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THE DESIGN OF A RIVETED PLATE
GIRDER RAILROAD BRIDGE

Thesis for the Degree of B. S.
MICHIGAN STATE COLLEGE

C. E. Christenson

1949

**The Design of a Riveted Plate Girder
Railroad Bridge**

A Thesis Submitted to

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of

AGRICULTURE AND APPLIED SCIENCE

by

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Candidate for the Degree of

Bachelor of Science

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THE DESIGN OF A PLATE GIRDER
RAILROAD BRIDGE

Data and Specifications:

The design is to be a through plate girder bridge for a single track railroad, the span being 60 ft.-0 in. center to center of end bearings. The governing specifications are those of the A.R.E.A. revised to 1948. The live load is Cooper's Standard E-72 loading and an alternate loading consisting of two 90,000-lb. axles spaced 7 ft.-0 in. center to center as given in specification 203.

In order to satisfy the clearance requirements of specification 105, the main girders are spaced 17 ft.-2 in. center to center, thus allowing for 14-in. cover plates on the upper flanges of the girders. The stringers are spaced 6 ft.-6 in. center to center (Spec. 103). Three equal panels of 20 ft.-0 in. each will be used, since this arrangement gives a reasonable slope to the diagonals of the lateral system. An odd number of panels is preferable to an even number because the maximum moment in the main girders occurs at some distance from the center of the span in the former case, and the resulting maximum moment is smaller.

Structural grade, open-hearth steel is to be used for all parts except the shoes and pedestals of the end bearings which are to be of cast steel. Rivets with a nominal diameter of $\frac{7}{8}$ in. will be used throughout.

The order of design which will be followed is;

1. Ties.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every sale, purchase, and transfer must be properly documented to ensure transparency and accountability. This includes recording the date, amount, and parties involved in each transaction.

Additionally, it highlights the need for regular audits and reconciliations to identify any discrepancies or errors. By implementing robust internal controls and procedures, organizations can minimize the risk of fraud and ensure the integrity of their financial data.

The second part of the document provides a detailed overview of the accounting cycle, from identifying transactions to preparing financial statements. It outlines the steps involved in recording transactions, adjusting entries, and closing the books. This process is essential for determining the true financial position of the organization at any given time.

Furthermore, it discusses the various methods used to value assets and liabilities, such as historical cost, fair value, and liquidation value. Each method has its own advantages and disadvantages, and the choice of method depends on the nature of the assets and liabilities being measured.

Finally, the document touches upon the role of management in overseeing the financial operations of the organization. It stresses that management should be actively involved in monitoring financial performance and making informed decisions based on accurate and timely financial information.

2. Stringers.
3. Intermediate floor-beams.
4. End floor-beams.
5. Main girders, including web and flange splices.
6. Lateral bracing.
7. End bearings.

DESIGN OF TIES.

The specifications affecting the design of the ties are numbers 103, 109, 202, 203, 204 and 301. The ties rest directly on the stringers, the live load being applied at the base of the rails, which, for standard gage railroads, are approximately 5 ft.-0 in. center to center. The dead load of the ties and rails is considered as concentrated at the rails in order to simplify the computations. The maximum axle load of 90,000 lb. is assumed to be distributed over 3 ties (Spec. 204). The total live load concentration at each rail on each tie, including 100 per cent allowance for impact, is

$$\frac{1}{3} \left(\frac{90,000}{2} \right) = 30,000 \text{ lb.}$$

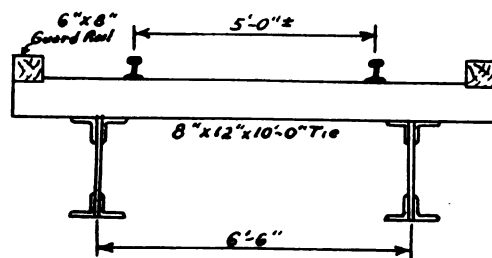


Fig. 1

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In estimating the dead load, provision must be made for the weights of the ties, the wooden guard rails at each end of the ties, and the steel rails and fastenings. The rails, guard rails and fastenings are assumed to weigh 200 lb. per lin. ft. of track and the weight of timber is assumed to be 60 lb./ft.³ The total weight per tie is assumed as 600 lb. The total bending moment on one tie is

$$30,300 \left(\frac{6.5 - 5.0}{2} \right) \times 12 = 272,500 \text{ in.-lb.}$$

The allowable extreme fiber stress is 2000 lb. per sq. in. Using the equation for flexure, $M = f \left(\frac{I}{e} \right)$, in which for rectangular sections $\frac{I}{e} = \frac{1}{6} (bh^2)$, the required product of b x h² is $bh^2 = \frac{6 \times 272,500}{2000} = 818 \text{ in.}^3$

An 8 x 12-in. tie, laid with the long dimension vertical in accordance with standard practice for bridge ties, is satisfactory. ($bh^2 = 1152 \text{ in.}^3$). The length of ties is 10 ft.-0 in. (Spec. 109).

The weight of the floor per tie is then as follows:

Tie = $\frac{8 \times 12}{144} \times 10 \times 60 =$	400 lb.
Rails, guard rails & Fastenings = <u>200</u> lb.	
Total =	600 lb.

With a clear spacing of 4 in. between ties, this is also the weight per lineal foot of the floor which will be used in the following computations.

DESIGN OF STRINGERS.

The dead weight of each stringer per lineal foot may be estimated from the equation;

$$w = \frac{k}{2} (12.5 L + 100)$$

The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

The second part of the document outlines the various methods used to collect and analyze data. It includes a detailed description of the sampling process and the statistical techniques employed to ensure the reliability of the results.

The third part of the document presents the findings of the study. It shows that there is a significant correlation between the variables being studied, which supports the hypothesis of the research.

