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Sustainable Practices in Canal Water Irrigation

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ABSTRACT: A canal is an artificial channel that is constructed to carry water to the fields to perform irrigation. The water is taken either from the river, tank or reservoirs. The canals can be constructed either by means of concrete, stone, brick or any sort of flexible membrane which solves the durability issues like seepage and erosion.

KEYWORDS-canal,irrigation,reservoirs,seepage,erosion

I. INTRODUCTION

The canal alignment is selected based on the following considerations:

1. Canal alignment must be chosen such that the maximum area is served with the least length. It also must minimize the use of cross-drainage works.
2. If the length of the canal is short, there is less head loss, seepage loss, and evaporation loss. This also brings additional areas for irrigation.
3. Following a straight alignment helps to reduce the loss.
4. Always a canal alignment with less cross-drainage work must be chosen.
5. The canal must not pass through forest, town, village or costly areas reducing the chance of giving heavy compensation.
6. Among different canals, ridge canals help to irrigate either side of the canal.
7. It must help reduce heavy cutting and filling i.e costly embankment construction must be avoided.
8. It is recommended to attain a balance in depth of cutting and depth of filling.
9. The selection of alignment over brackish, rocky or cracked strata must be avoided.[1,2,3]

Curves in Canals

It is always recommended to align the canals without curves. Curves result in disturbance of flow. This scours the outer side of the canals and results in silting in the inner curves.

In order to avoid, scouring in the concave side, it is required to provided pitching. The canal curves must be more gentle and posses more radius in order to take large discharges.

Advantages of Canal Irrigation

The main advantages of canal irrigation are:

1. Development of un-irrigated wasteland.
2. Dangerous droughts can be avoided that expedite economic development.
3. The water requirement of crops during fluctuation in rainfall intensity can be met by having a proper irrigation system.

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4. Compared to conventional watering, higher productivity per hectare land is obtained due to canals.
5. The canals constructed are permanent that require regular maintenance.
6. Canal irrigation does not let the water table level go down. It only helps to increase the water level thus facilitating the digging of wells.
7. Canals also serve the purpose of hydroelectricity, drinking water supply, fishery development, and navigation.

Disadvantages of Canal Irrigation[4,5,6]

The major disadvantages of canal irrigation are:

1. Any imbalance in the water distribution process results in a scarcity of water in some areas and water clogging in other areas. This hence makes the soil unproductive due to the movement of harmful underground salts and alkalies to the surface level.
2. Water present stationary in the canal results in the growth of worms, mosquitoes, and insects.
3. Improper maintenance results in the collection of sediments in the canals that in turn affects the capacity of the canal.
4. Canal construction demands economic investment and time. Hence, this is not a solution for all irrigation

To ensure that the agricultural fields get an adequate amount of water flow, the canals have been constructed with the appropriate breadth and depth. From the place where the water is drawn, it will be dispersed throughout the various agricultural areas in the appropriate way.

Controlling the flow of water from its source to the agricultural fields using appropriate valves is possible. As soon as the water reaches its intended location, it will be pushed into the agricultural field, either manually or automatically, depending on the circumstances. The slope of the agricultural field will have a very minor contour added to it to facilitate the natural flow of water.

Canal irrigation system: Distribution network

The water that is being carried from the place of origin will divide into many channels so that it may be delivered to all of the necessary locations. The following is an explanation of the many components that make up the canal irrigation system.

- The Main Canal

Main canals are defined as those with a discharge of 10 cumecs or more. The primary canal, or arterial canal, is the body's primary blood vessel. The main canal is the drainage system's highest-ranking canal, and it is responsible for carrying water from the other drainage canals to the water intake. The main canal is inaccessible for direct irrigation.

- Branch Canal

The typical range of discharge for branch canals is 5-10 cumecs. Each of the main canal's branches can go in either direction at regular intervals. The maximum head discharge into this canal is around 14–15 cumecs from the main canal. In addition to its primary function, a branch canal also acts as a feeder channel for larger and smaller tributaries. [7,8,9]

- Major distributary

Major distributaries are canals that receive water from the main canal or a branch canal with a head discharge of 0.028% to 15.0 cumecs. Their output is lower than that of branch canals since they sometimes draw their water supply from the main canal. Because water is piped through these channels and onto the field, they are often referred to as irrigation channels.

