangle problem simple, directly, easier and more accurately, paralleling Albert Einstein's famous quote: Everything should be made as simple as possible, but not simpler.

In addition, Albert Einstein's also quote:
1. If you can't explain it simply you don't understand it well enough,
2. We cannot solve our problems with the same thinking we used when we created them
3. “Genius is making complex ideas simple, not making simple ideas complex.”
4. God always takes the simplest way.
5. When the solution is simple, God is answering.

Isaac Newton quote Nature is pleased with simplicity. And nature is no dummy.

From the Albert Einstein's and Isaac Newton quote above, it can be seen that simplifying knowledge is very important.
7. Acknowledgement

7.1 Peter Chew Triangle Diagram received Best Presentation Award from International Conference on Engineering Mathematics and Physics (ICEMP 2023, July 5-7, 2023), KL, Malaysia.
7.2 Peter Chew Triangle Diagram has passed peer review by The 12th International Conference on Engineering Mathematics and Physics, ICEMP 2023.

7.3 The aim of the Peter Chew Triangle Diagram aims to facilitate the teaching and learning of the Topic ‘Solution of Triangle’ easily especially during a pandemic such as Covid-19, the Peter Chew Triangle Diagram (preprint) has been published at the World Health Organization (WHO) and Europe PMC. Peter Chew's rule on Peter Chew Triangle Diagram can be applied to Aerospace Engineering, Electrical Engineering and Mechanical Engineering (Jib Crane). Peter Chew's Rule was found to overcome errors in chat GPT and overcome limitation in chat GPT, pioneering Tomorrow's AI System. Peter Chew's Rule was also found to address limitations and error in chat GPT and Wolfram Alpha. Peter Chew's Method on Peter Chew Triangle Diagram can be applied to Aerospace Engineering, Electrical Engineering, Mechanical Engineering (Jib Crane) and Civil Engineering. Peter Chew's Method was found to overcome Incomplete Answers in chat GPT and overcome limitation in chat GPT, pioneering Tomorrow's AI System. Peter Chew's Method was also found to overcome Incomplete Answers and address limitations and in chat GPT and Wolfram Alpha.
8. Reference
12. HOW Tall is the Leaning Tower of Pisa? https://leaningtowerpisa.com/facts/how-tall--leaning-tower-pisa


20. Europe PMC. https://europepmc.org/article/PPR/PPR620074


28. Chew, Peter, Application of Peter Chew Method in Aerospace Engineering (Ground Speed) (February 12, 2023). Available at
SSRN: https://ssrn.com/abstract=4355559 or http://dx.doi.org/10.2139/ssrn.4355559