The fourth part of the document discusses the implications of the findings and offers suggestions for future research. It highlights the need for further investigation into the underlying causes of the observed phenomena.

The fifth part of the document provides a conclusion and summarizes the key points of the study. It reiterates the importance of the research and the potential impact of the findings on the field.

The sixth part of the document includes a list of references and a list of figures and tables. It provides a comprehensive overview of the sources used in the study and the visual aids used to present the data.

The seventh part of the document contains a list of appendices and a list of footnotes. It provides additional information and details that are not included in the main text of the document.

The eighth part of the document includes a list of abbreviations and a list of symbols. It provides a key to the symbols and abbreviations used throughout the document to ensure clarity and consistency.

The ninth part of the document contains a list of acknowledgments and a list of contact information. It expresses gratitude to the individuals and organizations that supported the research and provides a way for readers to get in touch with the author.

The tenth part of the document includes a list of references and a list of figures and tables. It provides a comprehensive overview of the sources used in the study and the visual aids used to present the data.

$$w = \frac{1.22}{2} (12.5 \times 20 + 100) = 213.5 \text{ lb.}$$

The total dead load per ft. per stringer is $\frac{600}{2} + 214 = 514 \text{ lb.}$

Maximum Moment and Shear.

The dead load moment = $\frac{1}{8} \times 514 \times (20)^2 \times 12 = 308,000 \text{ in.-lb.}$

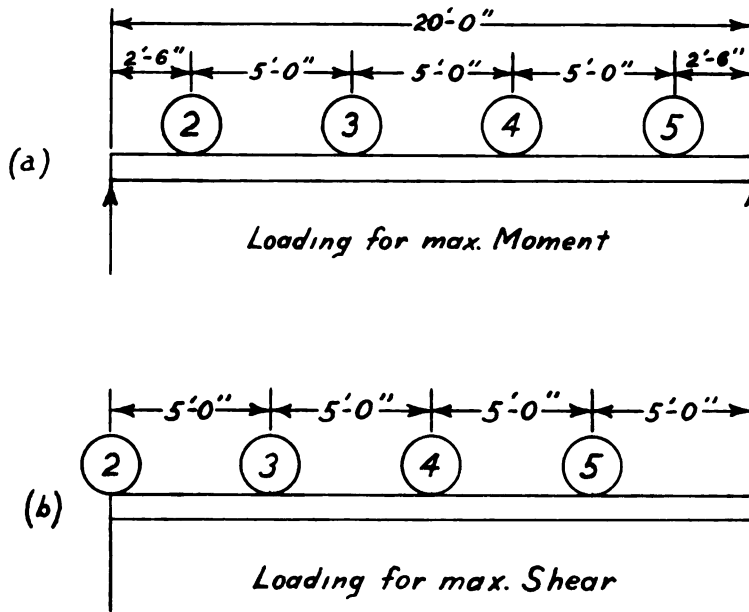


Fig. 3

The absolute maximum live load moment occurs when wheels 2, 3, 4 and 5 are on the stringer as shown in Fig. 3a.

$$\begin{aligned} \text{The live load moment} &= (72,000 \times 10 - 36,000 \times 7.5 \\ &\quad - 36,000 \times 2.5) 12 \\ &= 4,320,000 \text{ in.-lb.} \end{aligned}$$

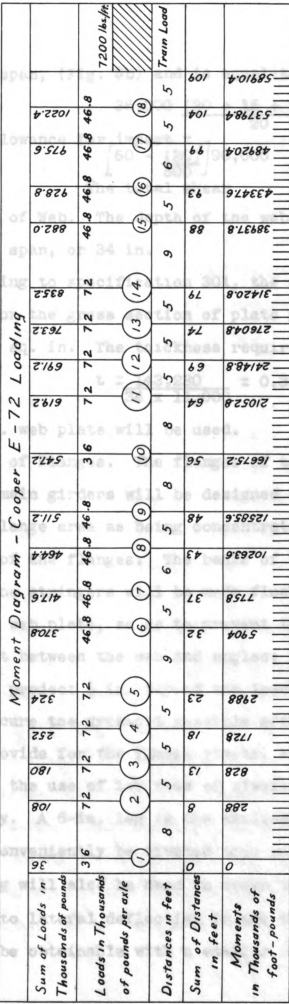
The allowance for impact =

$$\left[60 - \frac{(20)^2}{500} \right] 4,320,000 = 2,557,440 \text{ in.-lb.}$$

$$\text{The total moment} = 6,877,440 \text{ in.-lb.}$$

The maximum dead load shear = $10 \times 514 = 5140 \text{ lb.}$

The maximum live load shear occurs with wheel 2 at the



MOMENT DIAGRAM

Fig. 2

end of the span, (Fig. 3b) and is equal to

$$36,000 \frac{(20 + 15 + 10 + 5)}{20} = 90,000 \text{ lb.}$$

$$\text{The allowance for impact} = \left[60 - \frac{(20)^2}{500} \right] 90,000 = \underline{53,280} \text{ lb.}$$

$$\text{The total shear} = 143,280 \text{ lb.}$$

Design of Web. The depth of the web will be made equal to $\frac{1}{7}$ of the span, or 34 in.

According to specification 301, the allowable unit shearing stress on the gross section of plate girder webs is 11,000 lb. per sq. in. The thickness required is

$$t = \frac{143,280}{34 \times 11,000} = 0.383 \text{ in.}$$

A 34 x $\frac{1}{2}$ -in. web plate will be used.