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- Minor Distributary

Minor distributaries are canals where the discharge was between 0.25 and 3 cumecs. Discharges of 0.25 cumecs or less from a large distributor are considered to be modest. Sometimes the branch canals will feed a small distributary. Minor distributaries have a smaller discharge than large distributaries. Furthermore, they provide water to the courses through the faucets that are installed beside them.

- Watercourse or Field Channel

In the watercourse channel, the stream discharge is less than 0.25 cumecs. A field channel can originate from a big distributary or a small one, depending on the scope of the irrigation. In a few instances, the field is additionally supplied with water from the branch canal.

The canal distribution system is comparable to how energy is transmitted from the powerhouse to your home. The quantity of water that must be transported to the agricultural regions will decide the canals' width as well as their depth.

The stream from the river will provide the main canal with a considerable volume of water. Therefore, both the width and the depth of the channel will be significant. After that, the flow will be distributed to the branch line according to the sub-branch and the distributor line, as well as to the minor lines, via the central canal. At last, we arrive at the agricultural fields.[10,11,12]

II. DISCUSSION

Types of canal irrigation systems

In canal irrigation systems, there are primarily two types of canals used.

Inundation Canals

They are extracted from rivers and do not have any kind of weir or other structure at the head of the river to control the flow of water coming out of the river. Canals similar to this may be found in the Brahmaputra valley and the plains of the Sutlej and Ganga rivers.

Perennial Canals

These canals maintain a steady flow of water throughout the year, especially during the colder winter months, and they get their water supply either from rivers or from reservoirs that are part of river project reservoirs. A weir is constructed underneath the intake of the canal, and the intake itself has sluice gates to control the flow of water.

Designing a canal irrigation system: Things to consider

The following factors will be taken into consideration while planning the path of the canal:

- The path of the canal should go through all of the farmlands so that it can supply water.
- The course of the canal, which is straight, will assist to maintain the appropriate velocity of the water flow, and it will also help to limit the amount of heat loss that occurs.
- The shorter length of the canal, which covers all of the areas that are used for agriculture, will lower the expenses of construction and the work that is required for cross drainage.
- The canal path that is shorter and more direct will lower the amount of water that is lost as a result of seepage and evaporation.
- Because it causes unneeded complications and delays in the building work, the path of the canal shouldn't be designed to pass through any forest area, villages, towns, or other settlements of any kind.
- It is recommended that you do not take the canal path that goes through the rock region.[13,14,15]
- Adding more bends to the canal is something that has to be avoided as it slows down the flow of water.
- It is important to strike a balance between digging into the soil and filling it in if you want to keep building costs down.
- Since gravity force is responsible for the movement of the water, the canal line should be planned appropriately.

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- When there is a scarcity of rain throughout the growing season, farmers will benefit from having an effective irrigation system.
- It helps to speed up the effort involved in the cultivation, and it also helps to speed up the economy.
- It contributes to a rise in the level of groundwater.
- Canals facilitate not only the production of power but also the delivery of potable water.

Canal irrigation in India

Canal irrigation is one of the most important sources of irrigation for farmlands across India. It accounts for nearly 24% of the total irrigated land in the country. This effective source of irrigation has greatly benefited deep fertile soil, low-level relief, and perennial river areas. Canal irrigation is more prevalent in the northern plains as compared to other parts of the country. One of the reasons behind the decline of the prevalence of canal irrigation in India is the heavy maintenance required to ensure efficiency. [16,17]

- Canals were the most important source of irrigation until the 1960s, when wells and tube wells surpassed them to become the second most important source of irrigation in India.
- The proportion of canal irrigation area to total irrigated area in the country has decreased from approximately 39.77 percent in 1950-51 to 29 percent in 2000-01.
- Canals can be an effective source of irrigation in areas with low level relief, deep fertile soils, a perennial source of water, and a large command area.
- As a result, the northern plains of India, particularly the states of Uttar Pradesh, Haryana, and Punjab, have a high concentration of canal irrigation.
- Canal digging in rocky and uneven terrain is difficult and expensive. As a result, canals are almost non-existent on the Peninsular plateau. However, some canals for irrigation exist in South India's coastal and delta regions.
- Canal irrigation covers approximately 15.8 million hectares. The main canal irrigated areas in India are in the northern plains, where Uttar Pradesh, Punjab, Haryana, Rajasthan, and Bihar account for roughly 60% of the country's canal irrigated area.
- Andhra Pradesh, Maharashtra, Karnataka, Madhya Pradesh, Chhattisgarh, Orissa, and Tamil Nadu are important canal irrigation states in south and central India.