Design of Flanges. The flanges of the stringers, floor-beams, and main girders will be designed assuming the total effective flange area as being concentrated at the centers of gravity of the flanges. The backs of the top flange angles of the stringers will be made flush with the upper edge of the web plate, so as to prevent the formation of a water pocket between the web and angles; the bottom flange angles will project $\frac{1}{4}$ in. beyond the lower edge of the web plate to secure the greatest possible effective depth. In order to provide for the flange rivets, a vertical leg which will permit the use of two rows of rivets will undoubtedly be necessary. A 6-in. leg is the smallest standard size which may conveniently be riveted this way. A 6-in. outstanding leg will also be used in order to secure greater resistance to lateral deflection in the compression flange than would be obtainable with a smaller angle. According

The first part of the document discusses the importance of maintaining accurate records of all transactions. This includes not only sales and purchases but also the flow of cash and the collection of receivables. It is essential to ensure that all entries are supported by proper documentation, such as invoices and receipts, to avoid any discrepancies or errors.

In addition, the document highlights the need for regular reconciliation of the accounts. This process involves comparing the internal records with the bank statements and other external sources to identify any differences. By doing so, the company can quickly detect and correct any mistakes, ensuring that the financial statements are accurate and reliable.

Furthermore, the document emphasizes the importance of maintaining a clear and organized system for recording transactions. This can be achieved by using a consistent set of accounting principles and a well-defined chart of accounts. By doing so, the company can ensure that all transactions are recorded in a uniform and understandable manner, making it easier to analyze and interpret the financial data.

The second part of the document discusses the various methods used to record transactions. One common method is the double-entry system, which requires that every transaction be recorded in two accounts, one as a debit and one as a credit. This system helps to ensure that the accounting equation remains balanced and provides a clear picture of the company's financial position.

Another method discussed is the use of journals and ledgers. Journals are used to record transactions in chronological order, while ledgers are used to summarize the transactions and calculate the balances for each account. This method allows for a detailed and systematic recording of all financial activities, making it easier to track and analyze the company's performance over time.

The document also touches upon the importance of using appropriate accounting software and tools. Modern accounting systems can automate many of the manual tasks involved in recording transactions, such as calculating totals and generating reports. This not only saves time and reduces the risk of human error but also provides more accurate and timely financial information to the management.

Finally, the document concludes by emphasizing the role of the accounting department in providing valuable insights into the company's financial health. By maintaining accurate records and using effective recording methods, the accounting team can help management make informed decisions and identify areas for improvement. This is a key function of the accounting department and is essential for the long-term success of the organization.

to specification 406, the minimum thickness of a 6 x 6-in. flange angle that may be used is $\frac{1}{10} \times 6$, or 0.6 in. If allowance is made for the thickness of the angle, this value may be reduced to $\frac{9}{16}$ in. Angles 6 x 6 x $\frac{9}{16}$ -in. will be assumed.

The center of gravity of each flange is 1.71 in. from the backs of the angles. The effective depth is then $34.25 - 2 \times 1.71 = 30.8$ in. The maximum flange stress is $6,877,440 - 30.8 = 223,500$ lb., and the required net flange area is $223,500 - 18,000 = 12.4$ sq. in. Since $\frac{1}{8}$ of the gross section of the web ($\frac{1}{8} \times 34 \times \frac{7}{16} = 1.86$ sq. in.) is considered effective in resisting bending stresses, the lower flange angles must furnish a net area of $12.4 - 1.86 = 10.54$ sq. in.

Assuming that the rivet pitch near the point of maximum moment is equal to or greater than 4 in., according to spec. 409 only one rivet hole need be deducted from the gross section of each angle. The net section furnished by the assumed angles is $2(6.43 - 1 \times \frac{9}{16}) = 11.74$ sq. in.

The allowable unit stress in the compression flange (Spec. 301) is $18,000 - \frac{5(20 \times 12)^2}{(12,44)^2} = 16,140$ lb. per sq. in. The gross area required in the angles is

$$\frac{6,877,440}{30.8 \times 16,140} - 1.86 = 11.97 \text{ sq. in.}$$

The gross area furnished is 12.86 sq. in., and the same angles are satisfactory for both flanges.

Rivet Spacing. The smallest rivet pitch is required at the ends of the stringers, at which points the shear is a maximum. Since the top flange supports a direct vertical load, the stress in the rivets due to this load must be con-

sidered in addition to that caused by the horizontal shear. In order to simplify the shop work, the rivets in the lower flange will be spaced the same as those in the upper flange.

In determining the vertical load on the rivets, the weight of one of the heavy drivers, plus 100 per cent allowance for impact, is assumed to be distributed over 3 ft. of flange (Spec. 428). The vertical load per lin. ft. , per stringer is as follows:

$$\begin{aligned} \text{Dead load} &= 514 \\ \text{Live load} &= \frac{36,000}{3} = 12,000 \\ \text{Impact} &= \underline{12,000} \\ \text{Total} &= 24,514 \text{ lb.} \end{aligned}$$

The vertical load per linear inch, is

$$w = \frac{24,514}{12} = 2040 \text{ lb.}$$

The total horizontal increment of flange stress per linear inch is equal to the shear, 143,280 lb., divided by the effective depth, 30.8 in. Since part of this stress is resisted by the web itself, the amount that must be transmitted to the rivets is reduced in proportion to the ratio of areas involved; therefore

$$\text{H.I.} = \frac{143,280}{30.8} \times \frac{12.86}{12.86 - 1.86} = 4060 \text{ lb.}$$

The resultant increment is

$$\text{R.I.} = \sqrt{(4060)^2 - (2040)^2} = 4540 \text{ lb. per lin. in.}$$

The strength of one rivet is governed by the bearing value on the $\frac{7}{16}$ -in. web plate, and is equal to 11,800 lb.

with the 27,000 lb. unit stress allowed by spec. 301. The maximum allowable pitch at the ends of the stringer is then $11,800/4540 = 2.6$ in. $2\frac{1}{2}$ in. will be used. Since the two gage lines in the 6-in. leg are $2\frac{1}{2}$ in. apart, the actual distance center to center of the rivets is 3.36 in., which satisfies the requirements of spec. 414.