III. RESULTS

Classification of Canals

Based on Nature of Supply	Permanent Canal	• A permanent canal is a type of canal that has water available all year. • This type of canal is typically directed from a permanent supply water body. • In this type of canal, several permanent hydraulic structures are built for water regulation and distribution. • A perennial canal is another name for a permanent canal.
	Inundation Canal	• An inundation canal is a type of canal in which water is only available during floods. • These canals are diverted from rivers to control the water level during floods. • To control the flow into the canal, a canal head regulator is provided.[18,19]
Based on Functions	Irrigation Canal	• An irrigation canal is a canal that is aligned along the boundaries of cultivatable areas to supply water for agricultural purposes.
	Power Canal	• A power canal is a canal built specifically for the generation of hydraulic

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		power.
	Feeder Canal	• A feeder canal, as the name implies, is built to feed two or more other canals or branch canals.
	Carrier Canal	• A carrier canal is a multi-purpose canal that serves as both an irrigation canal and a feeder canal.
	Navigation Canal	• A navigation canal is one that is built specifically for navigational purposes. • To accommodate large ships and vessels, the water level required in a navigation canal is generally much higher.
	Alluvial Canal	• An alluvial canal is one that was excavated in alluvial soils such as silt, sand, gravel, and so on.
Based on Type of Surface Soil	Non-alluvial Canal	• Non-alluvial canals have a boundary surface composed of non-alluvial soils such as loam, clay, rock, and so on.
	Rigid Surface Canal	• Non-alluvial canals include rigid surface canals, but the canal's boundary surface is lined artificially with a hard layer of lining material such as cement, concrete, stones, etc.
Based on Financial Output	Protective Canal	• Protective canals are relief projects that are built to protect a specific area from a lack of water. • The primary goal of a protective canal is to meet the needs of cultivators during times of famine.[20,21]
	Productive Canal	• Productive canals are those that generate enough revenue to cover their operating and maintenance costs as well as the initial investment made in the canal's construction.
Based on Discharge	Main Canal	• The main canal originates in a river or reservoir. • It transports a large amount of water to feed the branch and distributary canals. • It is not recommended to do direct irrigation from the main canal due to the conveyance of very high discharge.
	Branch Canal	• At regular intervals, branch canals branch off from main canals. • These canals provide water to both major and minor distributary canals. • Direct irrigation is not recommended for branch canals unless their water carrying capacity is extremely low.
	Major Distributary Canal	• The major distributary canal branches off the branch canal or, in some cases, the main canal. • They provide water to minor distributaries as well as field channels. • When the discharge of a canal ranges between 0.25 and 5 m3/sec, it is said to be a major distributary.
	Minor Distributary	• Depending on the discharge of canals, minor distributary canals branch off from major distributaries and sometimes directly from branch canals.

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	Canal	• Their discharge rate is typically less than 0.25 m3/sec. • Water is supplied to the field channels via these canals.[22,23]
	Field Canal	• Field channels, also known as watercourses, are small channels excavated in the irrigation field by cultivators. • The distributary and branch canals feed these channels via canal outlets.
	Ridge Canal	• A canal that runs along a region's ridgeline or watershed line is referred to as a ridge canal or watershed canal. • Because it runs at the area's highest point, irrigation on both sides of the canal is possible to a greater extent.
Based on Canal Alignment	Contour Canal	• A contour canal is a canal that runs roughly parallel to the area's contours. • This type of canal is common in hilly areas. • Because it runs parallel to the contour line, the ground on one side of the canal is higher, allowing irrigation only on the other side. • A contour canal must pass through the drainage, so cross drainage works are required.
	Side-slope Canal	• A side-slope canal is one that is nearly perpendicular to the contour of the area. • It is not on the ridgeline or the valley line, but rather somewhere in the middle. • Because it runs parallel to the natural drainage line, no cross drainage works are required.

Canal Administration is primarily responsible for operation and maintenance of a very well developed and widespread 14500 Kms long canal system and 5 Head Works. Total cultivable command area in Punjab is 42.90 lac hectare out of which 30.88 lac hectare has been brought under command of canals networks (In addition to pre-partition utilization of 32MAF in Shahnehar Canal System).