In a similar manner the maximum allowable pitches at the quarter point and at the middle point of the span are computed. The maximum live load shears at the center occurs with the alternate load.

Quarter point.

$$\text{Total shear} = \left(\frac{15}{20} + \frac{10}{20} + \frac{5}{20}\right) \frac{72,000}{2} - 514 \times 5 = 51,430 \text{ lb. per stringer}$$

$$\text{Load per ft.} = 514 + \left(\frac{36,000}{3}\right) 2 = 24,514 \text{ lb.}$$

$$w = \frac{24,514}{12} = 2040 \text{ lb./in.}$$

$$\text{H.I.} = \frac{51,430}{30.8} \times \frac{12.86}{12.86 - 1.86} = 1457 \text{ lb.}$$

$$\text{R.I.} = \sqrt{(2040)^2 + (1457)^2} = 2500 \text{ lb. per lin. in.}$$

$$\text{Max. pitch} = \frac{11,800}{2500} = 4.7 \text{ in.}$$

Middle point.

$$\text{Total shear} = \left(\frac{10}{20} + \frac{3}{20}\right) \times \frac{90,000}{2} - 514 \times 10 = 24,110 \text{ lb. per stringer}$$

$$\text{Load per ft.} = 514 + \left(\frac{45,000}{3}\right) 2 = 30,514 \text{ lb.}$$

$$w = \frac{30,514}{12} = 2540 \text{ lb./in.}$$

$$\text{H.I.} = \frac{24,110}{30.8} \times \frac{12.86}{12.86 - 1.86} = 683 \text{ lb.}$$

$$\text{R.I.} = \sqrt{(2540)^2 - (683)^2} = 2630 \text{ lb.}$$

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$$\text{Max. pitch} = \frac{11,800}{2630} = 4.5 \text{ in.}$$

From the above, the pitch is selected as 4.5 in. over the center half of the stringer span.

Connection to floor-beam. The stringers will be connected to the floor-beams at either end by means of a pair of angles, one leg of each connection angle being riveted to the web of the stringer and the other leg riveted to the web of the floor-beam. Shop rivets are used in the web of the stringer and field rivets in that of the floor-beam. The latter rivets are power driven, however, so that the same unit values are used as for the shop rivets. The minimum size connection angle, according to spec. 425 is 4 x 4 x $\frac{1}{2}$ in.

The number of rivets which must pass through the stringer web is governed by the bearing value on the web.

$$\frac{143,280}{11,800} = 13 \text{ rivets are required}$$

Of these, a sufficient number must be placed through the angles to prevent failure of the rivets in double shear.

$$\frac{143,280}{16,200} = 9 \text{ rivets}$$

Theoretically, those rivets which pass through the flange angles should not be considered effective in the end connection as they are already stressed in transferring the horizontal shear from the flange to the web. Since the entire end connection serves to stiffen the stringer at this point, however, it may be considered as safe practice to count one-half of these rivets as available for the end connection.

• Stressors and Stressors

• Stressors are environmental factors that trigger a stress response.
• Stressors can be physical (e.g., noise, temperature, light) or psychological (e.g., work pressure, social isolation).
• Stressors can be acute (short-term) or chronic (long-term).
• Stressors can be positive (e.g., excitement, challenge) or negative (e.g., fear, anxiety).
• Stressors can be controllable or uncontrollable.
• Stressors can be predictable or unpredictable.
• Stressors can be specific or general.
• Stressors can be direct or indirect.
• Stressors can be acute or chronic.
• Stressors can be physical or psychological.
• Stressors can be positive or negative.
• Stressors can be controllable or uncontrollable.
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• Stressors can be specific or general.

• Stressors can be direct or indirect.

• Stressors can be acute or chronic.

With this number of rivets required, it will be necessary to place them in two rows. Thus the connection angle size will be increased to 6 x 6 x $\frac{1}{2}$ in. to satisfy spec. 413. The detail shown in Fig. 4 furnishes 9 rivets in double shear and 13 in bearing on the stringer web, 4 of the latter being in the filler plates outside of the angles. The actual spacing of the double-shear rivets is 3 -in. center to center, which is permitted by spec. 413.

The number of rivets required in the outstanding legs of the connection angles must be sufficient to provide for the maximum stringer reaction in single shear, or for the maximum floor-beam reaction (which provides for the maximum simultaneous loads on two adjacent stringers) in bearing on the floor-beam web. The latter number cannot be determined until the floor-beam is designed. The number required in single shear is

$$143,280/8,100 = 18 \text{ rivets}$$

Nine rivets will be placed in each angle, unless the number required for bearing on the floor-beam web necessitates an increase. This will be investigated at the end of the floor-beam design. These rivets cannot be spaced finally until the position of the angles with respect to the floor-beam is fixed. The complete stringer detail is shown in Fig. 4.

Computed Weight. Before proceeding with the design of the remaining parts of the bridge, the actual weight of one stringer will be determined in order to check the value which was previously assumed. In determining the finished

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance with a desired state or goal. For example, a manager might notice that sales are declining or that customer satisfaction is low. Once a problem is identified, the next step is to define it more precisely. This involves determining the scope of the problem, its causes, and its effects. A clear definition of the problem is essential for developing an effective solution.

2. The second step is to gather information about the problem. This can be done through various methods, such as interviews, surveys, and data analysis. The goal is to understand the underlying causes of the problem and to identify any constraints or resources that may affect the solution. For example, a manager might conduct interviews with employees to learn about their perceptions of the problem or analyze sales data to identify trends and patterns.