The total river water allocated to Punjab is 14.22 MAF which is distributed to command area through 7 main canal system namely Sirhind Canal System, Bist Doab Canal system , UBDC system , Sirhind Feeder System , Eastern Canal system, Bhakra Main line System and Shahnehar Canal System.[24,25]

The canal infrastructure which was developed in pre independence and post independence period as per details:

Canal irrigation systems in Punjab comprise of

a. Sirhind Canal system
b. Bist Doab Canal system
c. Bhakra Main Line (BML) Canal System
d. Upper Bari Doab Canal system, Kashmir Canal
e. Ferozepur Feeder/Sirhind Feeder system
f. Eastern Canal system
g. Makhu Canal System
h. Shahnehar Canal system
i. Kashmir Canal system.
j. The Rajasthan Feeder and Bikaner Canal which carry Ravi-Beas water exclusively for Rajasthan run a considerable length over Punjab Territory.

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Objectives

Water is the most essential natural resource, a basic human need and the most important input for all human development activity. The main objective of the Admn is to develop, plan, utilize and manage this important resource for irrigation in a judicious, equitable, sustainable and sound economic manner.

An Act to regulate irrigation, namely 'Northern India Canal and Drainage Act, 1873 has been enacted for this purpose.[26,27]

Projects

Rehabilitation/Remodeling of the following canals is in progress:-

a. Project for rehabilitation of Ist Patiala Feeder and Kotla Branch:-
b. Conversion of Banur canal from Non perennial to perennial
c. Rehabilitation/ Remodeling/ Construction/ Extension of 74 distributaries and Minors.

New Projects

The following projects have been submitted to Central Water Commission, New Delhi for technical appraisal.

	Estimated Cost (Rs.)
1.Relining of Rajasthan Feeder	Rs.889.95 Crore
2.Relining of Sirhind Feeder	Rs. 363.50 Crore
3.Extension, Renovation and Modernization of canals being fed from River Sutlej	
Bathinda Branch	Rs. 213.21 Crore
Abohar Branch	Rs. 187.96 Crore
Sidhwan Branch	Rs. 92.96 Crore
Bist Doab Canal system	Rs. 187.54Crore
Sub Total	Rs. 681.67 Crore
TOTAL	Rs. 1935.127 Crore

The technical appraisal is in final stage. The projects are proposed to be taken up during 2009-10 with financial assistance from Govt. of India.[28,29]

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IV. CONCLUSION

Today, canals, such as the one for Sangbast and Ghalmaran villages, allow farmers to harness rain and flood water for irrigation. They are being improved under the Irrigation Rehabilitation and Development Project (IRDP), under the Ministry of Energy and Water. With support from the World Bank and Afghanistan Reconstruction Trust Fund, the project builds upon and scales up activities supported under the completed World Bank-financed Emergency Irrigation Rehabilitation Project, closed in December 2012.

Better access to irrigation and jobs

IRDP supports rehabilitation of irrigation systems serving some 300,000 hectares of land throughout the country, as well as the design and construction of a limited number of small multi-purpose dams and related works, while establishing hydro-meteorological facilities and services. To date, under the irrigation component of this project, approximately 20,000 hectares (44 percent of the target 45,000 hectares) of incremental irrigated area have been achieved.

According to Project Manager Engineer Mirwais Ghoriani, the Sangbast village canal was successfully completed in April 2013 at a cost of little over Afghani 10 million (US$175,000).

“Our assessment revealed a drastic need for water canal development here,” says Mirwais. “With this project now implemented, farmlands are better irrigated and people have access to more job opportunities.”

Padar, a 40-year-old farmer and father of four children, cultivates various crops on one hectare of land in partnership with other farmers. He says prior to the implementation of IRDP in his village he was not willing to cultivate his land from fear of lack of water; however, now he has even succeeded convincing some friends to become his partners.

“This sub-project began last year. Prior to that, we could hardly block water overflow from the river. We would go out and work on the intake for 10 to 15 days. We also had to buy sandbags. My contribution alone was around $100,” he says.

Water in all seasons

Fazel Ahmad, 50, a farmer from Ghalmaran village, says he does not remember ever having had enough water for irrigation in the fall season in the past, especially when the old reservoir filled up with mud sedimentation. Although the old reservoir still fills up with mud, farmers are now able to irrigate their lands even during fall season following the improvement made in the canal scheme.[30,31]

“We are relieved now. All we need to do is pile up a few sandbags against the wall and the water will stay in the reservoir. Whenever water is needed, we pull up the main hatch and direct the water to whatever secondary canal system we wish,” explains Fazel. “There are a total of nine hatches in different directions. If we do not want water in a certain direction, we simply close the concerned hatch and the water stays inside.”[32]

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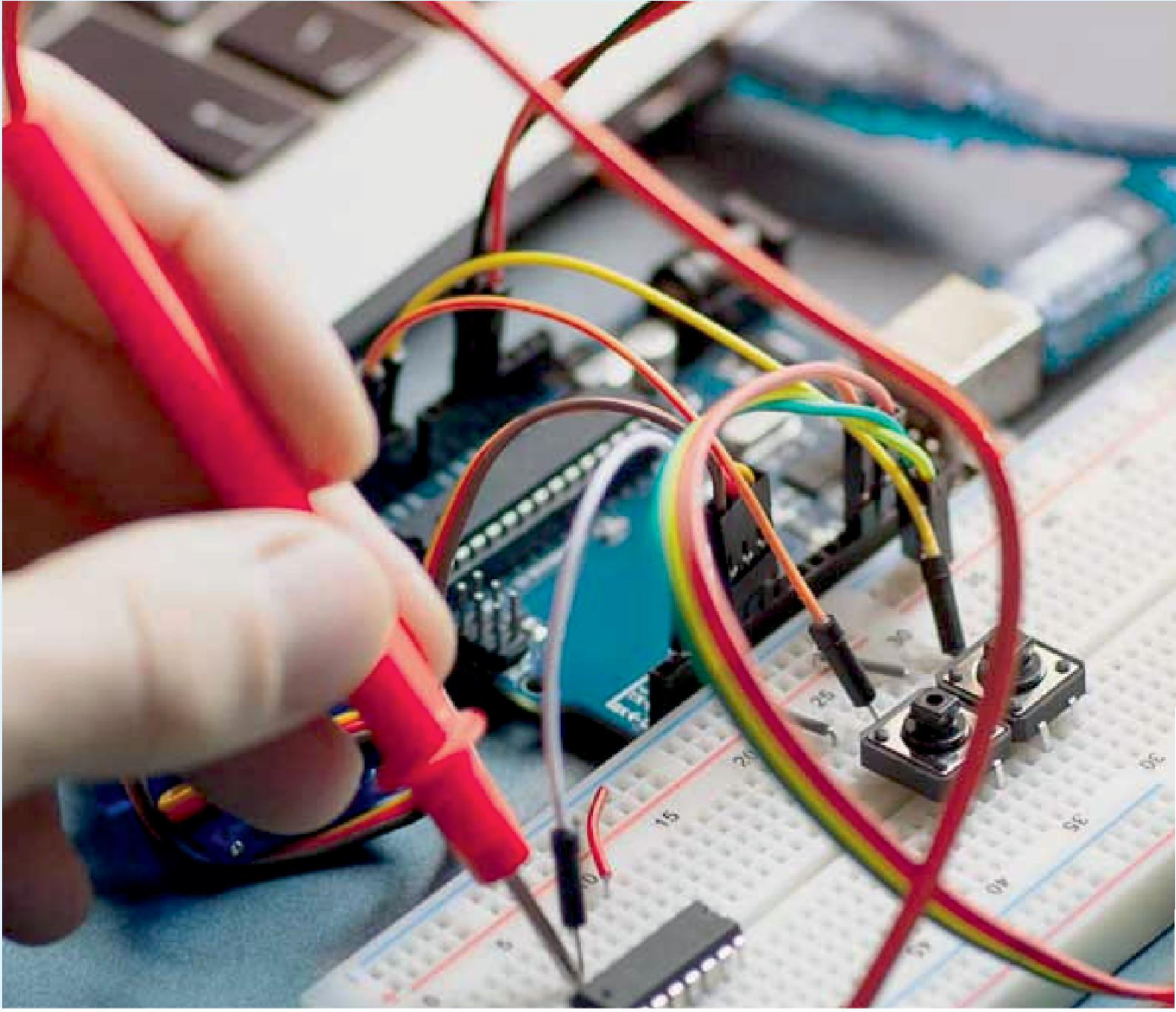

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