3. The third step is to generate potential solutions. This involves brainstorming ideas and evaluating them based on their feasibility and effectiveness. It is important to consider a wide range of options and to evaluate them based on their potential to address the problem. For example, a manager might brainstorm ideas such as increasing marketing efforts, improving customer service, or reducing prices, and then evaluate each idea based on its potential to increase sales and customer satisfaction.

4. The fourth step is to select a solution. This involves choosing the most promising solution based on the information gathered in the previous steps. The selected solution should be one that is feasible, effective, and aligned with the organization's goals and resources. For example, a manager might choose to increase marketing efforts if it is the most promising solution for increasing sales and customer satisfaction.

5. The fifth step is to implement the solution. This involves putting the chosen solution into action and monitoring its progress. It is important to communicate the solution to all relevant stakeholders and to provide them with the necessary resources and support. For example, a manager might implement a new marketing campaign by hiring a marketing agency and allocating a budget for advertising.

6. The final step is to evaluate the results of the solution. This involves measuring the impact of the solution on the problem and comparing it to the desired state or goal. If the solution is effective, the problem should be resolved and the organization should be able to achieve its goals. If the solution is not effective, the manager may need to re-evaluate the problem and generate new potential solutions.

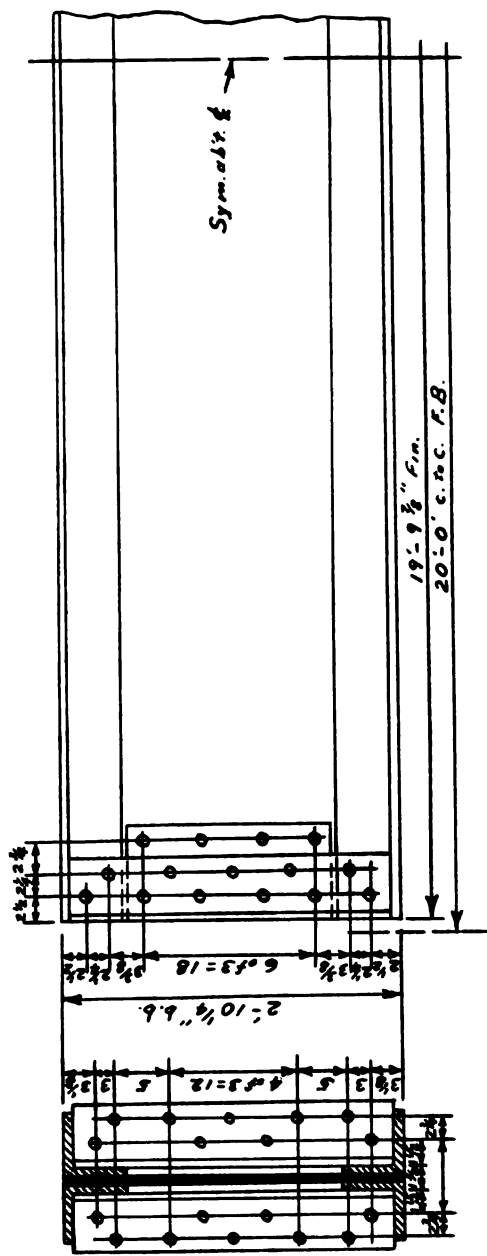


Fig. 4

length of the stringer flange angles and web, an erection clearance of $\frac{1}{16}$ in. is provided at each end; the thickness of the floor-beam web is assumed as $\frac{1}{2}$ in. and that of the floor-beam flange angles as $\frac{3}{4}$ in.

The resulting weights are as follows:

1 web plate $34 \times \frac{7}{16} \times 19$ ft.- $9\frac{7}{8}$ in. @ 51.2 #/ft.	= 1014 #
4 flange angles $6 \times 6 \times \frac{3}{4} \times 19$ ft.- $9\frac{7}{8}$ in. @ 21.9#/ft.	= 1736
4 filler plates $9 \times \frac{9}{16} \times 1$ ft.-10 in. @ 31.5 #/ft.	= 128
4 conn. angles $6 \times 6 \times \frac{1}{2} \times 2$ ft.- $9\frac{7}{8}$ in. @ 19.6#/ft.	= 216
300 rivet heads @ 21.3 #/100	= 70
Total	= 3164 #

The weight assumed was $214 \times 20 = 4280$ lb., which is acceptable.

DESIGN OF INTERMEDIATE FLOOR-BEAM.

Each intermediate floor-beam is a built-up girder, the span of which is equal to the distance center to center of the main girders, 17 ft.-2 in., and which supports two symmetrical concentrated loads (Fig. 5) spaced 6 ft.-6 in. apart, in addition to its own weight. Each of the concentrated loads is equal to the sum of the maximum simultaneous end reactions at the abutting ends of the two adjacent stringers, including the dead load, live load, and the

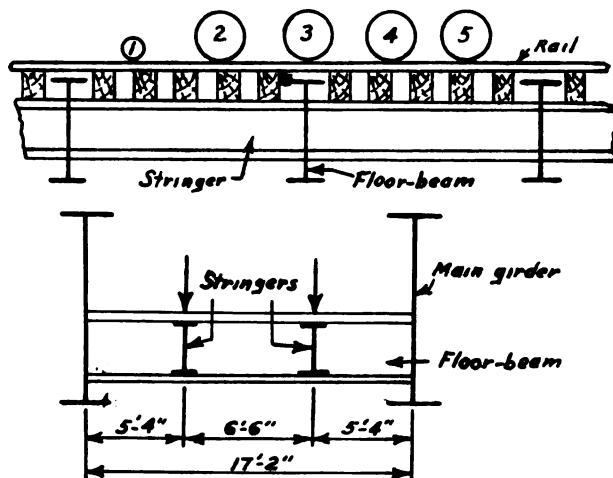


Fig. 5

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allowance for impact. The weight of the floor-beam varies with too many factors to permit of an accurate preliminary estimate, other than may be obtained by comparison with previous similar designs. Some of the influencing factors are the spacing of floor-beams, the spacing of girders, the depth of the floor-beam, the maximum thickness of metal which may be used, which effects the composition of the flanges, the class of loading, etc. A sufficiently approximate criterion of the weight, W , of one floor-beam is given by the formula

$$W = 2600 + 2Ed$$

in which E = the class of Cooper's loading

d = the distance between floor-beams in feet.

$$W = 2600 + 2 \times 72 \times 20 = 5480 \text{ lb.}$$

In order to simplify the computations for moment and shear, one-half of the weight of the floor-beam will be considered as concentrated at each stringer.

Maximum Moment and Shear. The maximum live load floor-beam reaction for the given conditions occurs when wheel 4 is placed at the middle support of two adjacent panels, wheels 1, 2, and 3 being on one span and wheels 5, 6 and 7 on the other span. The live load reaction is

$$\begin{aligned} & \frac{2}{20} \times 18 + \frac{10}{20} \times 36 + \frac{15}{20} \times 36 + 36 + \frac{15}{20} \times 36 + \frac{6}{20} \times 23.4 \\ & + \frac{1}{20} \times 23.4 = 118,000 \text{ lb.} \end{aligned}$$

The allowance for impact, assuming the loaded length to be 2 panel lengths is

1. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting two heads)

2. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting two tails)

3. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting one head and one tail)

4. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting one tail and one head)

5. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting one head and one tail)

6. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting one tail and one head)

7. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting one head and one tail)

8. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (Probability of getting one tail and one head)

Total probability = $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = 2$

Therefore, the probability of getting two heads is $\frac{1}{4}$.

The probability of getting two tails is $\frac{1}{4}$.

The probability of getting one head and one tail is $\frac{1}{4}$.

The probability of getting one tail and one head is $\frac{1}{4}$.

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$$\left[60 - \frac{(40)^2}{500} \right] 118,000 = 67,000 \text{ lb.}$$

The dead load concentration is $3164 + 20 \times 300 = 9164$ lb., and the total maximum floor-beam load from the stringers is $118,000 + 67,000 + 9164 = 194,164$ lb.

Assuming the weight of the floor-beam as 5480 lb., the total concentrated load at each stringer connection is

$$194,164 + \frac{5480}{2} = 196,904 \text{ lb.}$$

The maximum moment = $196,904 \times \frac{17.17 - 6.5}{2} \times 12 = 12,600,000$ in.-lb.

The maximum shear = 196,904 lb.

Design of Web.

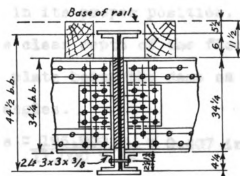


Fig. 6

The depth of web must be selected with due consideration for the connection of the stringer. The angles of both the upper and lower flanges project $\frac{1}{4}$ in. beyond the edges of the web plate, so as to provide for the proper placing of the cover plates (assuming that such are necessary).

As shown in Fig. 6, the depth of the floor-beam web is 10 in. greater than that of the stringer. The upper surface of the top flange angle of the stringer is made flush

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In addition, the document outlines the process for handling discrepancies. If there is a difference between the recorded amount and the actual amount received or paid, it is crucial to investigate the cause immediately. This could be due to a clerical error, a missing receipt, or a misunderstanding of the terms of a transaction.

The second part of the document provides a detailed breakdown of the accounting cycle. It lists the eight steps involved in the process, from identifying the accounting entity to preparing financial statements. Each step is explained in detail, including the necessary documents and the specific actions that must be taken.

Finally, the document concludes with a summary of the key points discussed. It reiterates the importance of accuracy, transparency, and thorough documentation in all accounting activities. It also provides contact information for further assistance and support.

The following section details the specific procedures for recording transactions. It includes instructions on how to properly format entries, how to handle complex transactions, and how to ensure that all entries are balanced. The document also provides examples of common transactions and how they should be recorded.

Furthermore, the document discusses the importance of regular reconciliations. It explains how to perform a bank reconciliation and how to identify and correct any errors. This process is essential for ensuring that the accounting records are accurate and up-to-date.

The document also covers the process of closing the books at the end of each accounting period. It outlines the steps for calculating the net income or loss, preparing the financial statements, and archiving the records. This process is critical for providing a clear and accurate picture of the company's financial performance.

In conclusion, this document serves as a comprehensive guide for anyone involved in accounting. It provides the necessary information and instructions to ensure that all transactions are recorded accurately and transparently. By following the guidelines outlined in this document, you can ensure that your accounting records are reliable and trustworthy.

with the lower edge of the top flange angle of the floor-beam. With the 12-in. ties notched $\frac{1}{2}$ in., a clearance of $2\frac{3}{4}$ -in. ($4\frac{1}{8}$ to top of rivet heads) is provided between the base of the rail and the uppermost surface of the floor-beam. This clearance is based on the assumption that a 6-in. vertical leg will be necessary for proper riveting, and that one $\frac{3}{4}$ -in. cover plate will be sufficient to provide for the flange stresses in the floor-beam. The lower surface of the bottom flange angle of the stringer is so located with the arrangement indicated above, that a 3 x 3 x -in. erection angle may be riveted to the lower gage line of the 6-in. floor-beam angle and at the same time support the stringer in its proper position. A filler plate is placed in the clear depth of the floor-beam web, the thickness of this plate being the same as that of the floor-beam flange angles.

$$\text{Web thickness} = \frac{196,900}{11,000 \times 44} = 0.407 \text{ in.}$$

Since the commercial thicknesses are multiples of $\frac{1}{16}$ in., a $\frac{7}{16}$ -in. web is selected.

Design of Flanges. In the preliminary investigation, the effective depth is assumed to be $2\frac{1}{2}$ in. less than the distance back to back of flange angles, or 42 in. The maximum flange stress is

$$\frac{12,600,000}{42} = 300,000 \text{ lb.}$$

and the total effective net flange area required is

$$\frac{300,000}{18,000} = 16.67 \text{ sq. in.}$$

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance with a desired state or goal. For example, a manager might notice that sales are declining or that customer satisfaction is low. Once a problem is identified, the next step is to define it more precisely. This involves determining the scope of the problem, its causes, and its effects. For instance, a manager might define a problem as "a 10% decrease in sales over the last quarter, primarily due to a loss of market share in the competitive market." The third step is to analyze the problem. This involves gathering data, identifying key factors, and determining the underlying causes. For example, a manager might analyze sales data to identify trends, compare performance with competitors, and identify areas where the company is losing market share. The fourth step is to generate potential solutions. This involves brainstorming ideas and evaluating them based on their feasibility, effectiveness, and cost. For instance, a manager might generate several potential solutions, such as increasing marketing efforts, improving product quality, or offering discounts to customers. The fifth step is to select a solution. This involves evaluating the potential solutions and choosing the one that is most likely to be effective and feasible. For example, a manager might select a solution based on its potential to increase sales, improve customer satisfaction, and reduce costs. The final step is to implement the solution. This involves putting the chosen solution into action and monitoring its progress. For instance, a manager might implement a solution by increasing marketing efforts, improving product quality, or offering discounts to customers. Once the solution is implemented, the manager should monitor its progress and evaluate its effectiveness. If the solution is not working, the manager should be prepared to make adjustments or try a different solution.

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Flange elements must furnish $16.67 - \frac{1}{8} \times 42 \times \frac{7}{16} = 14.37$ sq. in.

A rivet pitch of $2\frac{1}{2}$ in. in the flange angles is assumed, thus requiring 1 rivet holes to be deducted from each vertical leg. A total of $4\frac{3}{4}$ holes must be deducted from the two angles and a total of two holes from each cover plate. The former number may have to be revised when the exact rivet pitch is known.

The flange section assumed is:

Section	Total gross area, sq. in.	Total No. of rivet holes	Total area of rivet holes, sq. in.	Total net area, sq. in.
2 Ls $6 \times 4 \times \frac{3}{4}$	13.88	4 $\frac{3}{4}$	3.56	10.32
1 Cover Pl. $10 \times \frac{5}{8}$	6.25	2	1.50	4.75
Total	21.38	15.07

The true effective depth may now be determined. The distance from the backs of the angles to the center of gravity of the flange section, using gross areas, is

$$\bar{x} = \frac{13.88 \times 2.08 - 6.25 \times 0.312}{13.88 + 6.25} = 1.34 \text{ in.}$$

And the effective depth of the floor-beam is

$$h = 44.5 - 2 \times 1.34 = 41.82 \text{ in.}$$

The revised required net section of the flange elements is

$$\frac{12,600,000}{18,000 \times 41.82} \times 2.3 = 14.43 \text{ sq. in.}$$

The same section will be used for the compression flange.

Pitch of Rivets.

$$H.I. = \frac{196,900}{41.82} \times \frac{20.13}{20.13 + 2.3} = 4225 \text{ lb. per in.}$$

The strength of one rivet is governed by the bearing value on the $\frac{1}{2}$ -in. web plate, 11,800 lb. The maximum pitch is

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$$p = \frac{11,800}{4225} = 2.79 \text{ in.}$$

A value of $2\frac{3}{4}$ in. will be used from the supports to the stringer connections. This is a greater pitch than the value assumed in computing net flange area and no revision of design is necessary. Since the shear at any section between the stringers is practically zero, the maximum pitch allowed by specifications, 7 in., will be used in this portion of the floor-beam.

The required pitch in the cover plates is

$$(\text{H.I.})' = \frac{196,900}{41.82} \times \frac{6.25}{20.13 + 2.3} = 1310 \text{ lb. per in.}$$

$$p' = \frac{8100}{1310} = 6.2 \text{ in.}$$

Since two cover plate rivets are placed in the same cross-section, this value of p' may be doubled for the pair of rivets. According to spec. 413, however, the maximum allowable pitch is 6.5 in., which governs in this case.

Connection to Main Girders. The end connection of the floor-beam will consist of a pair of 6 x 6 x $\frac{1}{2}$ -in. angles, riveted to the floor-beam and to the main girders in a manner similar to that used in fastening the stringers to the floor-beams. The number of shop rivets required in bearing on the $\frac{7}{8}$ -in. web plate is $196,900/10,350 = 19$; the number required in double shear is $196,900/16,200 = 13$; and the number of field rivets (power driven) required in single shear through the web of the main girder is $196,900/8100 = 25$.

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Computed Weight. Assuming a $\frac{1}{2}$ -in. girder web, and $\frac{3}{4}$ -in. girder flange angles, and allowing $\frac{1}{2}$ -in. erection clearance at either end, the actual finished length of the floor-beam is 19ft.-10 in. The weight of one floor-beam is as follows:

1 web plate $42 \times \frac{7}{16} \times 19$ ft.-10 in. @ 63.1#/ft.	= 1250 lb.
4 flange \angle s, $6 \times 4 \times \frac{3}{4} \times 19$ ft.-10 in. @ 23.6#/ft.	= 1820
2 cover plates $10 \times \frac{5}{8} \times 19$ ft.-10 in. @ 21.5#/ft.	= 850
4 filler plates $9 \times \frac{3}{4} \times 2$ ft.-10 in. @ 23.0#/ft.	= 260
4 conn. $6 \times 6 \times \frac{5}{8} \times 3$ ft.- $8\frac{7}{8}$ in. @ 24.2#/ft.	= 360
4 filler plates $20 \times \frac{3}{4} \times 2$ ft.-10 in. @ 51.0#/ft.	= 580
800 rivet heads @ 21.3#/100	= 170
4 erection \angle $5 \times 3 \times \frac{3}{8} \times 1$ ft.-1 in. @ 9.8#/ft.	= <u>40</u>
Total	5330 lb.

The assumed weight was 5480 lb., so no revision is necessary.

Time does not permit the completion of the design, but the procedure for designing the end floor-beams and main girders is similar to that used for the stringers and intermediate floor-beams.

1. The first part of the document discusses the importance of maintaining accurate records in a business setting. It highlights how proper record-keeping can help in decision-making and provide a clear history of operations.

2. The second part focuses on the legal implications of record-keeping. It explains that businesses must adhere to various regulations and standards to ensure their records are valid and accessible when needed.

3. The third part addresses the challenges of record-keeping, such as data security and storage costs. It offers practical solutions and best practices to overcome these obstacles.

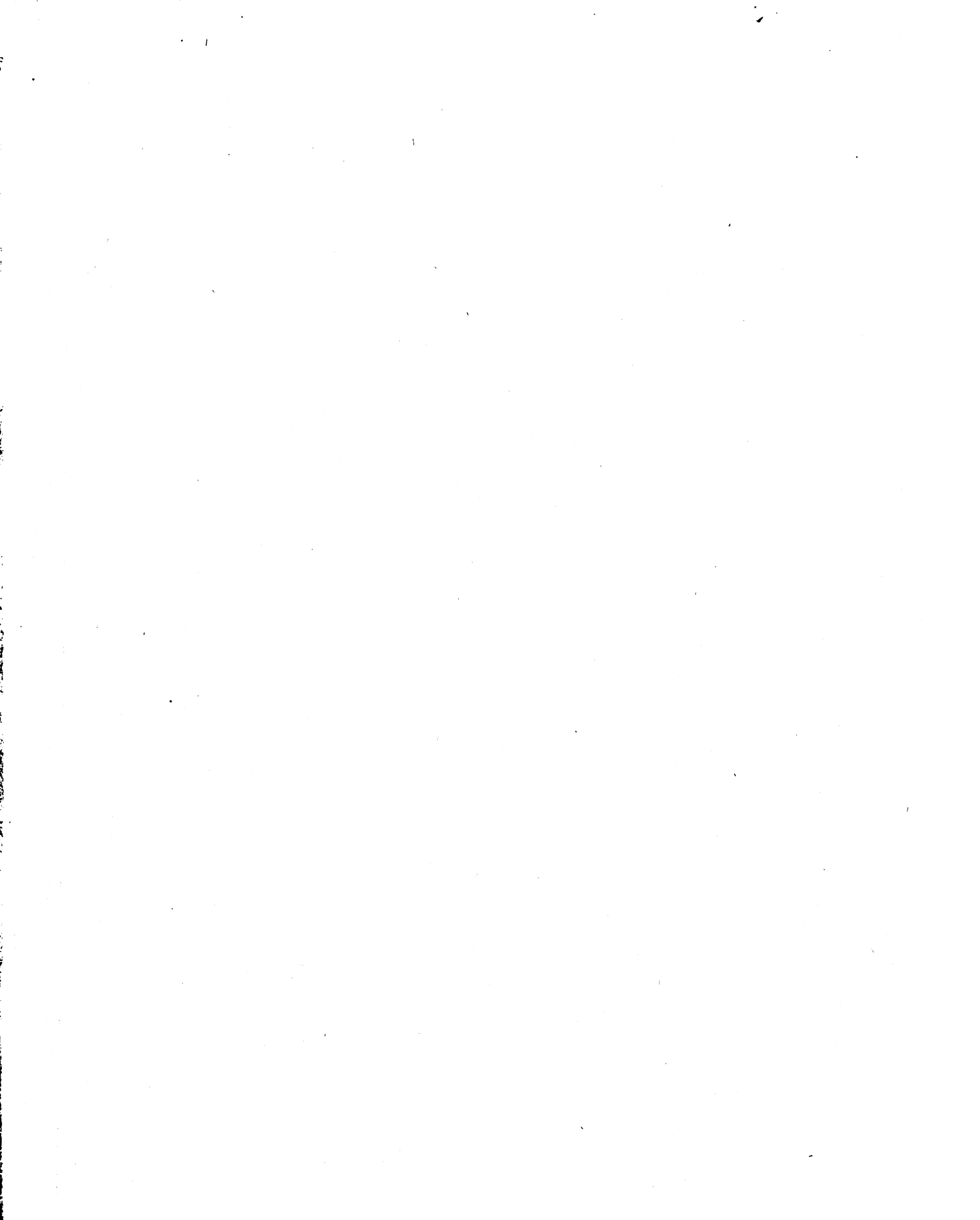
4. The fourth part discusses the role of technology in modern record-keeping. It explores how digital tools and software can streamline the process and reduce the risk of human error.

5. The fifth part covers the importance of training and education for staff involved in record-keeping. It emphasizes that well-trained personnel are essential for maintaining high standards of accuracy and compliance.

6. The sixth part provides a summary of key points and offers final thoughts on the overall importance of record-keeping for long-term business success.

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